Vessel must be on the bearing lines (position lines) at the time of respective observations.
If the current & engine speed are steady, the ratio of distances made good between first two & last two bearings must be in ratio of time elapsed between first two & last two bearings.

In above diagram, comparing similar triangles FF'R & RR'G,
we get, $^{FR}/_{RG} = {}^{FF'}/_{RR'}$.....(1)
Comparing triangles AA'B & BB'C ,
we get, $^{AB}/_{BC} = {}^{AA'}/_{BB'}$.....(2)
But FF'/RR'= AA'/BB'. ∴ RHS of (1) = RHS of (2) ∴ LHS of (1) = LHS of (2)
Which gives FR/RG = AB/BC
Thus it may be concluded that ratio of distances steamed = ratio of time interval = ratio of distances made good.

Caution:
It is assumed that current is uniform from 1st bearing till last bearing.
It is assumed that engine rpm is steady during above observations.
FA & GC must be // to RB.
By the principle *'3 bearings of same point from different positions'* CMG direction may be found out.
Although normally it is always said that the vessel physically traverses (moves over & lies on) CMG line but CMG as found by this principle gives only CMG direction. Since the SMG is not known, we cant say that the ship lies on the CMG line, found by above principle.

Summary: After the CMG direction is found. The question may involve one of the following situations.
(1) Any one fix is given
(2) Set & rate of current both are given
(3) Only set, only rate given.
In situation (1) transfer ⟶ through the fix.
In situation (2) Place the current vector on 1st bearing line & from the end of this vector draw ⟶.
In situation (3) place ⟶ on 1st bearing line & current vector at end of ⟶.

Exercise:
Chart: Alpha to Zulu Roads:
Q.1 A ship in DR Position to the West of 'O' light steered a certain course approximately in SE direction. 'O' light bore 080°T at 1800h and at 1825h colour of light was seen to change from white to red. At 1900, colour of 'O' light changed from red to white. Find the direction of CMG.
Ans. CMG 136.5°T.
Q.1a If at 1900h, in above question 'O' light was 7.5 off , find position at 1800h. Also if the course steered was 132°T and engine speed was 7kn find set, rate of current and SMG.
Ans Position 1800h 2°15.5 N, 80° 8.4 E, SMG 8.85kn, set 156°T, rate 2 kn.
Q.2 Stranded wreck N of Zulu anchorage bore 315°T at 0900h, 282.5°T at 0915h & 240° at 0945h. If current set 156° at the rate of 1.93kn & engine speed was 9.6kn during above interval. Find Co steered, CMG & SMG, also the position of vessel at 0945h.
Ans CMG = 023.5°, Co steered = 015°, SMG = 8.13kn. Pos at 0945h 02°5.42N, 080°33.95E.

Chart: South coast of Sri Lanka:
Q.1 From a ship steering 277°T @ 12kn, Dondra Hd light was seen bearing 325°T, 358°T & 034°T at 1800h, 1830h & 1850h respectively. Find CMG, rate of current. (Given direction of set = 352°T)
Ans 288.75°, 2.7kn.
Q.2 Barberyn light was seen at following bearings: 119°T at 1900h, 074°T at 1940h & 050°T at 2010h, while steering 175°T, speed 12.6kn. If current set 230°T. Find rate of current, SMG & pos at 2010h..
Ans: 3.6kn, CMG, 186°T, pos 6°16.7'N 079°45'E.

Q.3 From a ship steering a steady Co at steady speed, Dondra head appeared on following bearings: 030°T at 1100h, 000°T at 1125h & 330°T at 1200h. If Dondra Head light was 14M off at the time of third bearing, find Co steered & speed steamed. (Given: current 165°T x 3kn)
Ans: CMG 105.5°T, Co steered 092°T, 11.15kn.
Q.4 A vessel steaming a steady Co and speed, found Colombo light to bear as follows:
0900h 125°C
0920h 105°C, while in transit with Welikada Lt house.
1000h 031.5°C.
If nearest distance from Colombo Lt, during above passage was 5.35M, find position of vessel at 1000h.
Ans. Compass error 3.5°E. CMG = 162°. Pos at 1000h ≡ 06°50.4N 079°46.3'E.
Q.5 A vessel while steering 226°T @ 11kn found Great Basses Rf light to bear 274.5°T, 307°T & 003°T at 0800h, 0835h & 0920h respectively. If current in the area was known to set 291°T, find CMG,SMG & rate of current.
Ans. CMG = 235°T, SMG = 12 kn. Rate of drift = 2.1kn.
Q.5a In above example, find bearing & dist of G.B.Reef Lt, & time when abeam.
Ans. 316°T x 8.05M at 0842.5h.
Q.6 While steering a Co of 212°T, Little Basses Reef Lt bore 248° at 2000h. At 2030h it bore 287°T & at 2115h same light bore 009°T, at same time Great Basses Reef light bore 256°T. Find pos at 2000h, CMG & SMG. (June,94 2nd Mate FG)
Ans: Pos 06°28.4'N 081°53.5'E. CMG 219°T SMG 14.4kn.

More Questions on 'Alpha to Zulu Roads' chart

Q.1 A vessel steering a course of 125°T at steady speed found 'B' lighthouse to bear as follows: 1700 hours 55.5°T, 1720 hours 023°T & 1750 hours 340.5°T. Current set 070°T at the rate of 2.4 knots. Find the CMG speed over water, position at 1700 hours and 1750 hours.
Ans. CMG = 115°T, SOW = 9.6 knots. Position at 1700 hours 02° 18.2'N 0.80 1.6'E
1750 hours 02° 14.3'N 080°10.1'E
Q.2 Following bearings of 'X' light were observed by a ship steaming at 13 knots steering 323° T, While the current set Easterly.
1800h 250°T, 1820h 224.6°T, 1855h 192.5°T
Find position of ship at 1855 hours, CMG and rate of drift. From the position at 1855h find a course to steer in order to find 'S' buoy at 1.5 miles on port side when closest.
Ans. CMG 329.5°T Rate of drift 1.75 knots Co to steer = 285°T

Q.3 140m peak to the East of W beacon was in transit with sea view point at 1000 h. It was in transit with Brother's point at 1030h and with stranded wreck at 1055h. If the nearest distance from standard wreck was found to be 4 miles & the course steered during above interval was 144°T at 12.5 knots, find set and rate of current.
Ans. CMG = 152.5°T set 245°T rate of current = 1.85 knots.

Chart English Channel

Q.1 From a ship steering a steady course of 262°T, following bearings were taken of Lizzard Point light.
1700 299.5°T
1735 330°T
1825 024°T
Find CMG, if ship's speed over water is 14 kn & direction of set 119°T. Also find the find the rate of current & position at 1825h.
Ans. CMG = 256°T, 2.4 kn 49°46.4'N 005° 20'W
Q.2 Seven Stones light & Wolf Rock lights were in opposite bearings at 1920h. Seven Stones light & Long ship's light were in opposite bearings at 1950h. At 2005h seven stones was in opposition with Pendeen light. Current set 140°T @ 3 kn, engine speed 12.5 kn. Find the co steered & position at 2005h.
Ans. 351°T, Position = 50°6.5'N 005°53.6'W.

Light House Of Alexandria: *Was one of the earliest navigational aids. The lighthouse with a light at a height of about 110m was built in the years 299-280 BC. It was one of the most famous lighthouses of antiquity and served as a reliable guide for shipping until 1300 AD, when the lighthouse was toppled due to earthquake.*

[Pic. Ancient Light House Of Alexandria]

Chapter 12: List of Lights, Met. Visibility, GR, NR, PLR

'Admiralty List of Lights' is published by Hydrographer of Navy in 11 volumes viz. A to L (except I). 'Admiralty List of Lights' provides details of light houses, beacons & buoys. The details are regarding location, day & night time characteristics of lights, sound signals etc. 'ALL' volumes cover different areas of the world. Obviously the navigators find these publications very useful. ALL are kept updated by corrections, which are published in weekly notices to mariners. It is important that a passage planner gives consideration to the characteristics of light (especially the range) while planning the courses & deciding the way points on the chart. OOD on the other hand, must keep the publication handy for reference. List of Lights is useful when making land & when making a port, especially when making that port for the first time.

Admiralty List of Lights

Q. 12.1 What information is provided in Admiralty List of Lights?

Ans.

ALL contains following information.

(1) Explanation of various terms associated with ALL viz. various characteristics (like phase intensity elevation etc) , various types of lights (like aero Lt, fog Lt, obstruction Lt, leading Lt etc.), various types of ranges (like nominal, geographical , luminous etc.).

(2) Explanation of various light characteristics & fog signals. viz. fixed, flashing, iso-phase, occulting etc.

(3) Luminous range diagram, which may be used to relate luminous range, nominal range & met visibility.

(4) Geographical range table.

(5) Main text contains information regarding various light houses, beacons, other lights including some buoys, tabulated under eight coloumns. Coloumn headings are as follows.

(1) No. (2) Location - name (3) Latitude Longitude (4)Characteristics (5) Elevation - metres (6) Range - miles (7)Structure - Height in metres (8) Remarks

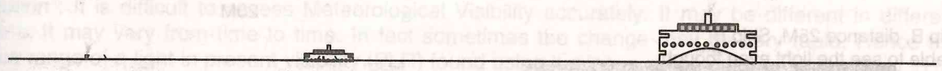
ALL's alphabetical index is not only a source of finding out the detailed information about any light, but it also provides a sure way of finding out lat & long of a new port, which is still unknown. The alphabetic index of ALL is one of the most exhaustive lists of harbours & lights in harbour. From index the number of light is read, which leads to the page where details of the required light can be found.
This information is especially useful when,

(1) Day / night characteristics of light is crucial in approach, or
(2) Large scale chart for the area is not available.
(3) Latest edition of the chart is not on board.

Raising and Dipping distance or Geographical Range, (GR)

Some times when visibility is very good, a light may show its loom before being picked up. A little later the light may appear like a tiny bulb at horizon. To this, we say 'the light is raised on horizon'. Also sometimes in the situation of very good / excellent visibility during the day hours, the superstructure & funnel of an approaching ship is seen before the rest of the hull. Approaching ship is thus raised at horizon. This is because the intervening portion of earth is curved or spherical. The distance at which this happens is raising distance of the object for observing ship.

Raising Distance: Is the distance beyond which a target of given height will not be visible from the observer's position or 'height of eye', even in the best of visibility condition. This distance is dependent on the *Ht. of Eye & Ht. of Object.* For an object to be viewed at GR the meteorological visibility should be good enough for an object or light to be visible at its GR. Present luminous range of a light should also be more than geographical range.



On a day of very good visibility an approaching ship is seen at the raising distance of her
(a) funnel, (b) Wheelhouse, (c) Forward part of hull

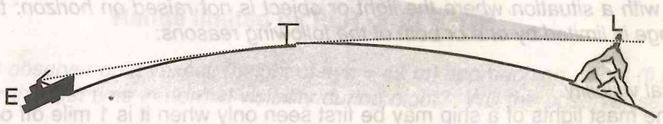


Fig. 12.1 Raising / dipping distance

Distance of Sea Horizon in Nautical Miles

$= 1.15 \sqrt{Height.in.feet}$ or $= 2.095 \sqrt{Height.in.meters}$

In Fig. 12.1 ETL is the path followed by a ray of light
(a) Starting from the uppermost conspicuous part of the target.
(b) Reaching the observer's eye.
(c) Curving along the path. (extent of curving dependent on the relative densities of air layers)
(d) Tangenting the curvature of earth at T.

Note:

(a) Raising or Dipping distance
= Geographical range
= Sea horizon of observer for his height of eye + Sea horizon for target's height.

(b) For an object to be raised or dipped at horizon it is essential that,
(i) At night the 'Present Luminous Range' is more than 'Geographical Range'.
(ii) In daytime meteorological visibility is more than Geographical Range.

Present Luminous Range (PLR): Owing to the *Luminous Intensity*, the maximum distance in horizontal distance at which a light can be seen in *Present Meteorological Visibility* is *Present Luminous Range*. Referred to as PLR, hereafter.

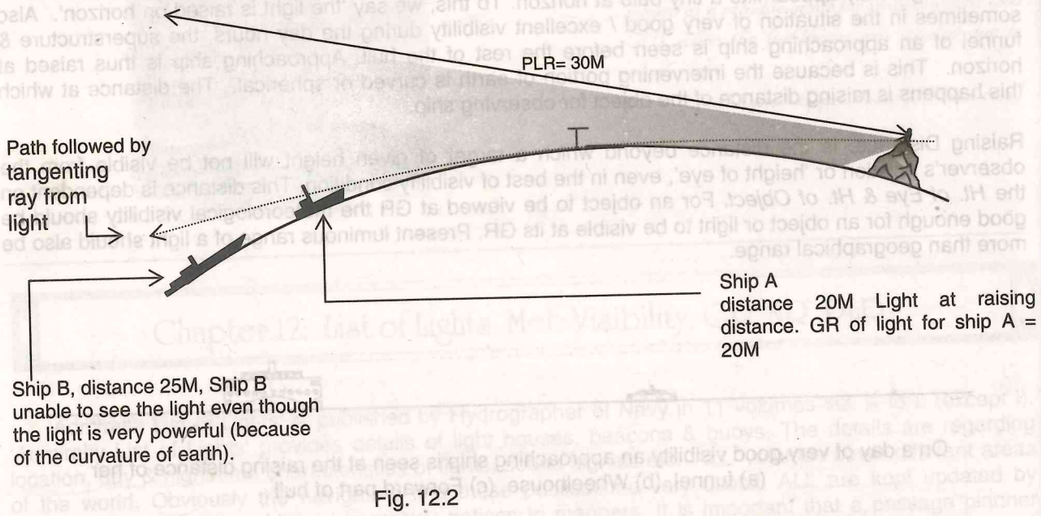


Fig. 12.2

Let us now deal with a situation where the light or object is not raised on horizon: thus we see a target whose visible range is limited by one or both of the following reasons:

(i) *Meteorological visibility*
e.g. in mist the mast lights of a ship may be first seen only when it is 1 mile off or a light which has a charted range of 20M is seen for the first time at a distance of 5 miles. PLR (Present luminous range) of light is 5 miles.

(ii) *Target's own luminous intensity,*
Let us consider a situation where visibility is 10M. Ship has sufficient height of eye & there is a weak light (charted range 12M) on top of a mountain. The GR may be 35 miles or so but charted range of light is 12M. Then the first time that the light will be seen is at a distance of 12 miles or at PLR (present luminous range)

During Night the Present Luminous Range PLR is found by entering *Luminous Range Diagram* with arguments viz. (a) Nominal Range & (b) Meteorological Visibility.

*During Day a*n object will normally be seen at a distance which is also the meteorological visibility at that time. Hence if meteorological visibility is less than G.R. then the object will be first seen at a distance equal to meteorological visibility.

Note:

1. *Meteorological Visibility:* is the greatest distance at which a black object of suitable dimensions can be seen and distinguished against the horizon, sky or in case of night observations, could be seen & distinctly recognised if the general illumination were raised to the normal daylight level.
2. In all the cases where one wants to find the range of first sighting or last sighting of light one must
   a) Find GR by formula
   b) Find PLR from luminous range diagram. The first sighted distance is the smaller of the two.

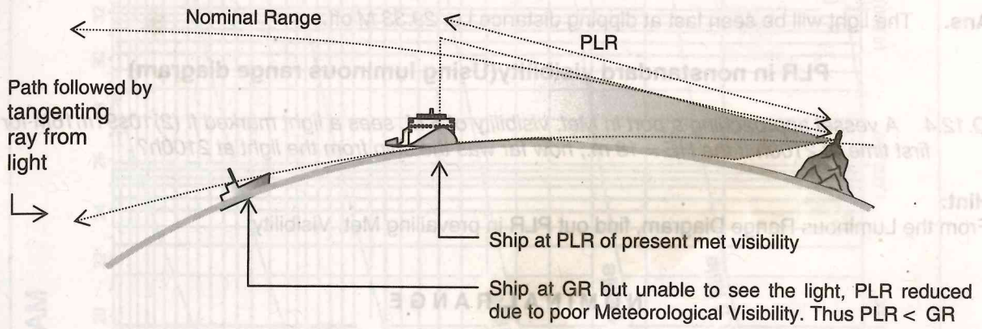


Fig. 12.3

Caution : It is difficult to assess Meteorological Visibility accurately. It may be different in different directions. It may vary from time to time. In fact sometimes the change may be very rapid. Hence the luminous range of a light in present visibility (PLR) found using luminous range diagram is not likely to be accurate enough to provide a reliable fix. However some examples have been set in this book to highlight the relationship between Meteorological Visibility, NR and PLR.

PLR found on the basis of 'assumed Meteorological Visibility' should be used basically to find expected 'time when' or 'range at which' a light will be seen for the first time or will be seen for the last time & not for position fixing.

Range limited by PLR or PLR<GR

Q.12.2 When will an observer on a vessel, (height of eye = 49 m) approaching a light (fl.5sec121m25M), see the light for the first time in normal visibility during night? Will the observer see the light rising at horizon then?

Hint:

Procedure:

In normal (good) visibility Present Luminous Range (PLR) = Nominal Range = 25M.

Geographical range = sea horizon for observer + sea horizon of light

$$= 2.095\sqrt{121} + 2.095\sqrt{49} \text{ M} = 37.71 \text{ M}$$

Thus PLR < GR. ∴The light for the first time will be seen when 25 M off. The light then is already within the observer's visible horizon. From 37.71 M to 25 M off the light could not be seen as the present luminous range PLR did not permit it to be seen beyond 25 M.

Caution:

Read the explanation regarding GR, PLR & NR & the caution above.

Q. 12.3 A vessel is going away from a light whose range indicated on the chart is 31 M. Meteorological visibility = 10 M. Ht. of light = 64 m Ht. of observer = 36 m. Will the observer be able to see the light dipping off?

Hint:
GR = 2.095(8 + 6)
= 29.33 M
PLR = 31 M

Ans. The light will be seen last at dipping distance i.e. *29.33 M* off.

PLR in nonstandard visibility(Using luminous range diagram)

Q.12.4 A vessel approaching a port in Met. visibility of 5 M, sees a light marked fl (2)10s91m16M for the first time at 2100h If the HE = 18 m., how far was the ship from the light at 2100h?

Hint:
From the Luminous Range Diagram, find out PLR in prevailing Met. Visibility.

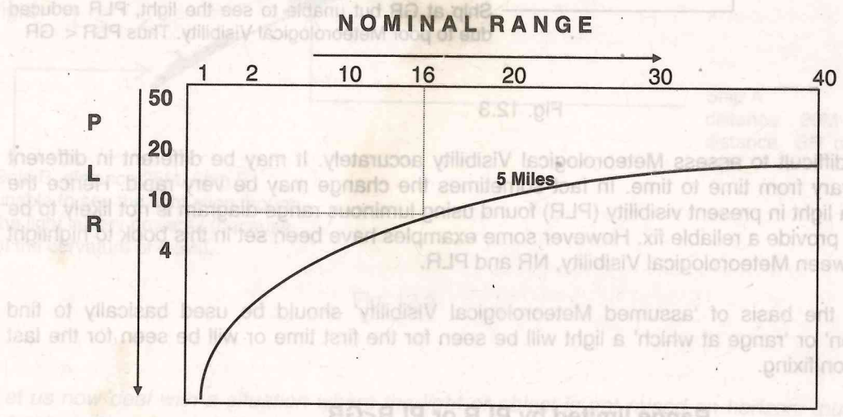


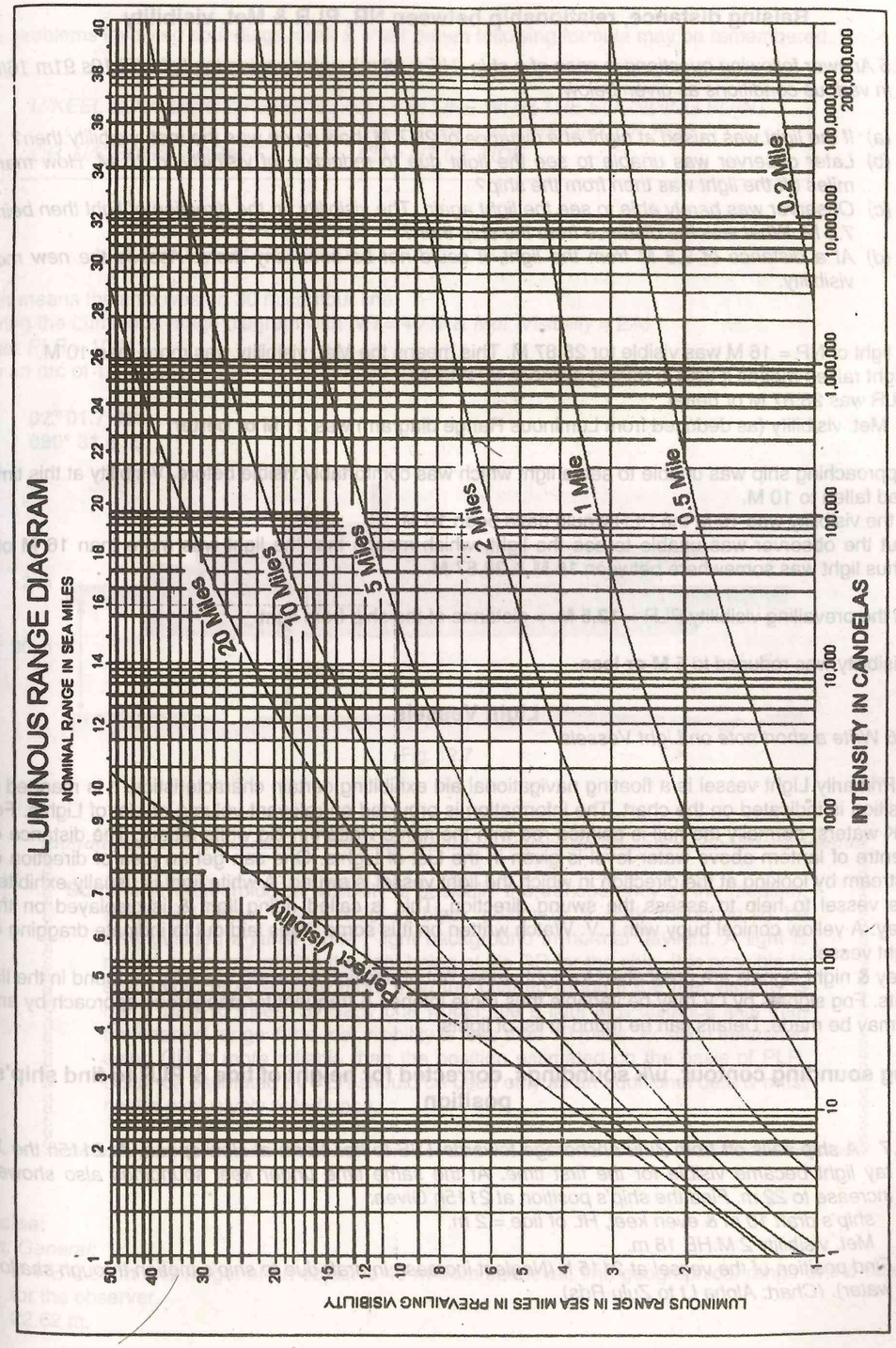
Fig. 12.5

The above diagram is given in the Admiralty List of Lights volumes. The diagram is entered with Nominal Range from top (read along x - axis). The present Luminous Range is then read off along vertical side (y - axis). A perpendicular (dotted line) is dropped at NR = 16 M. From the point at which this line meets the 5 M visibility curve, draw a horizontal line to meet vertical side (y - axis) at PLR In above case PLR = 9.6 M.

Note:
PLR found for Met. Visibility of 10 M will give PLR equal to Nominal Range. This is in agreement with the definition of Nominal Range.

Caution: See the remark regarding PLR & Caution above.
GR = 28.87 M
PLR = 9.6 M

Ans: Thus the ship was **9.6 M** off at **2100 h.**



Raising distance, relationship between NR, PLR & Met. visibility

Q. 12.5 Answer following questions in case of a ship (HE = 18 m), approaching the light (Fl 10s 91m 16M) in various conditions as given below:

(a) If the light was raised at night at a distance of 28.7 M, how much was the met. visibility then?
(b) Later observer was unable to see the light due to reduction of visibility to 10 M. How many miles off the light was then from the ship?
(c) Observer was barely able to see the light again. The visibility, in the direction of light then being 7.5 M. What was the distance from the ship then?
(d) At a distance of 9.8 M from the light, it could not be seen any more. Assess the new met. visibility.

Hint:

(a) A light of NR = 16 M was visible for 28.87 M. This means the Met. visibility was more than 10 M.
Light raised means it was at raising distance ie. 28.7 M.
PLR was 28.87 M or better.
∴ Met. visibility (as deduced from Luminous Range diagram) was **21 M or better**.

(b) Approaching ship was unable to see a light which was comfortably visible before. Visibility at this time had fallen to 10 M.
If the visibility was 10 M the PLR would have been 16 M.
But the observer was unable to see the light, which means that the light was more than 16 M off.
Thus light was somewhere between **16 M & 28.87 M.**

(c) In the prevailing visibility PLR = **12.5 M**. = distance of the ship from light.

(d) Visibility was reduced to **5 M or less**.

Light Vessels

Q.12.6 Write a short note on Light Vessels.

Ans: Primarily Light vessel is a floating navigational aid exhibiting certain characteristics. It is manned & its position is indicated on the chart. The information is provided on relevant volume of List of Lights. For the UK waters, normally the hull is painted red with the name written in big white letters. The distance of the centre of lantern above water level is given in the List of Lights. One can get an idea of direction of tidal stream by looking at the direction in which the light vessel is swung. A white light is usually exhibited on the vessel to help to assess the swung direction. This is called riding light & is displayed on the forestay. A yellow conical buoy with L.V. Watch written on it is some times laid out to indicate dragging of the light vessel.

Day & night signals are prescribed for light vessel out of position & the signals may be found in the list of lights. Fog signals by LV may be variable thus more intense & frequent for dangerous approach by any vesel may be made. Details can be found in list of lights.

Using sounding contour, u/k soundings, corrected for height of tide & PLR to find ship's position

Q. 12.7 A ship sails off from Zulu anchorage towards TSS to her North at slow speed. At 2115h the X-ray light became visible for the first time. At the same time under keel soundings also showed increase to 22 m. Find the ship's position at 2115h Given:
ship's draft 10 m & even keel, Ht. of tide = 2 m.
Met. visibility 2 M.HE 18 m.
Find position of the vessel at 2115 h (Neglect increase in draft due to ship's motion through shallow water). (Chart: Alpha Lt to Zulu Rds)

Hint:
In the problems involving soundings, draft & chart datum following formula may be remembered.

U/KEEL SOUNDINGS + SHIP'S DRAFT IN LINE WITH THE SOUNDING POINT	= *CHART DATUM + HEIGHT OF TIDE*
OR, U/K SDGS + DRAFT	= *CD + HT OF TIDE*

Thus 10 + 22 = CD + 2
∴ CD = 10 + 22 - 2 = 30 m.

Which means the ship was on 30 m contour line.
Entering the Luminous range diagram with *NR* = 40 M & *Met. Visibility* = 2 M
We get *PLR* = 10 M.
Draw an arc of 10 M radius. The point it cuts 30 M contour is position of ship.

Ans. **02° 01.7' N**
080° 31.6' E

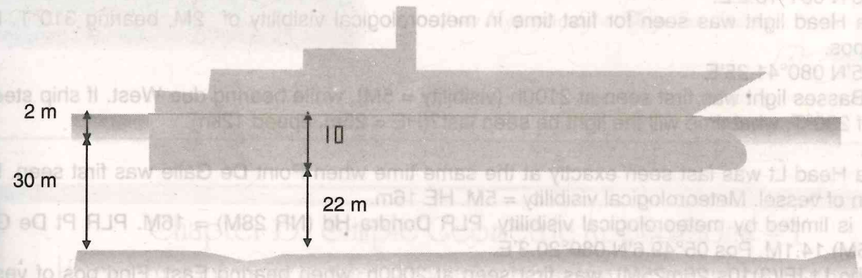


Fig. 12.7

Summary: Meteorological visibility is basically the transparency of the medium, which will allow, say a ship of black colour or a dark mountain to be distinguished against white / light background in normal daylight. A light is raised or dipped implies the light being at it's GR for the ship. It is possible to see a light at a distance more than the charted range if the met visibility is more than 10 miles. Similarly one would see a light at a distance less than the charted range if the met visibility is less than 10 miles. Position estimated using GR is more reliable than the position estimated on the basis of PLR. Distance estimated by PLR should be used only as an additional data & must not be exclusively relied upon.

Exercise:
Chart: General:
Q.1 If HE = 20 m and height of an object is 40 m from sea level, find geographical range of the object for the observer.
Ans. 22.62 m.

Q.2 If Nominal range of a light is 20 M, At what distance will the light be visible at night in a meteorological visibility of 5M.
Ans. 11.8 M, provided GR > 11.8 M, otherwise at GR.
Q.3 If Nominal range of a light is 18 M, what is the maximum distance at which the light would be visible on a night, when meteorological visibility is 20 M.
Ans. 30 M, provided GR >30 M, otherwise at GR.
Q.4 On a clear day masts of an approaching ship (height of mast, 25m) were seen rising on horizon. If HE = 19m, find distance of approaching ship.
Ans 19.60M.

Chart: South coast of Sri Lanka:

Q.1 In meteorological visibility of 10M, Barberyn light Fl 20s 46m 27M was seen for the first time, while approaching it at 2000h. Find distance from light. (Height of eye = 40m).
Ans: GR 27.46M, PLR 27M, DIST 27M.
Q.2 On a southward Co, at 2000h, Colombo light was last seen & Barberyn light Fl 20s 46m 27M was first seen at the same time. Find position at 2000h. (HE = 25m).
Ans: Colombo Lt 21.16M, Barb Lt 24.68M. Pos: 06°40.1'N 079°36.5'E.
Q.3 Find ship's pos when Dondra Hd light dipped off on horizon at true bearing of 65°. (HE = 20m)
Ans: 05°45.2'N 080°13.9'E.
Q.4 Great Basses light was raised on NE'ly bearing, find position of ship.(HE = 22m).
Ans: 05°55.3'N 081°13.2'E.
Q.5 Dondra Head light was seen for first time in meteorological visibility of 2M, bearing 310°T. Find ship's pos.
Ans: 05°50.5'N 080°41.25'E
Q.6 Great Basses light was first seen at 2100h (visibility = 5M), while bearing due West. If ship steered a Co of 230°T, what time will the light be seen last?(HE = 25m, speed 12kn).
Ans: 2248h.
Q.7 Dondra Head Lt was last seen exactly at the same time when Point De Galle was first seen. Find position of vessel. Meteorological visibility = 5M. HE 16m.
Hint Range is limited by meteorological visibility. PLR Dondra Hd (NR 28M) = 16M. PLR Pt De Galle (NR 25M) 14.1M. Pos 05°49.6'N 080°20.3'E.
Q.8 Colombo Lt [Fl(3)10s 26m25M], was first seen at 2000h, when bearing East. Find pos of vessel. (Given H.E. = 14.8m)
Hint. GR = 18.75M. NR = 25M. Assume met visibility = 10M, thus PLR = 25M. Bearing & distance of light = 090° x 18.75M. Pos ≡ 06°55.3' 079°31.5'E.
Q.9 Barberyn Lt Fl 20s 45.5m 27M was first seen bearing 041°T, find own pos. HE = 41m.
Hint. Visibility not given, assume it to be 10M. PLR = 27M. GR = 27.56M.
Caution: Position based on PLR must be considered approximate only. Read the remark, stated earlier in this chapter.
Q.10 Barberyn Lt Fl 20s 45.5m 27M was raised when Point de Galle was 15M off, find pos of own ship. HE = 41m.
Ans Raising distance of Barberyn Lt = GR = 27.56M. Pos ≡ 06°00.2' 079°58'E.
Q.11 Colombo light bore as 120°T at 2000h, 085° at 2035h & 050°T at 2100h from a ship steering a Co of 154°T at 17kn. If at the time of taking 3rd bearing met visibility was 5M & Colombo light was last seen then. Find set & rate of current.
Ans: CMG, 162°T. Current 201° x 3.8kn.

Magellan Ferdinand: *[1480- 1521] born in 1480 in Portugal his parents were members of nobility. He commanded the first expedition, which sailed round the globe & thus practically prove the world to be round. Magellan discovered the passage route to Pacific through Chile. The route since is known Straits of Magellan. Magellan found the new ocean very peaceful compared to Atlantic & gave it the name Pacific. Magellan with crew were first of Europeans to start for 98 days across Pacific. Many starved to death, crew ate rats, saw dust etc to avoid starvation. On April 27th 1521 Magellan was killed in a conflict between rival Philippino groups in Philippines. The voyage was completed after in 3 years, with most crew of 240 perished in three years. Though Portuguese considered Magellan a traitor & Spanish condemned him later for his harshness & errors in navigation as Magellan could not find a short route to spice islands, his voyage contributed to the knowledge of world geography & Magellan Passage.*

[Pic Ferdinand Magellan]

Chapter 13: Simple Geometric Applications – 1
[Doubling of bow angle, 4 points bearing, Special bow angles & Sailing round the arc]

Doubling of angle on bow: Is a simple method of determining (in advance), the nearest distance that a ship is going to pass off a point, beacon or lighthouse, without using radar. Let there be no current or tidal stream during the observation period. The 1st bow angle of a shore light is say 20° at 0800h. Let the 2nd bow angle be double of the first i.e. 40° & say its occurs at 0840h. The distance traveled between 0820 & 0840 (20 minutes) = $\frac{12 \times 20}{60}$ = 4M

The distance of the shore light at the time of 2nd observation is equal to distance traveled between the two observations i.e. 4M.

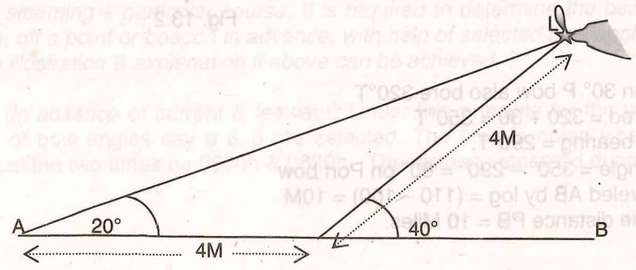


Fig 13.1

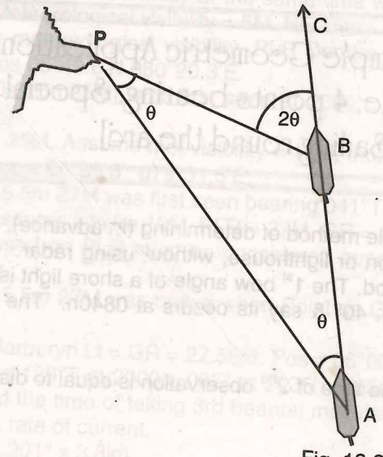
Doubling of angle on bow (in absence of current)

Q. 13.1 A point of land bore 030° on port bow & 320°T, log showed 100 M at this moment. On the same course later the point bore 290°T. Log read 110 then. Find the position of ship wrt. point of land at the time of 2nd observation. What course was she steering? (Given: wind & current in the area nil).

Principle: 'Doubling of angle on bow'

> ***In absence of leeway effect of wind & drift due to current, (which makes CMG ≠ Co Steered), distance made good between two observations, during which the bow angle of any object is doubled = distance off from the same object at the second observation.***

Explanation:
Let P be the point on paper, representing a lighthouse or a point of land.
Let AC represent a course steered by ship.
Let PA & PB be the bearings taken by ship.
Let ∠ PAB be = θ, 30° in this case & ∠ PBC be = 2θ, 60° in this case
By theorem : sum of 2 internal angles = angle external to 3rd internal angle.
angle BPA = θ
Since internal angle P = internal angle A
BP = BA
Δ PAB is an isosceles Δ with PB = AB.
In present example log distance steamed = DMG = 10M.
Assume P a point anywhere on the paper & let the scale be 1cm = 1M.
Draw the two bearings & ship's Co line along AB as shown in Δ PAB.(fig. 13.2).



∠ B = 2 ∠ A
But in Δ PAB external ∠ B = ∠A+∠P
∴ ∠ P = ∠B - ∠A = 60°- 30° = 30°
∴ ∠A = ∠P. ∴ AB = PB.

Fig. 13.2

Ans:
Since the point on 30° P bow also bore 320°T
The course steered = 320 + 30 = 350°T
The second true bearing = 290°T.
∴ Second bow angle = 350° – 290° = 60° on Port bow
The distance traveled AB by log = (110 – 100) = 10M
By above principle distance PB = 10 Miles.

Doubling of four-point bearing is extension of above principle only. The first observation is made when bow angle is 45°. The second bow angle will be 90° i.e. the shore light will be abeam. The distance traveled between two observations will then be equal to beam distance.

Doubling of 4 point bow bearing

Q. 13.2 A beacon bore 165°T & was 4 points on port bow at 1200 h At 1240 h the beacon was abeam on port side. If ship's speed over water was 12 kn Find out beam distance of beacon. Also find out the bearing & distance of ship from the beacon at 2nd observation.

Hint:
This problem is based on the 'four point bearing' principle & is extension of the 'doubling of bow angle principle'.
In fig.13.2 Let P be a point of land.
Let AB represent the ship's course & distance steamed between the times that the bow angles were 45° & 90°.
BP represents: 1) Beam bearing as well as
2) Distance at the time of 2nd (beam) bearing
By the theorem of isosceles triangle AB = PB = 8M. Course = 165°+ 45° = 210°. Ship was 300° x 8 M at the time of 2nd observation.

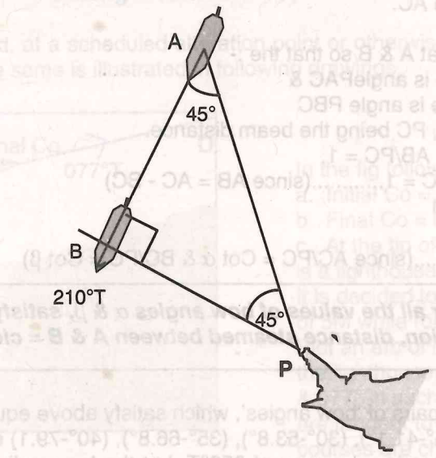


Fig. 13.3

Ans. Ship will lie at **300°T x 8 M** from beacon at the time of 2nd observation. Beam distance = **8 M.**

To find CPA of a shore object using selected bow angles & dist log

Q. 13.3 A vessel is steaming a particular course. It is required to determine the beam distance & the nearest distance, off a point or beacon in advance, with help of selected bow angles & distance log. Explain with due illustration & explanation if above can be achieved.

Principle:
'Selected bow angles (in absence of current & leeway)': Under this principle for the vessel steaming at uniform speed, a pair of bow angles say α & β are selected. The time is noted when these two bow angles are observed. Let the two times be 0600h & 0620h. The distance steamed during this interval can be found.

At the rate of 12 kn this distance is 4M. The same is the closest distance at which the ship is going to pass from point or beacon, whose bearings were taken. The two bow angles are chosen in such a way that Cot of 1st bow angle – Cot of 2nd Bow angle = 1

Let P be the shore point. Let α be the first bow angle. Ship's position then is at A. At the time of second bow angle β, the ship is at B. For selected pair of angles α & β, AB is equal to PC (the closest distance). The condition which must be met is Cot α – Cot β = 1

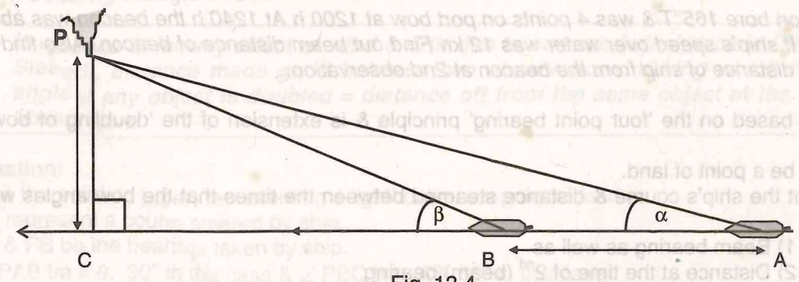


Fig. 13.4

Proof:
Let the ship steer a course AC.
Let P be a point of land.
Let the bearings be taken at A & B so that the :-
1) 1st selected bow angle is anglePAC &
2) 2nd selected bow angle is angle PBC
The point P is abeam at C, PC being the beam distance.
For AB to be equal to PC, AB/PC = 1.
Which means (AC - BC)/PC = 1.....(since AB = AC - BC)
Which means $\frac{AC}{PC} - \frac{BC}{PC} = 1$

Or Cot α - Cot β = 1.....(since AC/PC = Cot α & BC/PC = Cot β)

Thus for all the values of bow angles α & β, satisfying above Cotangent relation, distance steamed between A & B = closest distance CP.

Some of the selected pairs of 'bow angles', which satisfy above equation, are (10°- 12°),(20°- 29.2°), (25°-41.1°), (30°-53.8°), (35°-66.8°), (40°-79.1) etc.
e.g. Let there be a ship steering a course of 050°T. Let the log reading be 015 at certain instant & let a beacon bear 080° at that time. The 1st bow angle thus is 30°. The second bow angle of the pair is 53.8°. The beacon must bear (50 + 53.8)° at second bearing. The second bearing thus is 103.8°. Let the log reading be 21, when beacon bears 103.8°. Therefore the distance steamed between two bow angles is 6M.

The closest distance at which ship will pass the beacon is 21 - 15 = 6 M. This is because DMG between the two selected bow angles viz. 30° & 53.8° is 6 M.

To find the time & distance of beam bearing from the distance traveled during the doubling of bow angle

Q.13.4 A beacon was seen at 20° on port bow at 1630 h & then at 40° on port bow at 1700 h Find;
(a) Distance from beacon at second observation.
(b) Time when beacon will be abeam.
(c) Beam distance of beacon.
Given that the ship's speed = 14 kn.

Hint.
In figure let ABC be the ship's course line.
∠ PAB = 20° & ∠ PBC = 40°
By the principle of doubling the angle at bows AB = PB.
Since AB = 7 M,
PB = 7 M.....(a)
In Right ∠ed Δ PBC;
BC/PB = Cos 40°,
∴BC = 7 Cos 40° = 5.4 M
Which means that the beacon will be abeam at 1723h

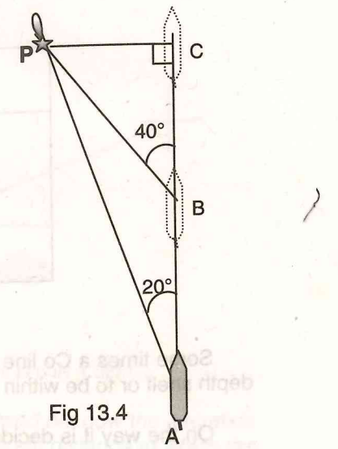


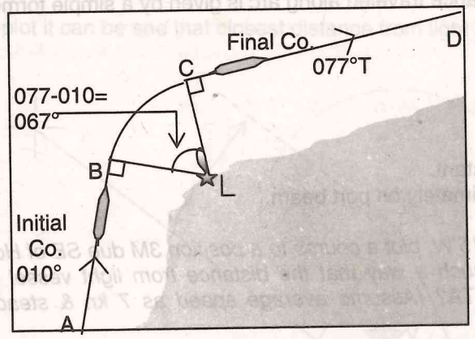
Fig 13.4

PC/PB = sine 40°
PC = 7 Sine 40° = 4.5 M. Thus
Beam distance = Sine of 2nd bow angle x Distance traveled during doubling of bow angle.

Ans. (a) 7M (b) 1723h (c) 4.5 M

Sailing Round the Arc

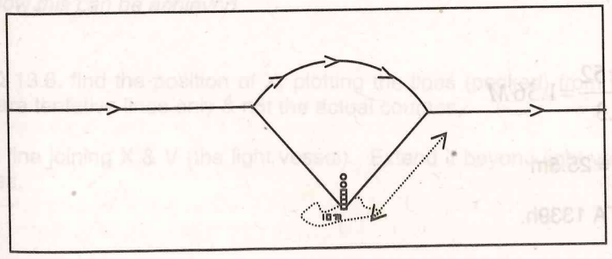
Whenever the course is altered, at a scheduled alteration point or otherwise, she describes a curved track, along the arc of a circle. The same is illustrated in following drawings.



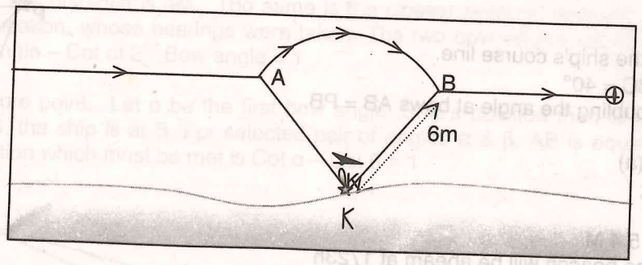
In the fig following is illustrated:
a. Initial Co = 010°T = AB
b. Final Co = 077°T = CD
c. At the tip of the 'point of land there is a lighthouse.
It is decided to keep it at a distance of 5M while rounding to alter Co.
Plot an arc of radius = 5M rounding the lighthouse. Plot Co-lines 010° & 077° in such a way that they are tangent to the 5M-arc. The two courses are checked for safety.

The initial & final courses are tangent to the 5M-arc at points B & C. L is the lighthouse on which the arc is drawn.

Join BL & CL. Angle ABL = 90°. Also angle DCL = 90°. Note that angle BLC = 077°-010° = 067°.
Length of arc BC = radius-BL $\times \frac{67}{57.3}$



Avoiding the shoal in otherwise deep waters



Some times a Co line is drawn // to the coast which is sharp & straight. This may be to avail a certain depth shelf or to be within a depth contour, to avoid rolling.

On the way it is decided to round the lighthouse (that is close south of a stranded wreck) with an arc of 6m. This will ensure a safe clearance from the wreck & shallow waters.

Sailing round the arc involves many principles. viz. geometrical, ship handling, manoeuvring characteristics of ship etc. In this chapter we will consider pure geometrical aspects only. Later in the chapter on 'passage planning' we will discuss other aspects in detail.

Let us assume that K is a lighthouse, around which ship travels along an arc AB of say 70°. Let the radius of above circle be 6 miles. Then the distance traveled along arc is given by a simple formula viz

$$L = \frac{6 x 70}{57.3}$$

Note:
1) Distance from K anywhere along AB is constant.
2) Throughout the rounding of arc, K is approximately on port beam.

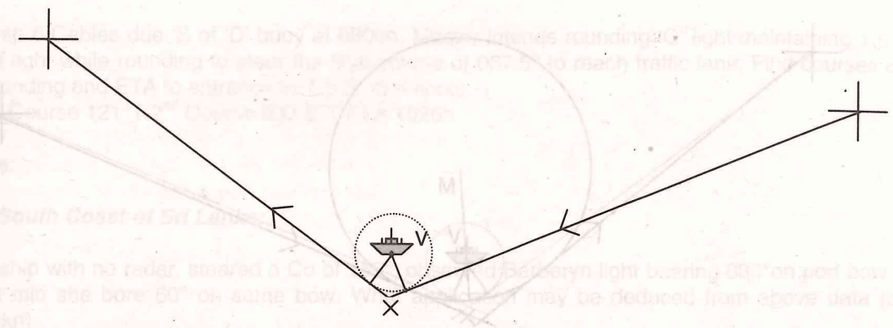
Q.13.5 From position at 1000 viz. 52°7'N 006°15'W, plot a course to a position 3M due SE of Hook Head via south of Coning Beg light vessel; in such a way that the distance from light vessel does not reduce to less than 1.5 miles. What is ETA? (Assume average speed as 7 kn & steady during manoeuvre).

Procedure
Plot initial & final positions
Draw a circle of radius ≈ 1.5 miles around the light vessel. Plot tangents to this circle from I.P. & F.P. The two tangent lines represent initial & final courses respectively. The two course lines meet at X. From light vessel drop perpendiculars on each course. The ∠ between these perpendiculars = 52°
(Note: Initial co ~ Final Co = 52°)

Distance sailed round the arc $= \frac{1.5 x 52}{57.3} = 1.36 M$

Total distance = (15.7 + 1.4 + 8.4) m = 25.5m

Traveling time = 3h 39m (approx). ETA 1339h.

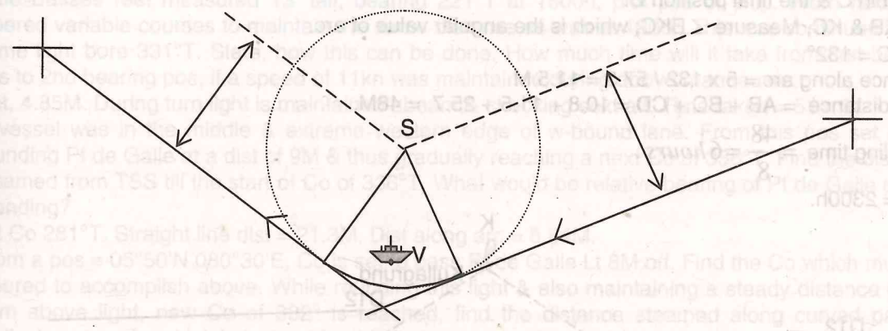


Ship takes a very tight turn of radius = 1.5M & distance sailed round the arc is only 1.36M

Q.13.6 The initial & final courses determined in above questions are to be followed but now the alteration of course is to be carried out along an arc of radius = 5 miles find the nearest distance at which the ship will be pass the light vessel.

Hint:
Draw lines // to & inwards of initial Co & final Co respectively, at a distance of 5 miles each.
Let the two lines meet at a point S. With S as centre plot a circle of radius equal to 5 miles. This circle will just touch, each of the course lines.

From the plot it can be see that closest distance from light vessel is 1.1M.

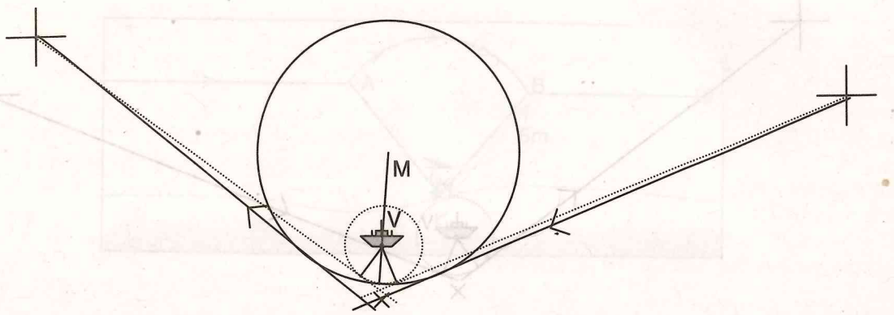


The ship takes a turn of larger radius than the one in last question

Q.13.7 It is required to maintain a distance of 1.5 miles, carrying out a turn of radius = 5 miles. Explain how this can be achieved.

Ans.
As in Q 13.6, find the position of X, plotting the lines (pecked) from initial & final positions respectively. These are tentative lines only & not the actual courses.

Draw a line joining X & V (the light vessel). Extend it beyond light vessel till M so that MV is (5 – 1.5) = 3.5 miles.



With M as centre draw an arc of radius = 5 miles.
Through IP & FP plot initial Co & final Co, tangenting the 5M-circle, respectively.
I/Co = 246° F/co = 302.5°

Distance along arc $= \frac{R\theta}{57.3} = \frac{5\,x\,(302.5° - 246°}{57.3} = 4.39M$

Q.13.8 Ship's position at 1700h was due south of Blonheim racon, at a distance of 3.2 miles. Decca read D–14 then. It was decided to home on this decca lattice in order to reach a position 2 miles due N of Svartgrund buoy.
Enroute it was decided to maintain a distance of 5M from Kullagrund light. Explain how this can be done. Stating the initial, Final course & ETA at 8 kn. (Chart: Falsterbo to Oaland)

Hint:
Plot Initial position A = 55°14.3'N 12°52.8'E at D-14
Draw an arc of radius = 5M with Kullugrund light (K) as centre. This arc meets D–14 at B & C. Join AB also Join C & the final position D.
Join KB & KC, Measure ∠ BKC; which is the angular value of arc.
∠ BKC = 132°.
Distance along arc = 5 x 132 / 57.3 = 11.5 M
Total distance = AB + BC + CD = 10.8 + 11.5 + 25.7 = 48M.

Traveling time $= \frac{48}{8} = 6\,hours$.

ETA = 2300h.

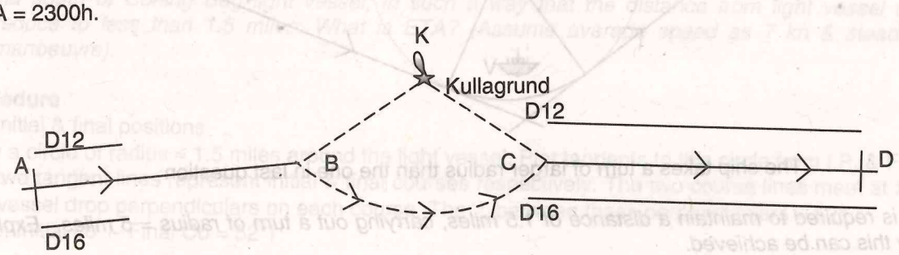


Chart: Alpha to Zulu Roads:

Q.1 A ship steaming at 8 knots found W beacon at 4 points on starboard bow and bearing 47°T at 0700h. Find the beam distance of W if beacon was abeam after 24 minutes. What principle is used this example
Ans. 3.2 miles doubling the bow angle principle.
Q.2 On a course of 175°T 'Q' light was 19° on starboard bow at 1500h. What is the second bow angle. so that the distance steamed between two bow angles will be also the beam distance from Q light
Ans. 23.8°

Q.3 Ship 6 Cables due 'S of 'D' buoy at 0800h. Master intends rounding 'Q' light maintaining 1.5 miles off light while rounding to steer the final course of 037.5° to reach traffic lane. Find courses before rounding and ETA to entrance to T.S.S. at 9 knots.
Ans. 1st Course 121°T 2nd Course 037.5°T ETA 1026h.

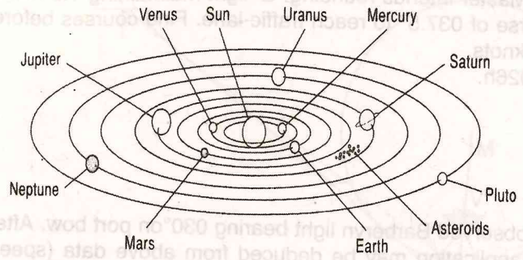
Exercise:

Chart : South Coast of Sri Lanka:

Q.1 A ship with no radar, steered a Co of 155°, observed Barberyn light bearing 030°on port bow. After 30 min she bore 60° on same bow. What application may be deduced from above data (speed 14kn)
Ans: 'Doubling of bow angle'. The dist from light at time of 2nd bearing = 7M, nearest distance = 7.Sin 60°M.
Q.2 A vessel steaming at 14kn found Kolonna point (05°58'N 080°44'E) at 4 points on starboard bow at 1000h, at 1030h it was abeam. Find pos of vessel at 1030h & Co if vessel was heading straight for mid point of W-bound lane.
Ans: Co 249° Pos: 05°51.8'N 080°46.7'E.
Q.3 At 2000h, a vessel steering due W at 15kn finds Dondra Hd bearing 17° on starboard bow. If continued on present Co vessel will pass West bound traffic lane from its middle. What will be the Dondra Hd's bow bearing & at what time so that distance steamed from 2000h till that time, will be equal to its beam distance.
Ans: 23.8°. (principle: Cot a° - Cot b° = 1)
Q.4 A ship steered 010°T at 12kn, finds S Kandu point to lie at 21° on port bow at 1900h. Later the beam distance was 6M. Find bow bearing at 1930h.
Ans: Bow bearing = 31.9°.
Q.5 Little Basses reef measured 13' tall, bearing 221°T at 1800h, plot pos of ship. From here ship steered variable courses to maintain the same distance as was at 1800h.This was continued till the same light bore 331°T. State, how this can be done. How much time will it take from first bearing pos to 2nd bearing pos, if a speed of 11kn was maintained during above manoeuvre.
Ans: dist, 4.85M. During turn light is maintained abeam & checking sext alt. Time taken = 51 min.
Q.6 A vessel was in the middle & extreme western edge of w-bound lane. From this pos set a Co, rounding Pt de Galle at a dist of 9M & thus gradually reaching a next Co of 336°T. Find the distance steamed from TSS till the start of Co of 336°T. What would be relative bearing of Pt de Galle during rounding?
Ans 1st Co 281°T. Straight line dist = 21.3M. Dist along arc = 8.64M.
Q.7 From a pos ≡ 05°50'N 080°30'E, Co is set to pass Pt de Galle Lt 8M off. Find the Co which must be steered to accomplish above. While rounding this light & also maintaining a steady distance of 8M from above light, new Co of 332° is reached, find the distance steamed along curved path. If vertical sext angle principle is used for this find out the sext altitude.
Ans. Co steered = 281°T, Arc = from 062°T to 011°T = 51°. Distance along arc = 7.12M. Sextant altitude = 6.49'.

Chart: Eng Channel:

Q.1 From a pos, 2M due S of Catherine's Pt, Co was set for Berry Head pilot station (50°24'N 003°21'W). While on above Co it was decided to maintain a distance of 5M from Bill of Portland Lt when passing it, by rounding it along arc. Find out the total distance which the ship will have to make good in above passage.
Ans. Co set 264°T. On this Co from a Pt with BoP Lt bearing 302° till it bears 46.5° i.e. over an arc of 104.5°, vessel traversed along arc of radius = 5M. Total distance = 71 + 9.12 = 80.12M.



Arya Bhatta: *Might have lived either in the 5th century A.D. or 26th century B.C. This is as per the date calculations of Kali's. He was an astronomer and a mathematician. He stated heliocentric theory of solar system. He knew earth was spherical, spins on her axis & that earth moves around the sun. He knew eclipses & calculated value of π as 3.1416.*

[Pic. Heliocentric Sun's family]

Chapter 14: Plotting of astronomical position lines

Astronomical Position Lines

Astronomical PL is a very small portion of a "very large-radius position-circle". Since the drawing of entire circle is not possible on a navigational chart, different methods are used to draw a small portion of position circle close to ship's DR.

Now,

i. Small portion of a large radius circle can be considered as a straight line.
ii. At any point along the circumference the circle is perpendicular to the radius through that point. In all cases the PL is perpendicular to azimuth line.

Let us compare & understand the plotting of different astronomical Pls.

Method of obtaining PL	Reference component of DR, which was used in finding of PL	PL is perpendicular to the direction of azimuth & passes through	Note	Remarks
Long by chron	DR lat	Intersection of reference latitude with calculated longitude	Calculated long is not the longitude of ship. The intersection point is not ship's position but merely a point through which PL will pass. It is a probable position though.	Normally used for sun sight at around 0900h Ship's Time
Intercept	DR lat + DR long	A point which is along azimuth line drawn through reference point, a few miles towards or away from body	Point a few miles towards or away from reference position is called ITP. ITP is not the ship's position, but merely a point through which PL passes. It is a probable position though.	Normally used for taking a set of star sights at AM & PM twilights
Lat by mer-alt	none	A // of latitude itself is a PL. No reference point is needed	// of latitude obtained is the actual latitude of ship.	Normally used for finding out running fix staggering it with sun's AM sight. PL is always EW
Ex-meridian	DR long DR lat	Reference longitude & observed latitude	Calculated lat is not the lat of position. Thus intersection point is not ship's position but merely a point through which PL will pass. It is a probable pos though.	Normally used for sun a little before or after meridian passage. PL is close to EW but never EW.
Polaris	DR long & approx latitude	Reference longitude & observed latitude	Calculated lat is not the lat of position, except when the azimuth is due N. The intersection point is not ship's position but merely a point through which PL will pass. It is a probable pos though.	Sight taken at twilight time at AM or PM, only in Northern hemisphere. PL can be EW or close to EW.

Q. 14.1Calculations, using pos 02°00'N 080°32'E, gave intercept of 1.1' towards sun bearing 095°. Stranded wreck off Zulu anchorage was in transit with aero radio beacon to WNW of it at the time of observation. Find the pos of ship.

Sol

Plot the given DR.Through DR plot a line DX along 095°T & also plot a point T (ITP) on DX at a distance of 1.1M from D.
Plot the astronomical PL, perpendicular to DX through T.
Plot terrestrial PL (the transit bearing line through the radio beacon & wreck.
Where the two PLs meet is the fix.

Ans Fix: **02°0.75'N 080°33.2'E.**

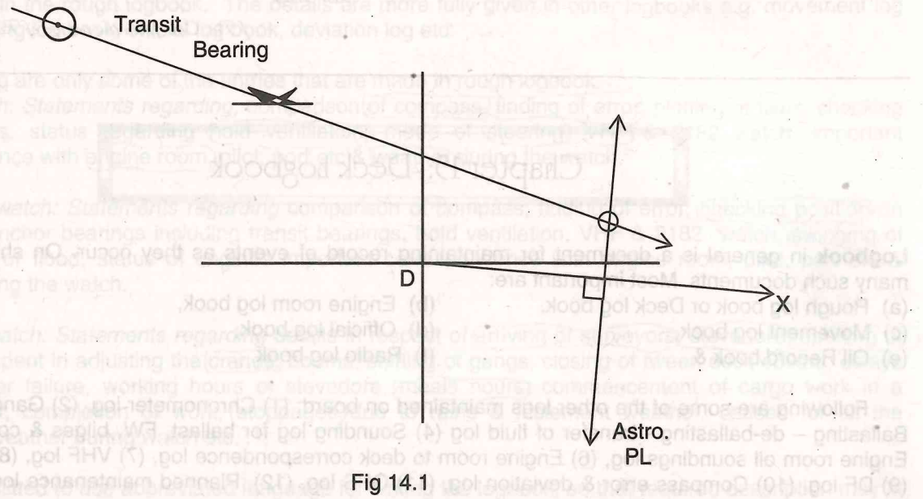


Fig 14.1

Exercise:

English Channel:

Q.1 At 1600h Start Point Lt was found 15M off, by a vessel steering a S'ly Co. Current set along 220°T @ 2kn. At 1800h sight of a star calculated using position, 49°33'N 003°30'W gave intercept of 3.1'(A) & azimuth 165°T. Plot the pos of vessel at 1600h. (English Channel)

Ans. 50°4.4'N 003°19'W or 49°59.5'N 003°48'W.

South Coast of Sri Lanka

Q.1 At 0700h vertical sext alt of Barberyn Lt Ho [height 46 metres]was 00°18' when the water level had fallen 1m below MHWS. The vessel steered 150°T for 1h when sun sight at DR 06°16'N 079°50'E gave an intercept of 6.5' towards & bore 120°T. If current was known to set 270°T @ 3kn, find vessel's pos at 0700h & 0800h. Given: ship's speed 12kn. (April,94 2nd Mate FG)

Ans: Dist 4.84M. Pos: 0700h 06°24.9'N 079°53.7'E. O800h 06°14.5'N 079°56.7'E.

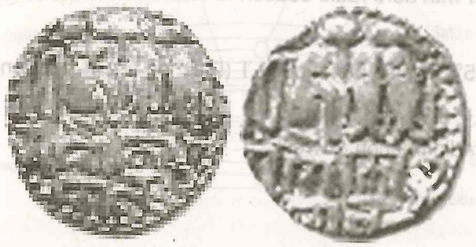
Q.2 At 2000h in DR 05°45'N082°00'E a steller observation gave an intercept of 3M away on azimuth of 310°. Vessel steered a Co of 295°T & observed Great Basses Reef Lt to bear due N at 2230h. During above period current was known to set 252°T @ 2kn. Find vessel's pos at 2230h. From 2230h pos find compass Co to steer to pass Dondra Hd Lt Ho 5M off counteracting same current, ship's speed 12kn. (June,94 2ndMateFG)

Ans: Co to MG 267.5°T, Co to steer 270°T. Pos 05°52.5'N 081°28.7'E

Chart Alpha to Zulu Roads

Q.1 From a ship steering 175°T at 10 knots, a sun sight was, calculated using DR latitude 02°20. It gave longitude 080°35.2E at 0900 hours. Sun's azimuth was 099°T then. At 1130 Brother's point bore 260°T Find position of ship at 1130 hours. Given: Current set S20°w at 2 knots

Ans. Position at 1130h = 02°5.7'N 080°38.2'E



Rajendra Chola: *[1014- 1044] The most powerful emperor of the famous Chola dynasty, ruled eastern & south eastern India, Rajendra chola led a naval expedition to the Sumatran Kingdom of Srivijaya & Shailendras & defeated its rulers. Such an expedition across dangerous Bay of Bengal meant mastery of the sea route & ship building technology, gained over many centuries in the course of trade between India & South East Asia.*

[Pic. Coin from the period of Rajendra Chola]

Chapter 15: Deck Logbook

Logbook in general is a document for maintaining record of events as they occur. On ship there are many such documents. Most important are:

(a) Rough log book or Deck log book,
(b) Engine room log book,
(c) Movement log book,
(d) Official log book,
(e) Oil Record book &
(f) Radio log book.

Following are some of the other logs maintained on board: (1) Chronometer log, (2) Gangway log (3) Ballasting – de-ballasting - transfer of fluid log (4) Sounding log for ballast, FW, bilges & cofferdam, (5) Engine room oil soundings log, (6) Engine room to deck correspondence log, (7) VHF log, (8) Radar log, (9) DF log, (10) Compass error & deviation log, (11) GPS log, (12), Planned maintenance log, (13) LSA-FFA log, (14) Meteorological report log.

We will only discuss rough logbook here. Rough logbook or deck logbook certifies the occurrence of events on board as they must have occurred. Entries made are usable in the court of law as proof of occurrence on board. Logbook is extremely important document. It provides a running, chronological description of events as they may have taken place. It is not only a record of events for future but it also provides up-to-date information to next watch keeper or the watch keepers who were off watch. Master & chief engineer must read logbook every day & ensure that it is written in a proper way. Logbook must be carefully filled up at the end of every watch. Entries should not be delayed at any cost. All the entries must be correct, true & precise.

Deck logbook is also called rough logbook. Duty officer may make entries in permanent blue or black ink. Writing in pencil is not a correct thing to do. A copy of this log book known as 'fair log book' is neatly written or typed & forwarded to head office & kept there as office copy. Office may some times refer to 'fair log book' during court proceedings, negotiations with chartrers etc. Therefore entries made in fair logbook must be same as made in rough logbook by individual watch keepers.

In case a of cargo claim, collision, grounding or any other accident, investigating authorities will first ask for the rough log book & then other relevant log books. Logbooks not only act as a record house of past facts but also device to find the attitude of duty officers, chief officer & master. A logbook makes the first impression regarding the attitudes of persons on board. And it is said that 'one never gets a second chance to create the 'first impression' with some one'. Attitude & state of mind of persons some times is very important in deciding a case in court of law.

logbook entries must never be erased. In order to change or amend any entry, the previous entry must be deleted with a straight line in such a way that previous entry is legible & the person making the change must initial next to it.

Handwriting may not be very good but entries must be legible & non ambiguous. For this reason rough logbook is more important in an inquiry as compared to fair logbook. Personal diaries have been used as circumstantial evidence in many cases.

Logbook writing is an art. It is something, which must be properly taught to a trainee-officer. If a new officer does not fill up log book correctly, he must be corrected, by chief officer or master, otherwise he is likely to continue writing in wrong way even as senior officer. Logbook writing must be taken seriously. A watch keeper must consider "being able to write the logbook correctly & precisely" as a matter of pride.

There is no hard & fast rule as to what should be written & what may be omitted. Senior officers may guide watch keepers from time to time to this effect. At least the required minimum entries must definitely find a place in the rough logbook. The details are more fully given in other logbooks e.g. movement log book, sounding log book, official log book, deviation log etc.

Following are only some of the entries that are made in rough logbook.
Sailing watch: Statements regarding, comparison of compass, finding of error, plotting of fixes, checking of soundings, status regarding hold ventilation, mode of steering, VHF & 2182 watch, important correspondence with engine room, pilot, port etc & weather during the watch.

Anchor watch: Statements regarding comparison of compass, finding of error, checking position on radar & of anchor bearings including transit bearings, hold ventilation, VHF & 2182 watch, swinging of ship to ebb or flood, status of engines important correspondence with engine room, pilot, port etc & weather during the watch.

Cargo watch: Statements regarding details in respect of arriving of surveyors, stevedore, opening of holds, time spent in adjusting the cranes, booms, shifting of gangs, closing of tween deck covers, delays due to power failure, working hours of stevedore, meals hours, commencement of cargo work in a compartment, completion of work, stoppages due to rains & inclement weather, causes for all the stoppages, weather during watch etc.

It is permitted to use abbreviated language for writing the logbook, so that required description may fit in the available space. There is no standard list of abbreviated terms but ambiguous terms must be avoided. Some of the terms used are as follows: The meaning is self-explanatory. *D.S.ahd, S.ahd., S.B.E., E.A.R, M.O.T., Slt sea, Mod. sea, Dk, E/R, SUF &A,* ⚓ aweigh, Comc'd, Res'd, Hd line, All gone & clear F'd & aft, 3 ggs abd etc. Entries made on upper part of log book page are regarding name of ship, voyage from / to, date, day, vessel's position at (port), name of master.

One line is provided for each hour of ship's time. LHS page has coloumns for following entries: Hour (ship's time), Log, Course (true,gyro,standard), Error (gyro, dev, var), Wind(direction, Beufort force, height of seas), Swell (direction & height), Sky, Pressure, Visibility, Lookout, temp of dry, wet air & sea water, RPM.

RHS page has space provided for writing remarks & entries related to entries made on LHS page. OOW initials in the last coloumn at the end of his watch.

In the middle part of logbook following entries are made: (a) Zone, (b) Vessel position at 0400h, 1200h, 2000h (DR/Observed) (c) Vessel BUT .....anchor with .....shackles at .....roads.(d) Number of steering motor on after 1200h. (e) Important entries regarding cargo (eg status of hold ventilation) (f) Distance, weather, average speed, current, wind for 24h. (g) Draft AM, PM, density. (h) ROB of FO.

In the lower part of logbook, key (number / alphabet) for lookout men & helmsmen is indicated. Soundings of freshwater & ballast tanks, bilges for both am & pm is indicated. Fresh water remaining, received, generated, consumed is also indicated.

Chief officer & master must carefully read, check & sign each page of logbook everyday. The master signs the logbook in the space provided or in the lower part of the right-hand side page.

M.V. *Jal Vallabh* **From** *Mumbai* **To** *Colombo* **At** *Inner Anchorage Mumbai*

	Log	Course			Error			Wind		Swell		Sea	Sky	Temp			Press	Vis	RPM	H/M	L/O
		T	G	C	G	D	V	Dir	Force	Dir	Ht	Ht		D	W	S					
01																					
02																					
03																					
04																					
05																					
06								Lt	airs	--	--	--	bc	26	24	--	1013	8	--	--	--
07																					
08																					
09																					
10																					
11	000	044	043	040	1°L	3°E	1°E													2	B
12	010	044	043	040	1°L	3°E	1°E	SE	3/4	SxE	3	1	bc	30	27	31	1014	8	106	2	A

Vessel at Outer Anchorage Mumbai

VESSEL AT OUTER ANCHORAGE MUMBAI

Time Zone	Position of vessel	Dist up to NN	Speed 24h 12.1 kn	V/I B.U.T. P/Stbd ⚓
-0530	1200 DR/Obs 17°12'N077°40'E	17M	G Av Spd 12.1 kn	with.....shackles in/on
	2400 DR/Obs	DTG 740M	Weather 24h	water/deck at .....Rds

13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							
21																							
22																							
23																							
24																							

Fresh Water		Ballast		Bilges	
6 P/S	40/30	F/Pk	140	1c -	5c -
11P/S	20/65	2P/S	5	2c -	6c -
Dom	30	3P/S	nil	3c -	7c -
Apk	35	4P/S	nil	4c -	8c -

ROB
HO 765t
DO 120t
FW 220

RamjiBhai 1
Devji Varma 2
Bhim Kharwa 3

Veerji Patel [A]
Ved Chauhan [B]
Bhiku Khalasi [C]
Ramakant [D]

Date *17th* **Month** *October* **Year** *2002* **Voyage No** *O/B-23*
Day *Thursday*

Remarks	OOD
Compasses Compared, Error checked	
0130-0145 v/l swung around to ebb	
Anchor bearings checked regularly	
Port & other Safety regs complied with	
Watch maintd on VHF Ch 16 & 2182.	
Rippled Sea Low Swell Partly cloudy & Clear	
0612 Engines tried out on ahead & astern propulsion	
0705 Agent's boat a'side. 0720 P/C & other formalities acomplished 0730 boat	*away*
Departure anchorage: 0815: C,S. & Controls tested as per regs, all found in order	
0915: 1 HN to E/R 1000: 10MN to E/R. 1018:SBE & ⚓ stations. 1005:Comc'd weighing P⚓	
1009 D.S.ahd/ EAR. 1024 Anchor aweigh. 1026: S.ahd 1030: F.ahd Vsl steered on hand. Pos plotted frequently.1036: In pos with Sunk Rk Bn brg 124°T x 3.1M Set/Co 044°T 043°G 040°Std, (GE 1°L, var 1°E, Dev 3°E)/RFA Sdgs checked regularly.	
St sea, low swell, P/cloudy & clear	

Steering Motor/Pump *1*	Hold Ventilation *Attd*	Draft AM *8.20m 9.04m* PM
Steering mode *Auto*	Cargo lash/temp *Attd*	Density *1.022t/m³*

FW		
Generated	*Nil*	
Received		
D. Consumption.	*14t*	
ROB	*220t*	**Master** .....

Prince Henry The Navigator: *[1394-1460] Was responsible for starting the great age of exploration. He was a Portuguese prince who promoted explorations of the West African coast during 1400's. Henry sent more than 50 expeditions but did not go on any of them. The navigational knowledge gained under his direction led to several historic voyages within 50 years after his death.*

[Pic. Prince Henry The Navigator]

Chapter 16: Use of single position line

Using a single bearing line to steer a safe course & to fix up alteration point, in prevailing current

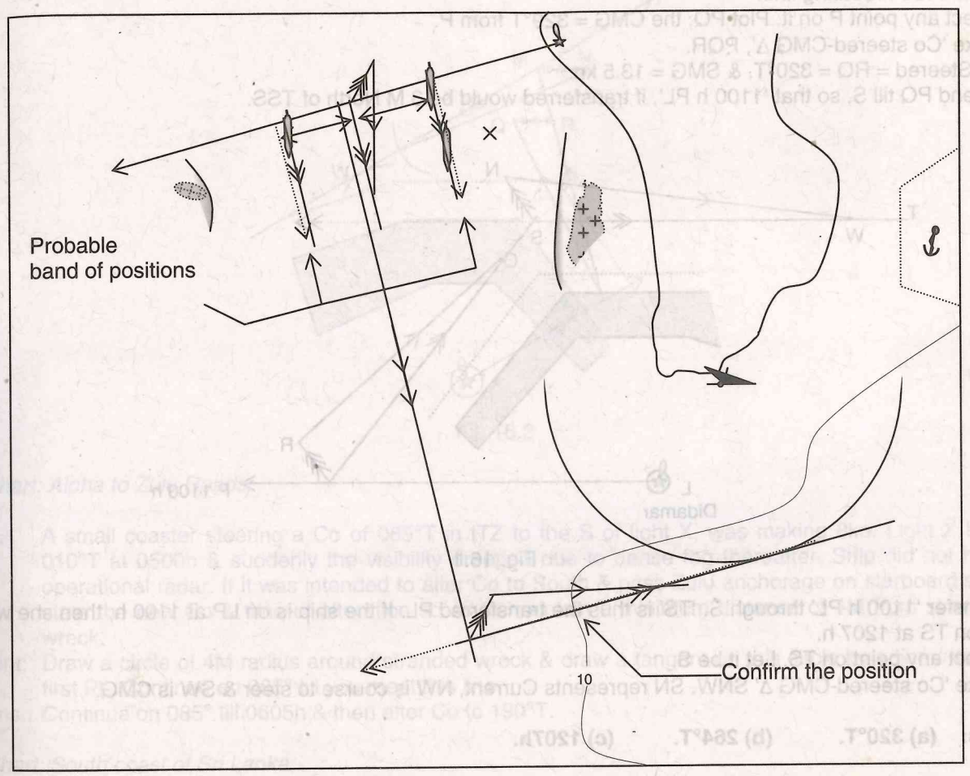
This topic deals with a situation where precise position fixing equipment like GPS & radar are inoperational. Radar is of great value in restricted visibility situation, especially in fog. It is possible that a single position line (terrestrial or celestial) was obtained just before the fog set in.

Navigation in fog is one of the most unwelcome situations, especially in the Coastal Navigation. Navigation in fog without radar must be avoided. A peculiar situation may however some times arise where a ship is forced to undertake a passage before reaching an anchorage for a temporary hault. A careful management of situation would help. The various aspects that must be considered are:

1) *Amend Passage Plan:* Clear visibility passage plan may not be suitable & a plan to suit the present conditions must be executed. In good visibility an under water rock is given a safe clearance, whereas a sharp island may be passed at much closer distance. In restricted visibility without radar both are equally dangerous.
2) *Safety & Seamanship*
   a. Master takes over.
   b. The situation is reported to VTMS & guidance sought. Normally if radar surveillance is available then one of the best solutions is to be guided to safe anchorage, where the necessary repairs can be undertaken.
   c. Report is made to port, speed, course, present position & intention etc reported. The traffic approaching, leaving the port is found.
   d. Safety message indicating above details transmitted. The same is supplemented with VHF message. The safety message will include the size, draft, intended speed, intention & present course & position.
   e. Echo sounder may be left on. The speed of advance recorder-paper can be slow but the depth range must be for shallow waters.
   f. Anchor is kept ready for letting go.

3) *ROR*
   a. Extra lookouts posted. (At forecastle with walkie-talkie if appropriate)
   b. Speed is adjusted for the prevailing condition.
   c. Engines are kept handy.
   d. Appropriate signals are made.

   e. International regulations for collision avoidance & conduct in prevailing situation complied with, as far as practicable. The fog signals for other type of vessels also are memorised.
   f. Navigation lights are switched on.
   g. Silence is maintained on deck. Posting of lookout on the mast is considered as some times the fog is very low-lying.



4) *Chart work or Geometrical*

The most probable DR is plotted on last available P/L. Clear water channel & no go areas are marked & course to make good are plotted giving due consideration to present navigational situation. More exact assessment of tidal stream & leeway is made to find course to steer for the reduced engine speed.

   a. The DR on the last observed PL may be in error by about 1 or 2 miles. Let us say the probable position band is 4 miles wide viz. 2 miles on either side of most probable position.
   b. The passage is checked for safety, under keel clearance & clearances with dangers. The passage must be safe for the entire probable band of positions.
   c. Next course to make good is normally the transferred PL or reciprocal of the PL. You must try that the course // to the P/L leads you to safe waters or an anchorage.

16.1 *A vessel with engine speed of 13 kn , is making good a course of 329°T, amidst current setting NE @ 2 kn & has Didamar Beacon bearing due West, at 1100 h. The vessel is clear of TSS The Radar is inoperational. Due to Meteorological visibility deteriorating continuously, observer is unable to see Didamar beacon now. It is intended to keep clear of TSS & alter course to make good a Westerly course & lying 3 M to the North of TSS Find,*

(a) *The first steered course*
(b) *The second course steered*
(c) Time of alteration of course. (Chart P.Gulf.)

Hint:
Draw 1100 h bearing line.
Select any point P on it. Plot PQ, the CMG = 329°T from P.
Make 'Co steered-CMG Δ', PQR.
Co Steered = RQ = 320°T. & SMG = 13.5 kn.
Extend PQ till S, so that '1100 h PL', if transferred would be 3 M North of TSS.

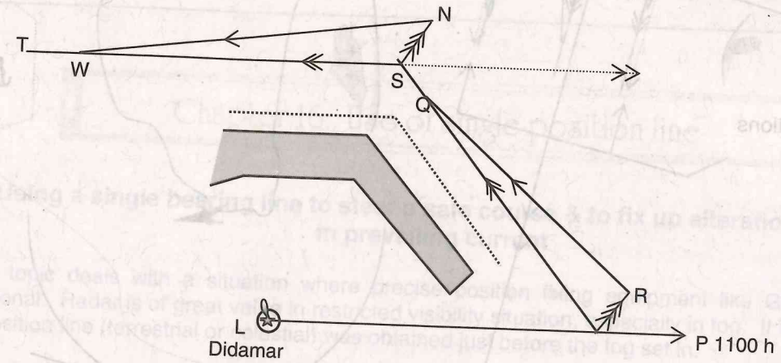


Fig. 16.1

Transfer '1100 h PL' through S. 'TS' is thus the transferred PL. If the ship is on LP at 1100 h, then she will be on TS at 1207 h.
Select any point on TS. Let it be S.
Make 'Co steered-CMG Δ' SNW. SN represents Current, NW is course to steer & SW is CMG.

Ans: (a) 320°T. (b) 264°T. (c) 1207h.

Using a single bearing line to steer a safe course & fix up alteration point, in prevailing current

Q.16.2 A ship in NW - bound lane of TSS steers 328°T at engine speed of 11 kn, has inoperational radar. Didamar Light bore 245°T at 2000 h & at 2005 h the light is extinguished. Current is known to set 'E' @ 2kn.
What time should the ship alter course, in order to pass the TSS from outside the TSS with a single course & maintain a minimum distance of 12 M from Didamar Beacon, while entering the Gulf? (P.Gulf).

Hint:
This problem is similar to the previous one. Here too the principle of transfer of PL is used. Thus the vessel may be anywhere on PL.
'How much, the PL has to be moved along the CMG so that the transferred PL is clear of dangers & represents a safe Co to steer along', is found.
Let this be x. Then x is the distance to make good along the original Co before the alteration may be caused.
Draw an arc of 12 M radius & draw transferred PL tangenting this arc.
Let P be any point on first PL,within the lane. Make PQR, the 'Course-Current Δ'. PR ≡ CMG & DMG.
Extend CMG line till transferred PL. It meets transferred PL at M.

MW is next course to make good.
MN is Set & Drift for 1 h & NW is course to steer.

Ans: In first leg: SMG = 10 kn, CMG = 338°T. A/Co at 2111 h.
New Co to Make Good = 245.5°T & Co to Steer = 250°T.

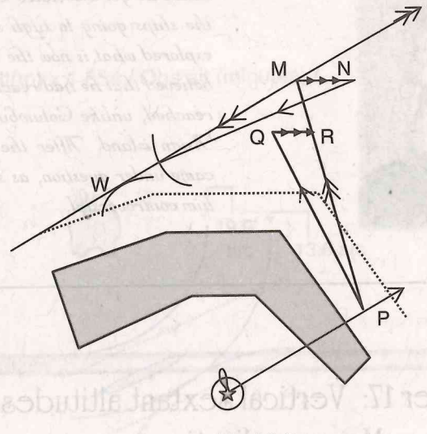


Fig 16.2

Chart: Alpha to Zulu Roads:

Q.1 A small coaster steering a Co of 085°T in ITZ to the S of light X, was making 8kn. Light X bore 010°T at 0500h & suddenly the visibility dropped due to dense fog thereafter. Ship did not have operational radar. If it was intended to alter Co to South & pass Zulu anchorage on starboard side, state the new Co & time of alteration so as to maintain a minimum distance of 4M from stranded wreck.
Hint: Draw a circle of 4M radius around stranded wreck & draw a tangent on this circle by a line // to the first PL. Continue on 085° till you meet this line.
Ans.: Continue on 085° till 0605h & then alter Co to 190°T.

Chart: South coast of Sri Lanka:

Q.1 Little Basses reef bore 005°T at 0900h. Ship steered a Co of 050°. Suddenly visibility dropped to less than 1M & at same time radar broke down. Master decided to anchor to NNE of reef, within 50m contour & stay there until fog cleared. How will you use 0900h bearing to keep L. B. reef light at a minimum distance of 6M, after alteration of Co.
Ans.: Continue on 050°T for 8.45M & anchor shortly after crossing 50m contour.

Vespucci Amerigo: *Born in Florence Italy earlier worked in a banking firm, later shifted to Spain, where he got associated with a company which dealt with the ships going to high seas. Vespucci claimed to have explored what is now the American main land in 1497 & believed that he had reached a new world & knew that he reached, unlike Columbus who thought he had reached Asian island. After the death of Vespucci his claims came under question, as scholars found evidences put by him controversial.*

[Pic. Vespucci Amerigo]

Chapter 17: Vertical sextant altitudes: More applications, [To get more accurate distance, Vertical danger angle]

Position circle by VSA (height of object corrected to present height of tide)

Q. 17.1 Vertical Sextant Angle of a light Fl 5s59m28M (IE nil), was observed to be 34.2'. Height of tide then was 0.3 m. Find the radius of position circle, if height of MHWS above Chart Datum on the chart used is 1.8 m.

Hint:

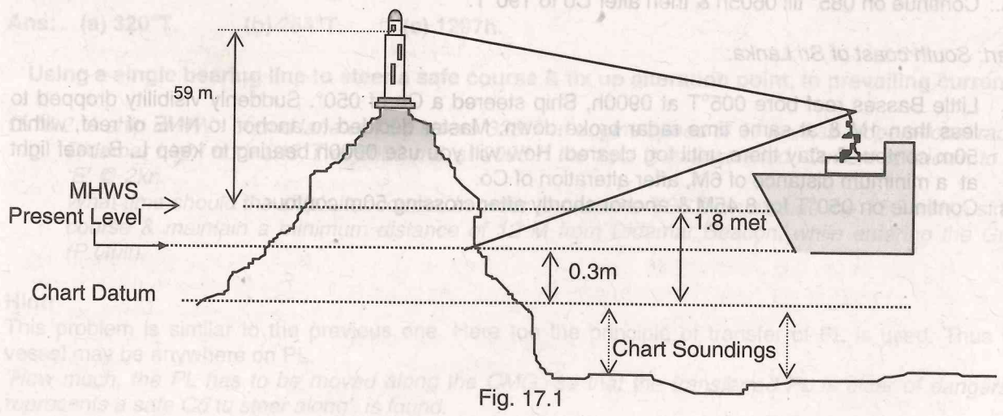


Fig. 17.1

Ht. of light from present level = 60.5 met. ∴ distance = 3.28 M.

Ans: Radius = 3.28 M.

Using VSA of an object to pass at a minimum / maximum distance from it

Q. 17.2 Find the Vertical Sextant angle to set, for Borzorg Light House, in order to keep the vessel at least 7 M from Light House but not closer than 4 M to Oil Platform on SSE side, while the ship follows ENE lane. (Persian Gulf)

Hint:
Ht of Lt House = 75 m.
We know that Distance = Ht(m) x 1.854 / Obs alt (minutes)

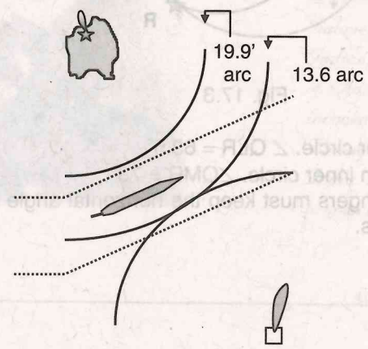


Fig. 17.2

∴ Sext alt in minutes = $\frac{75x1.854}{7}$ = 19.9'.

Sext angle should not be more than 19.9'.

For the 2nd part:

Draw an arc of radius = 4 M, around Oil Platform. Draw another arc, with Borzorg Light House as centre, tangenting the 4M arc from outside. This arc is of radius = 10.25 M. ∴ the ship should not be more than 10.25 M from Light House, while it is in opposition with the Oil Platform. Thus Sext angle should not be less than 13.6'.

Ans: 19.9' > Sext alt >13.6'.

Using principle of horizontal angle to pass a danger on Port or Stbd side

Q. 17.3 A vessel in ESE bound traffic lane, is presently in a position 1 M SE of 'N' Light float. She intends passing 4m rock on starboard side & 4.2 m shoal on port side atleast by a margin of 9 cables. Find out minimum & maximum Horizontal angles, the vessel must maintain between 'Q' & 'R' lights, to clear rock & shoal as desired. (A Lt to Z Rds)

Hint:
Plot initial position SE of 'N' Light Float.
Draw a circle of 9 cables radius around 4 m rock & 4.2 m shoal.
Join R-Q. Drop a perpendicular bisector SP on RQ.
By trial & error method find radius & centre of a circle, which will pass through Q, R & is tangenting, the 9 cable arcs from convex sides. This way two circles are plotted, say outer-circle & inner - circle. Centres of both circles should lie on SP.

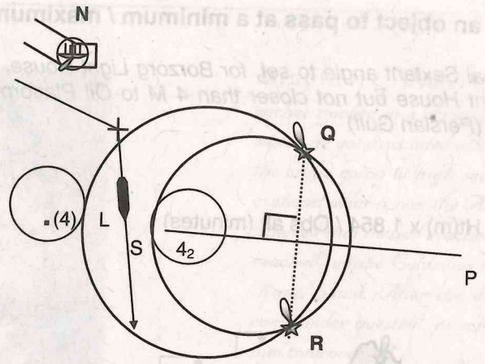


Fig. 17.3

Select a point L, somewhere on the outer circle. ∠ QLR = 63.5°.
Similarly select a point M, somewhere on inner circle. ∠QMR = 78°.
Thus the ship while transiting above dangers must keep the horizontal angle between 'Q' & 'R', between 63.5° & 78° until clear of the two dangers.

Exercise:

Chart: Alpha Lt to Zulu Roads:

Q.1 Find distance from X light if vertical observed angle of light was 16.5' at the instant when tide level was 2.4m below MHWS.
Ans. Distance = 62.4 x 1.854 / 16.5 = 7.01M.
Q.2 Find the range of vertical sextant angles to be maintained while following SSW bound traffic lane, using X light in order to maintain at least 8 cables from rock in separation zone as well as from nearest coast on starboard side.
Ans. Radii of two danger circles = 4.55M & 5.45M respectively. Accordingly minimum & maximum sext angles = 24.4' & 20.4' respectively.

Chart: South coast of Sri Lanka:

Q.1 Little Basses reef measured 11' above water line, when height of tide was 1m. Great Basses reef light was 17M off at the same time. Find pos. (Given MHWS = 3m)
Ans: 06°18.35'N081°44.2'E
Q.2 Vertical sextant altitude of Tangalla Peak(61m) was 12', (Index error 0.5'off), when water level had fallen by 2m below height datum. At the same time horizontal angle between above peak & Dondra Hd light was 65°. Find ship's position.
Ans. 05°51.75'N080°48.1'E.

Vasco da Gama: *[1469- 1524] Was born in Portugal, he learnt astronomy & navigation. He became a navel officer in 1492. With a convoy of 4 ships & 170 men Da–Gama sailed from Lisbon on July 1497, He rounded cape of Good Hope on November 22nd. Arabs in Mozambique & Mombassa caused resistance but were helped by people at Malindi, who also guided the convoy to India. The irony of fate is that da Gama's ship 'San Gabriel' was piloted to Calicut from Malindi by an Indian. King Manuel of Portugal gave Gama, the title of 'Admiral of the sea of India'. Da Gama killed many innocent Indians to take revenge of violence against Portuguese sailors. In 1524 he was named Viceroy of India. He died the same year. Vasco da Gama is known to open new sea route to India for Europeans.*

[Pic. Vasco da Gama]

Chapter 18: Transfer of a pos circle

Transfer of Pos Circle

In a chapter earlier in this book we have discussed different methods of obtaining a position circle. In another chapter we have discussed the method & purpose of transferring of a position line. Transfer of a position line on chart is rather simple. It can conveniently be done by running a point on the PL to be transferred & then drawing a //-line through the point thus transferred. Above method however is not suitable for transferring of a pos circle.

When must the transfer of a pos circle be done?

Basically transfer of PL or position circle is done in the situations where simultaneous fix is not available due to inadequate position fixing data at any instant. A ship may be on a pos circle obtained by vertical altitude, horizontal angle, raising distance or dipping distance etc. Subsequently, if additional data viz. bearing or position circle is available, then the first position circle is transferred for the time of such later position data to obtain a fix. Such a fix may be called running fix of a position circle.

Method of transferring;

Let A be the centre of first position circle, on which the ship was, at the time of first observation. Course made good by the ship & the distance made good between the first observation (pos circle) & second observation (pos circle or pos line) is allowed to the centre of first pos circle. By running the centre of the first circle we get a position, let's call it 'B'. With this point as centre, a circle of radius of original position circle is drawn. The circle thus obtained is position circle transferred for the time of second observation.

The method & application of transfer of position circle will be better understood with the following example.

Q. 18.1 Vessel on SE course saw Alpha light for last time at 2030h, HE 15m, meteorological visibility = 5M. If at 2100h 'N' racon bore due South, find position of vessel at 2100h. Given: ship's speed 10.4kn.

Sol.
Comparing the geographical range & PLR, we get PLR < GR. & PLR = 13.7M.
Position circle at 2030h is a circle of radius = 13.7M with 'A' as its centre.

Draw AB = 5.2M, (DMG in 30 m) along SE.
With B as centre, draw a circle of radius = 13.7M.

This is pos circle transferred for 2100h.....(1)
Plot ND, the bearing of 'N' at 2100h.....(2)

Transferred pos circle (1) & current PL (2) meet at C. (the fix at 2100h).

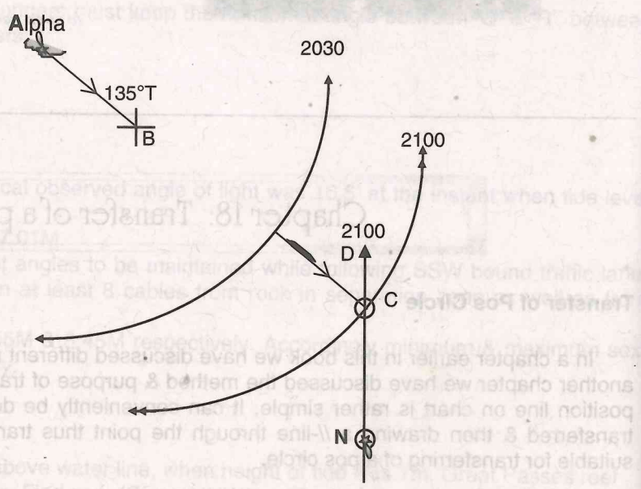


Fig 18.1

Ans. Pos at 2100h ≡ **2°8.5N, 80° 10.9E.**

Q. 18.2 'O' light was raised at 1930h, the same light was found at a distance of 5M at 2030h. Find position of the vessel at 2030h. Given that the ship steered a Co of 110°T at 11.2kn, during the above passage. HE 10 m.

Sol.
Draw pos circle for 1930h & transferred pos circle for 2030h, by the method explained in last example.
With '0' as centre, draw a circle of radius = 5M. This is current pos circle for 2030h. Where this circle meets transferred pos circle for 2030h, is the fix at 2030h.

Ans Position at 2030 h **02°11.8'N 080°12.6'E.**

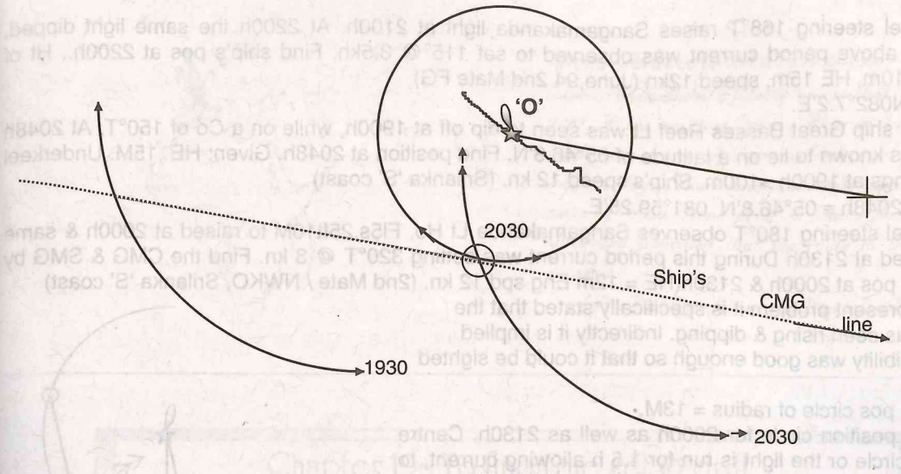


Fig 18.2

Exercise

Chart: Alpha Lt to Zulu Roads:

Q.1 A and B lights were 90° apart at 1800h. Vessel steamed a Co of 129°T & after sailing for 90 min found herself to be 6 M from T light. If current set 'S'ly at 1.2kn, find position at 1930h. If 'T' in transit of 'U' bore 54°C, during above passage, find compass error. Given: ships speed 13.60kn.
Ans. Position at 1930h: 2°7.05 N, 080° 17.3E. True Bearing at T / U transit = 48.5°T. Error = 5.5°W.

Q.2 In reduced visibility condition X- light was visible for a maximum distance of 9M from a ship steering 023°T at 9.5kn. Current set 323°T at 1.7 kn. Find position at 1900 and 2000h, if on above course the light was seen for first time at 1900 and for the last time to at 2000h.
Ans. 1900: 2° 2.8 N 80, 80°31.3'E, 2000 2°12.8 N, 80° 33.9 E, CMG 015°T.

Q.3 X light was seen for the first time at 1900h in a meteorological visibility of 2M, by a ship steering due 'N'. Ship's speed was 9.5kn. At 2000h, racon, 'U' bore 300°T find position at 2000h. From above position find course to steer to reach a position 2° 17.5' N 080°28.5'E counteracting current. Given current set due E @ 1kn.
Ans PLR 10M, position at 2000h: 02° 11.32N, 080° 32.85E, Course to MG 325°T, Co to steer 320°T.

Q.4 At 0600 hours horizontal angle between F buoy and 'N' light float was 128° ship steered 108°T at 10 knots then. At 0700 hours the course was altered to 041°T. At 0748 the horizontal angle between 'X' lighthouse and David peak was 68°. Find position of ship at 0600 hours and 0748 hours. Given: At 0600 hours ship was outside the traffic lane on the south side.
Ans. Post at 0600 hours: 02° 2.95'N 0.80° 6.95'E, 0748 hours: 02° 6.0'N 080° 21.75'E

Q.5 Vertical sextant altitude of X light was 18' at 0800 hours. From here ship steered a course of 131°T at 10 knots. Current set 168°T@ 2kn. At 0900 hours sun's sight calculated using DR 02°01' 080°34.2'E, gave Az. 0.70°T Intercept 3.6 miles towards. Find position of ship at 0900 hours and at 0800 hours.
Ans. Position at 0900 hours: 01°58.35'N 080°39.1'E. 0800 hours: 02°6.9'N 080°31'E

Chart: South coast of Sri Lanka:

Q.1 A vessel steering 168°T raises Sangamakanda light at 2100h. At 2200h the same light dipped. During above period current was observed to set 115°@ 3.5kn. Find ship's pos at 2200h., Ht of light = 10m, HE 15m, speed 12kn (June,94 2nd Mate FG)

Ans: 07°00'N082°7.2'E.

Q.2 From a ship Great Basses Reef Lt was seen to dip off at 1900h, while on a Co of 150°T. At 2048h she was known to lie on a latitude of 05°46.8'N. Find position at 2048h. Given: HE ,15M. Underkeel soundings at 1900h >100m. Ship's speed 12 kn. (Srilanka 'S' coast)

Ans. Pos at 2048h ≡ 05°46.8'N 081°59.25'E.

Q. 3 A vessel steering 180°T observes Sangamakanda Lt Ho, Fl5s.25ft10M to raised at 2000h & same Lt.dipped at 2130h During this period current was setting 320°T @ 3 kn. Find the CMG & SMG by vessel, pos at 2000h & 2130h(HE = 12m Eng spd 12 kn. (2nd Mate / NWKO, Srilanka 'S' coast)

Hint. In the present problem it is specifically stated that the light was seen rising & dipping. Indirectly it is implied that visibility was good enough so that it could be sighted at GR.
Draw a pos circle of radius = 13M.
This is position circle for 2000h as well as 2130h. Centre of the circle or the light is run for 1.5 h allowing current, to draw transferred pos circle for 2130h.
Position at 2130h is the intersection of 2130h, 'current position circle' & 2130 h transferred pos circle.
To find 2000 h pos, go back // & reciprocal to CMG from position at 2130h, for 1.5 h

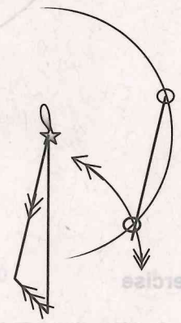


Fig 18.3

Ans. CMG = 191.5°. SMG = 9.87 kn. Pos at 2000 h ≡ 07°06.8'N 082°04.5'E
Pos at 2130 h ≡ 06°52.2'N 082°1.75'E.

Q. 4 Great Basses Lt was raised at 0530h. Ship while steering a Co of 225°T, at 13kn found the light passing abeam at 0700h. Find ship's pos at 0700h. HE = 15.5m.

Ans. Pos 06°6.6'N 081°33.1'E

English Channel:

Q. 5 At 1600h Start Point Lt was found 15M off, by a vessel steering a S'ly Co. Current set along 220°T @ 2kn. At 1800h intercept of a star calculated using position, 49°33'N 003°30'W gave intercept of 3.1'(A) & azimuth 165°T. Plot the pos of vessel at 1600h. (Speed 12 kn)

Ans. 50°4.4'N 003°19'W or 49°59.5'N 003°48'W

Dias Bartolomeu: *[1450–1500] A Portuguese captain commanded a fleet of 3 ships that left Portugal in 1487. At the mouth of Orange River in South Africa the ships were driven off to sea & land could not be seen for next 13 days. There after land was seen. Dias sighted cape of Good Hope prior to Vasco da Gama & this discovery indicated that sea route to India was soon possible.*

[Pic. The Route followed by Dias before Vasco da Gama]

Chapter 19: To find true set & drift [when estimated set & rate was wrong]

In Chapter 10 we learnt to find the course to steer in order to reach a position or make good a course, counteracting the current and wind. Now it may so happen that in spite of steering the above course you do not reach intended position.

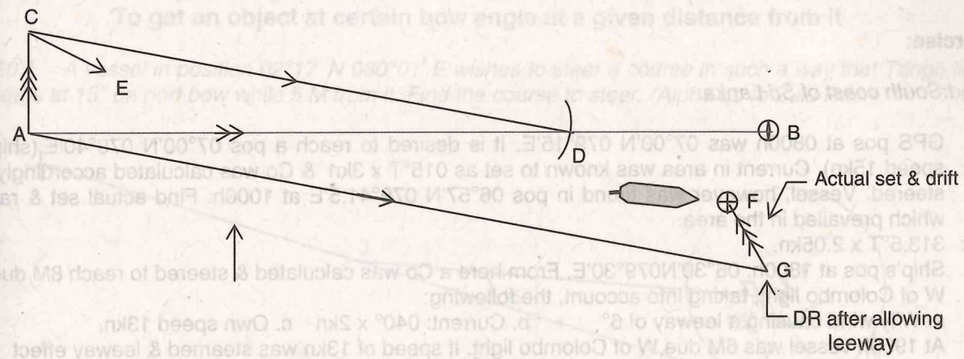


Fig 19.1

Suppose, present position is at 'A' and ship must reach 'B' pilots.

AC = current, ACD is triangle for 1 hour. ∠ ECD = leeway for S'ly wind. Ship must steer CE in order to reach B. in say 2 hours

Now suppose leeway estimated was correct but actual set & rate was not estimated correctly, ship will reach a different position say F after 2 hours.

If ship steers a course CE from A, leeway is correct as estimated but current is zero, where will the ship reach in 2 hours?

To find this we must draw a line // to CD through A and plot EP at end of 2 hours. Call it G.
Now position G will be reached if ship experiences above leeway and zero set & drift.
Whereas position F was reached by experiencing above leeway and actual set and drift.
This means from G to F must be actual set and drift in 2 hours.

Estimated current turns out to be incorrect. To find actual Set & rate of Drift

Q.19.1 A vessel in position, 4 M due West of EC1 Buoy, at 0400 h, wishes to reach 3 M due South of Needles Pilot boarding position at 0730h. If average current expected during the passage is SSE x 2 kn & maximum engine speed is 13 kn. Find out, at what engine speed to proceed & what course to steer to make good the desired ETA? (English Channel)

Hint:
Plot initial position, J & final position K. JK represents course to make good & distance to make good in 3.5h.
Draw JL ≡ 157.5° x 7 M. LK gives the distance steamed by engines or log distance in 3 h = 34.6 M.

Ans: Co to steer = 008°T. Engine speed = 9.9 kn.

Q. 19.2 The vessel in last Q, instead of reaching the desired position, finds herself to be a position 8 M due South of Needle Light, at 0730 h. Find out actual Set & Drift experienced by the ship.(English Channel)

Hint:
While solving Q. 19.1, Co to steer & engine speed were found to be 008°T & 9.9 kn respectively. In absence of current the ship would have reached M, where JM // LK & JM = LK. However in effect, the ship reached N, which is 8 M South of Needles Light. Thus MN gives actual Set & Drift experienced in 3h.
MN ≡ 139.5°T x 11 M.

Ans. Set & rate ≡ 139.5°T x 3.67 kn.

Exercise:

Chart:South coast of Sri Lanka:

Q.1 GPS pos at 0800h was 07°00'N 079°15'E. It is desired to reach a pos 07°00'N 079°40'E.(ship's speed 15kn). Current in area was known to set as 015°T x 3kn & Co was calculated accordingly & steered. Vessel, however was found in pos 06°57'N 079°41.5'E at 1000h. Find actual set & rate, which prevailed in the area.
Ans: 313.5°T x 2.05kn.
Q.2 Ship's pos at 1800h: 06°30'N079°30'E. From here a Co was calculated & steered to reach 8M due W of Colombo light, taking into account, the following:
a. W'ly wind causing a leeway of 6° b. Current: 040° x 2kn c. Own speed 13kn.
At 1950h vessel was 6M due W of Colombo light. If speed of 13kn was steamed & leeway effect was 6° only, what went wrong? Why vessel did not reach intended position?
Ans: Current which prevailed in area was 051°T x 3.6kn
Q.3 From pilot boarding point off T light, find a Co to steer to reach a position 4 M due S of A light . Given: ship's speed 9kn. Current setting along 180°T at 1.5kn. Vessel steered a Co to counteract current. If at the end of 2 hours of steaming vessel was found 5M due S of A, find actual set & rate of current experienced.
Ans. Co to steer 304.5°. From DR (not allowing current) at end of 2 h, to actual pos at the end of 2h, set & drift experienced = 223°T x 3.8M. ∴Actual set & rate = 223°T x 1.9kn.

Hipparchus: *[180 BC- 125 BC] One of the most important inventions of medieval shipping was introduction of Astrolabe by Greek astronomer Hipparchus. Hipparchus is also known for discovering precession of equinoxes. It must be noted that precession of equinoxes was known to Vedic Rishis. First point of Aries ' or Vishu Bindu, traveled 27th part of ecliptic in 1000 years or 100 years to travel 27th part of Saptarashi (Great Bear Constellation) gave a rate of 48" per year. The rate provided by Vedic description is extremely precise. Hipparchus drew the first catalogue of stars. Showing their brightness & position.*

[Pic. A Star chart with Mythological Figures]

Chapter 20: Simple geometric applications - 2:

[To get an object at certain bow angle at a given distance (with or without current). To get an object right ahead at a certain distance off in prevailing current. To get a light on beam after a given interval. To get a light θ° on bow at a certain distance in prevailing current]

To get an object at certain bow angle at a given distance from it

Q. 20.1 A vessel in position 02°17' N 080°01' E wishes to steer a course in such a way that Tango light appears at 15° on port bow while 5 M from it. Find the course to steer. (Alpha Lt. to Zulu Rds.)

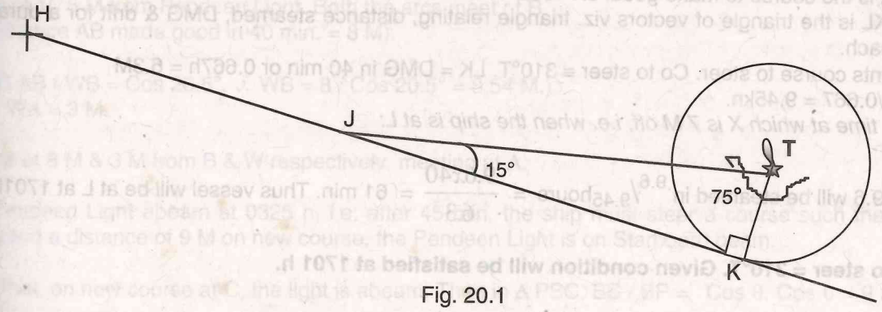


Fig. 20.1

Principle:
Plot 'H' , the initial position.(see fig. 20.1)
If HK is the line of approach & K is the position closest to light, we will try to find KT the distance between K & light.
Let J be a point on this line such that JT = 5 M, then ∠ TJK = 15°.
In triangle TJK, ∠ K = 90° ∴ TK/TJ = Sin 15° & ∴ TK = TJ Sin 15°
∴ TK = 5 x Sin 15° = 1.3 M

Beam distance = distance from light at any instant x sine bow ∠ at that instant

Construction:
Draw a circle of radius = 5 Sin 15° = 1.3 M.
From H draw a line which is tangent on above circle & T is to the left of this line.
Name the tangent point as K.
HK is co. to steer & = 107° T.

Ans. Co to steer = 107°T

To get an object right ahead at a certain distance off in prevailing current

Q. 20.2 A vessel in position 02°00' N 080°39' E at 1600 h wishes to use Inshore Traffic Zone (ITZ), south of X-ray light. Master wants to have the light X right ahead when 7 M from it. Find the steady course to steer to achieve above & time at which X-ray light will be 7 M off. (Given: current setting throughout ≡ 180° x 1.8 kn & log speed = 10.5 kn) [Alpha Lt. to Zulu Rds.]

Construction:
Plot initial position 'J'. Draw an arc of 7 M radius in direction of J.
Log spd = spd over water = 10.5 kn.
Distance over water equal to 7 M will be steamed in $\frac{7 \times 60}{10.5}$ = 40 min.

40 min is the interval of time for which we need to make a triangle at the lighthouse.

Interval of time $= \frac{Right\ Ahead\ dis\tan ce}{Engine\ speed}$ = 0.667 hours = 40 minutes.

Drift due to current in 40 min = $\frac{40x1.8}{60}$ = 1.2 M.
The drift vector for 40 min is applied at the light X.
Thus draw XK ≡ 180° x 1.2 M
Join JK, JK is the course to make good. JK ≡302°T. It meets '7 M arc' at L.
Triangle XKL is the triangle of vectors viz. triangle relating, distance steamed, DMG & drift for a duration of 40 min each.
LX represents course to steer. Co to steer ≡ 310°T. LK = DMG in 40 min or 0.667h = 6.3M
SMG = 6.3/0.667 = 9.45kn.
To find the time at which X is 7 M off, i.e. when the ship is at L:
JL = 9.6M

Distance, 9.6 will be steamed in $^{9.6}/_{9.45}$hours = $\frac{9.6x40}{6.3}$ = 61 min. Thus vessel will be at L at 1701h.

Ans. Co to steer = 310°T. Given condition will be satisfied at 1701 h.

Principle:

If L is the point at which above condition is satisfied then
(a) JL = co. to make good, as the ship must physically move on JL.
(b) Since at L light is right ahead & vessel is on steady course, LX represents the ship's head or co. steered.

Thus if length XL is made equal to distance steamed vector as well as equal to distance at which light is to be sighted right ahead then its possible to get CMG & DMG side of the vector triangle.

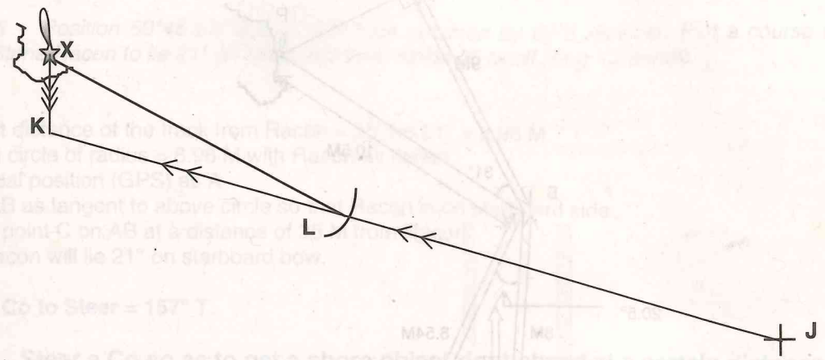


Fig. 20.2

To find out the nearest or beam distance if distance from light + Quarter angle is known. (No prevailing current). To calculate the Co to steer from a known pos in order to be abeam after traveling a given distance

Q. 20.3 A vessel following North bound traffic lane, has a speed of 12 kn. She finds Wolf Rock Light abeam at 0200 h & alters course at 0240 h, when Wolf Rock Light is 20.5° on Stbd quarter. Pendeen Light is 10.5 M off at this moment. In what position was the course altered? If it is possible to carry out the alteration instantly, find the new course to steer, in order to get Pendeen light abeam at 0325h. What was the first course & beam distance from Wolf Rock Light? (Eng.Channel)

Hint:

Suppose the ship is abeam Wolf Rock at 0200 h, i.e. at A. At 0240 she is at B.
Draw an arc of 8.54 M from Wolf Rock Light.
Draw arc of 10.5 M from Pendeen Light. Both the arcs meet at B.
Note: (Distance AB made good in 40 min. = 8 M).

In Δ WAB AB / WB = Cos 20.5°. ∴ WB = 8 / Cos 20.5° = 8.54 M.)
Similarly WA = 3 M.

Draw arcs of 8 M & 3 M from B & W respectively, meeting at A.

To get Pendeen Light abeam at 0325 h, i.e. after 45 min, the ship must steer a course such that after making good a distance of 9 M on new course, the Pendeen Light is on Starboard beam.

Assume that, on new course at C, the light is abeam. Then in Δ PBC, BC / BP = Cos θ. Cos θ = 9 / 10.5.
∴θ = 31°.

Ans: Initial Course = 356°T. Beam distance Pendeen Light = 3 M
Alter course position ≡ 50°04.3'N 005°54' W. New course = 027°T.

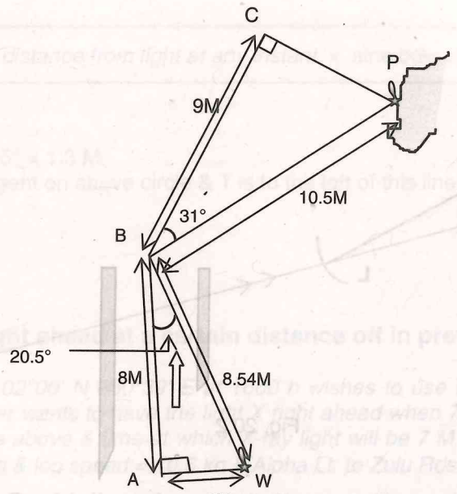


Fig 20.3

Shore object right ahd at a given distance on a known heading in prevailing current. Direction of Set & beam dist of the same object is known. To find the rate of current

Q. 20.4 A ship is steering a course of 237°T. She in a current setting 345°T, finds Greenwich Buoy right ahead at 0400h, whilst 20 M from it. Beam distance of Greenwich buoy on this course will be 6.5 M. Find the rate at which the current is setting & the time when the buoy will pass abeam & SMG. (Ship's speed = 15 kn) (Eng. Channel)

Hint:
This question is based on the principle of 'getting a light right ahead' principle. Thus the interval of triangle = 20/15 = 1.33h = 01h20m.
Draw KG ≡ 237° x 20 M.(20 M is engine distance in 1h 20 min & KG represents direction of course steered. (G is position of Greenwich Buoy).
Draw MG ⊥ ar to KG & = 6.5 M, (the beam distance). KM = 21 M.
Join KM. KM is direction of Course made good.
From G, draw a line in direction of 345° meeting KM at N. GN ≡ Set & Drift in 1h 20 min = 6 M. Also KGN is 'Co steered-CMG Δ' for 80 min.

Ans: SMG = 14.1 kn. Hourly rate of Drift = 4.5 kn. Greenwich Buoy abeam at 05h 29.4min.

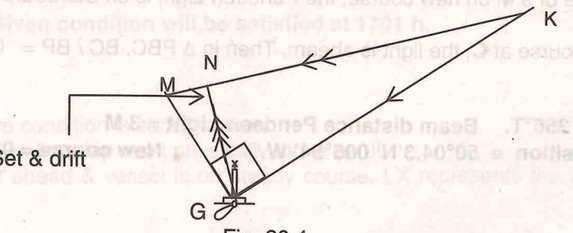


Fig. 20.4

To plot a Co to get shore object at a certain angle on bow

Q. 20.5 Position 50°46.5'N 006°17.6'W was obtained by GPS receiver. Plot a course to find Seven Stone Racon to lie 21° on starboard bow, whilst 25 M off.(Eng. Channel)

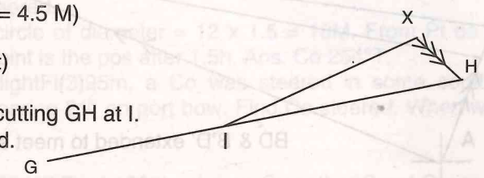
Hint:
Nearest distance of the track from Racon = 25 Sin 21° = 8.96 M.
Make a circle of radius = 8.96 M with Racon as centre.
Plot initial position (GPS) as A
Draw AB as tangent to above circle so that Racon is on starboard side.
Mark a point C on AB at a distance of 25 M from Racon.
At C Racon will lie 21° on starboard bow.

Ans: Co to Steer = 157° T.

Steer a Co so as to get a shore object right ahead at a certain distance off

Q. 20.6 A ship in position 6.5 M to S of Greenwich buoy, at 2330 h, sets a course in such a way that Bassurella Light is right ahead, whilst 25 M off. Given: Ship's speed 12.5 kn , Current in the area sets 132° x 2.25 kn. Find Co steered to achieve above & distance of light when abeam.(Eng. Channel)

Hint:
Plot the ship's position at 2330 h as G.
Distance from the light when right ahead = 25 M.
$\frac{25}{12.5} = 2hrs.$ (Eng. speed = 12.5 kn & current in 2 h = 4.5 M)
Draw XH ≡ 132° x 4.5 M, (X being the position of Light)
Join GH. GH is final course to make good & = 074°T.
Draw an arc of radius 25 M, on GH from X as centre, cutting GH at I.
Δ XHI is '*Co steered, CMG Δ*' & IX is the Co to steered.
Co Steered = 068°T. SMG = 13.3 kn.
Draw XJ ⊥ar to Co steered meeting the CMG line at J.
GJ = 39.6 M & Travel time @ 13.3 kn = 02h 58m. ∴ Light is abeam at 0228h



Ans: Beam-distance = 4 M.

To steer a course in order to find a light at a certain angle on bow in prevailing current.

Q.20.7 Ship's position at 1600h was 05°43'N 080°50'E. From this position find a course to steer to find Great Basses light at 40° on port bow when 18 miles off (Given: ship's speed 15 kn. Current set 330° @ 2 kn)

Hint
At G. Basses light draw a circle of radius 18M & 18Sine 40° = 11.57 miles.
Ship's Distance from 18M arc = 48-18 = 30M
Drift equivalent to engine distance of 30M $= \frac{30 x\, rate}{15} = \frac{30 x 2}{15} = 4M.$
Let the initial position be A. At A plot AB = 330° x 4M
From B draw tangent to 11.57 miles circle viz. BC
BC meets 18M circle at D. BD = 32.4M

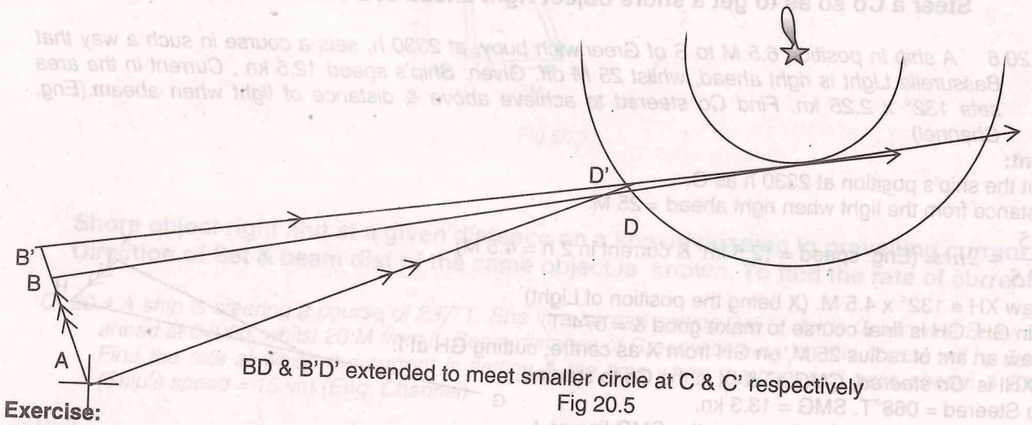
Drift equivalent to anengine distance of 32.4M $= \frac{32.4\,x\,rate}{15} = \frac{32.4\,x\,2}{15} = 4.32M$

At A plot AB' ≡ 330° x 4.32M
From B' draw tangent to '11.57 miles-circle' viz. B'C'
B'C' is CTS = 073.5°T B'C' cuts 18 miles arc at D'. AD' is CMG
When 18 miles off bearing of Great Basses Light = 033.5° T

AD' (31.6 miles) is DMG in $\frac{B'D'}{ES} = \frac{32.6}{15} = 2.17h = 2h10\min$

$$\therefore \text{SMG} = \frac{31.7}{2.17} = 14.61kn$$

Ans. CTS 073.5°T, SMG 14.61 kn, Light 18 miles off at 1610h.



BD & B'D' extended to meet smaller circle at C & C' respectively
Fig 20.5

Exercise:

Chart: Alpha to Zulu Roads:

Q.1 From pilot boarding point off 'T' light, steer a course in order to have B light 25° on stbd bow when at a distance of 7M.
Ans. Radius of circle to draw around B = 2.96M. Co = 300°T.
Q.2 From pilot boarding point off 'T' at 0600h, find a Co to steer to find R light at 30° on starboard bow when it is at a distance of 7M. If later while on this Co, it was decided not to go close to Q light within 5M, show how can this be achieved using the 'vertical sextant angle principle'. Given: height of 'Q' light 30m & ship's speed 12 kn.
Ans. Co steered = 182°T. Vertical sextant angle set, during sailing round the arc = 11.1'.
Q.3 In the previous example, find the expected time of passing 'R' light on starboard beam.
Ans. Straight line distance = 7.8M, distance along the arc = 7.86M. ETA abeam position = 0718h.
Q.4 From a position 02° 08' N, 080°15 E at 2100h, steer a course to have Alpha light right ahead at a distance of 10 M. Given ships speed 8kn current setting due E at 1.6kn.
Ans. Drift in 75 min = 2M. Co to MG = 324°T, Co to steer = 315°T.
Q.5 Find the time when the light A will bear right ahead in above example. Find also the distance of vessel from 'B', when closest.
Ans. SMG = 8.7 x 60 / 75 = 8.7 / 1.25 = 6.96kn. Time taken to reach the 'right ahead position' 11.45 / 6.96 = 01h 39m. Thus A will bear right ahead at 2239h. Closest distance from B = 1.94 M.
Q.6 From a position 02° 24' N 080°E at 1900h, steer a course in order to find Q light Fl(3)15s40m20M, right ahead when light is first seen in a meteorological visibility of 5M. Given current NE x 2kn, HE 12M, engine speed 9kn. Find CMG, SMG, course to steer, time when the light is first seen.
Ans Q light will be first seen when it is 11.8M off. Drift in 79 min = 2.62 M, CMG 141°T. SMG 8.54 kn, Co to steer 154°, Q- light will be first seen at 2046h.

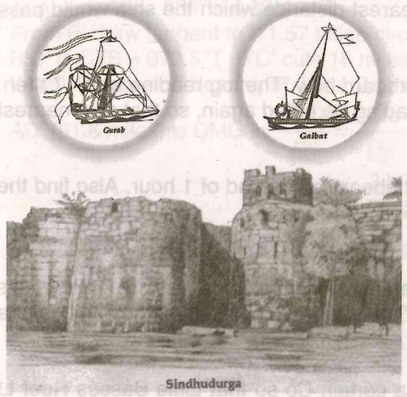
Q7 A light bore 45° on port bow. At this moment log was set to zero. Log read 7 when the light was seen abeam. Find the distance of the light from ship at 2nd observation.
Ans 7M, by 'doubling of bow angle principle'.
Q.8 At 1000 a light house was a° on port bow, at 1030h, same lighthouse was b° on port bow. If distance steamed from 1000h to 1030h is equal to the nearest distance which the ship would pass off the lighthouse, find the relation ship between a and b.
Ans. Cot a° - Cot b° = 1.
Q.9 A vessel while coasting saw a shore object at 20° on starboard bow. The log reading was 17 then. At what bow angle (of the same object) should the log reading be noted again, so that ship nearest distance of passing the object is known in advance.
Ans. Second bow angle is 29.78°, as Cot 20° - Cot 29.78° = 1.
Q.10 From a pos, 5M due S of A light steer a Co to find O light abeam at the end of 1 hour. Also find the distance of O light when abeam. Given: ship's speed 11.5 kn.
Ans. Co to steer 132.5°. Beam distance = 6.65M.

Chart: South coast of Sri Lanka:

Q.1 Little Basses Reef Lt bore dueW & at the same time its vertical sextant altitude was 13.1'. From this pos steer a Co in order to find Great Basses Reef Lt a 40° on starboard bow, when the same is at a distance of 15M.
Ans Dist from LB Rf Lt = 4.81M. Co to steer 214.5°T
Q.2 From pos 05°45'N 082°00'E at 1800h, a vessel steered a certain Co so that Little Basses Reef Lt was seen right ahead when it was at a distance of 20M. Find Co steered, time when light was right ahead & ship's pos then. (Given: ship's speed 15kn, Current 120°T x 3kn).
Ans. Co steered 334°T, CMG 341°, SMG 12.56kn. Light was right ahead at 1949h. Pos≡ 06°6.5'N 081°52.5'E.
Q.3 From a pos, 6M due S of Dondra Head, ship steered a certain Co so that in 1.5h Pt de Galle was abeam. If ship's speed was 12kn, find Co steered.
Hint: With the initial position as centre draw a circle of diameter = 12 x 1.5 = 18M. From Pt de Galle draw a line tangenting the circle. Tangent point is the pos after 1.5h. Ans. Co 254°T.
Q.4 From a pos, 8M due WSW of Colombo lightFl(3)25m, a Co was steered in some southward direction. Barberyn light was raised when bearing 21° on port bow. Find Co steered. When will the light be abeam?(speed 16kn HE 29m)
Ans: Co 167°T. Light beam in 01h 45min.
Q.5 From a pos 6M to 'S' of Hambantota point (081°7'E) at 1900h, steer a Co sothat Great Basses reef is seen right ahead, when at a distance of 13M. Also find the time when light is abeam, right ahead & nearest (Current: 120° x 3kn, speed 11kn)
Ans: Co to steer 060.5°T. Lt right ahd at 1950h, abeam at 20h 52.5min. nearest at 2052m.
Q.6 Draw a straight Co from 06°00'N 081°15'E to 06°25'N 082°00'E. On the way Great Basses Lt is to be maintained at a distance of 6M by rounding along arced path. Find total distance that the ship has to cover.
Ans: St line dist = 41M. Arced dist = 12.72M.

Chart: English Channel:

Q.1 Position 50°46.5'N 006°17.6'W was obtained by GPS receiver. Plot a course to find Seven Stone Racon to lie 21° on starboard bow, whilst 25 M off.
Ans: Co to Steer = 157° T.
Q.2 A ship in position 6.5 M due S of Greenwich buoy, at 2330 h, sets a course in such a way that Bassurella Light is right ahead, when it is 25 M off.
Given: Ship's speed 12.5 kn , Current in the area sets 132° x 2.25 kn.
Find Co to steer to achieve above & distance of light when abeam.
Ans: Beam-distance = 3.7 M. Co to MG = 074°.CTS = 065.5°
Q.3 From the position at 49°30'N 005°W, find CTS, counteracting a current setting 115°T x 3 kn to find the Channel Lt vessel at 30° on port bow at a distance of 20M. (Eng speed = 15 kn).
Ans CTS = 075°, SMOG = 17.4 kn.
Q.4 From a pos 15M due N of E Channel Lt Vessel at 1800h, find a CTS to raise St Catherine Lt (38m) Rt Ahd, counteracting assumed set (160° x 3kn). Later Lt was raised bearing 048°T, find true set & drift. (HE = 16m. Speed 13 kn)
Ans CTS = 058°T. True set & drift = 135°T & 10.8M respectively.



Pic. Sea View of Sindhudurg. Inset: Gurab & Gulbat, used by Mahratha Navy

Sea Experlise of Zamorians (Malabar) Mahratha Navy: *For nearly 90 years Zamorian kings of Calicut maintained their authority over south coast of India in spite of repeated attacks by Portuguese. During this period one of the most brilliant commanders of Indian history, viz. Kunjali III emerged, who defeated Portuguese in almost every naval engagement. He defeated Portuguese in their own den viz Diu in 1599. Another figure that appeared, established the Mahratha naval power with high potentials. The name was Shivaji. The man with eternal foresight & vision, the most remarkable emperor of Indian history. He kept a balance between land & sea power. He built large fleets & equipped them with powerful weapons. He died in 1680. Sambhaji his son personally continued his father's mission with great valour but died early, in 1690. Then the responsibility of sea power was taken up by Kanhoji Angre, one of the most brilliant commanders of all times. He was awarded the title of 'Sarkhel' or Admiral. Angre crushed the foreign power of all opponents at sea, whether they attacked singly or in combination. After his death his sons & grand sons maintained the supremacy over the West coast, right from Kathiawad to Malbar. Angres were defeated by British Navy with the naval assistance & naval intelligence provided by own kingdom's then prime minister. This was a strong setback to Mahratha naval power & hence to Indian naval power.*

Chapter 21: A Fix & later 2 bearings at different times. [To find CMG]

A fix & later 2 brgs at different times (all 3 at known intervals) are taken on a steady Co. To find CMG & pos at time of taking bearings

Q. 21.1 At 1600 h Pu Panjang Light is 4 M off & Pu Undan Light is 6 M off. From here the ship steers course of 290°T x 8 kn. Tanjong Keling pier head bore 335.5°T & 012°T at 1624 h & 1700 h respectively. Find the position of vessel at 1700 h (Malacca Straits).

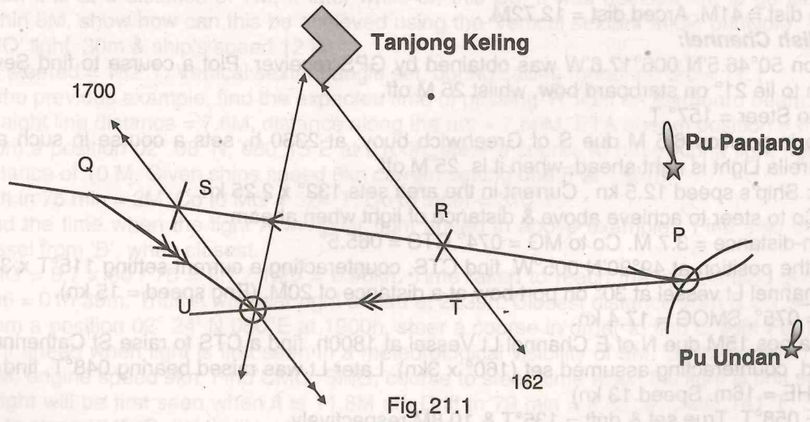


Fig. 21.1

Hint:
If the bearing lines at 1624 h & 1700 h meet CMG at T & U, then PT:TU should be equal to 24:36, the ratio of time intervals. Or the direction of CMG should be such that PT:TU = 24:36 = 2:3.
Plot 1600 h position P. Draw the bearings at 1624 h & 1700 h respectively.
Draw PQ, course steered through P along 290°T.
1624h PL meets PQ at R. PR = 3.24 M.

Cut an arc RS = 4.86M $\left(\frac{3.24x3}{2} = 4.86\right)$

From S, draw a line // to 1st PL. Where this line meets 2nd PL is the 1700h position. It is interesting to note that PT:TU = PR:RS = 2:3.

Ans: Position at 1700 h 02°06.8'N 102°08.1'E.

A fix & later 2 brgs at different times (all 3 at known intervals)

Q. 21.2 A vessel is 7M due South East of EC3 Buoy at 1800h, Co steered is 080°. At 1900h & 1930h, Greenwich Buoy bore 041°T & 011°T respectively. Find the vessel's position at 1930 h & also find Set & Drift experienced by her. (Ship's speed 12 knots) (Eng. Channel)

Hint:
Let P be initial position of vessel & let G be position of Greenwich Buoy.
Draw PQ ≡ 080° x 18 M. Plot both the bearing lines stated in the question.
1st bearing cuts course steered at R.
Mark T on PQ, so that PR:RT = 60:30.
Draw TU // 1st bearing line, meeting 2nd bearing line at U.
PU≡ CMG & DMG for 1.5 h.
Also QU ≡ Set & Drift.

Ans: Set 325°T, Drift = 2.7 M, Position at 1930 h ≡ 50°18.5' 000°02'.

Exercise:

Chart: South coast of Sri Lanka:

Q.1 Ship's pos at 0800h: 07°03'N 079°40'E, while on a Co of 180°T(speed by log = 13kn). Continuing on above Co Colombo light bore 095.5°T at 0824h & 044.5°T at 0900h. Find pos at 0900h & current which acted on the ship.
Ans: Pos: 06°48.3'N 079°42.6'E. Current: 121°T x 3.1kn.
Q.2 Vessel was in pos, 5M due S of Weligama light at 1800h, while on a steady Co & speed. While continuing on same Co Point de Galle Lt bore 324°T at 1830h & 060°T at 1930h. If current in area was known to set along 330°T @ 2kn, find Co steered, engine speed & pos of ship at 1930h.
Ans: Co steered 273.5°T speed 12.67kn. Pos at 1930h 05°56.8'N 080°4.4'E

Chart : Alpha to Zulu Roads:

Q.1 From a position with 'R' light bearing 270°T and 5 miles off at 1730 ship steered a steady course 015°T at 10 knots. On above course 'Q' light bore 283.5°T at 1754h and 245°T at 1824 h. Find CMG, set and drift experienced in 54 minutes and position at 1824h.
Ans. CMG = 010°T Set = 217°T drift = 1.8m. Pos at 1824 h = 02°4.6'N 080°21'E

Walchand Hirachand & Narottam Morarjee: *Mr Walchand Hirachand During a railway journey from Delhi to Bombay met Mr. Watson [a British engineer] on 16th Feb 1919. He came to know that a passenger ships S. S. Loyalty' owned by Maharaja Madhorao Scindia of Gwalior was on sale. Maharaja was ready to sell the ship for Rs 25 lakhs to the first bidder. Walchand went straight to docks in Bombay to look at the ship. After inspecting the ship he drove to the office of Narottam Morarjee [The leading textile magnate of Bombay] & placed the idea of purchasing the ship. They decided to buy the ship & established a limited company. 'The Scindia Steam Navigation Company Ltd. On 5th April 1919, S.S. Loyalty sailed from Bombay, as Indian passanger ship bound for Europe & U K. This was a golden event in Indian maritime history, where the commercial shipping was reborn.*

Chapter 22 Three Bearings From Two or Three Points at Known Interval

Q.22.1 'EC3' bore 350°T, at 1000 h & 330°T at 1024 h, from a vessel steering 080°T, at 12 kn. Greenwich Buoy bore 013°T at 1100 h. If current was known to set 113°T throughout, find the following;
(i) Course & speed made good by the vessel, (ii) Rate of drift,
(iii) Position of the vessel at the time of 3rd bearing. (English Channel)

Procedure:

Plot the three bearing lines & mark them appropriately, indicating the time of observation, viz. 1000h, 1024 h & 1100 h.

Transfer the '1000 h-position line' in the forward direction, to get a transferred position line for 1024h, using course steered & distance by engines. (Rate of current is assumed to be zero for allowing the run for transfer). Call this PL as PL-1.
Transfer the '1100 h-position line' backwards, to get a transferred position line for 1024h, using reciprocal of the course steered & distance by engines. (Rate of current is assumed to be zero for allowing the run for transfer). Call this PL as PL-2
PL-1 & PL-2 intersect each other at E.
Select a point A on 1000 h PL. AC ≡ 080° x 4.8 M (Engine distance in 24 minutes = 4.8M)
Note: 1st & 3rd bearing lines are converging southwards & diverging northwards. Since the current is favourable the point A must be selected northwards of E.

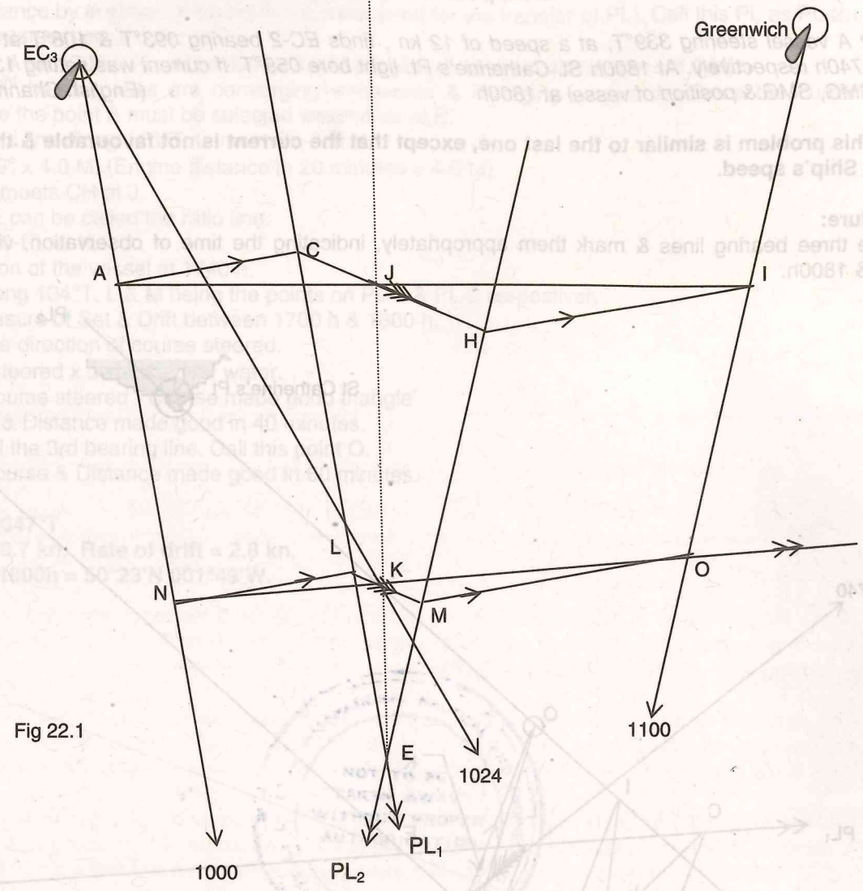


Fig 22.1

From C, draw a line in the direction of set (113°T), to meet PL-2 at H.
Plot HI ≡ 080° x 7.2 M. (Engine distance in 36 minutes = 7.2M)
Join A & I, AI meets CH at J.
Join J & E. Line *JE may be called a 'ratio line'.*
JE meets 1024-PL at K. K is the position of the vessel at 1024h.
Draw LKM in the direction of set (113°T),L & M being the points on PL-1 & PL-2 respectively.
LM is the measure of Set & Drift between 1000 h & 1100 h
Draw NL in the direction of Course steered.
NLK is the 'Course steered - Course made good triangle' for 24 minutes.
NK is Course & Distance made good in 24 minutes.
Extend NK, till the 3rd bearing line, ie.O.
NKO is the Course & Distance made good in 60 minutes.
[*Note: CH is a drift of unknown interval hence AJI is not the CMG or DMG].*

Ans. CMG≡ 085.5°T. SMG = length NO = 14.25 kn. Hourly drift = length LM = 2.8 M. Position of vessel at 3rd bearing ≡ 50°02.1'N 000°07.5'W.

Given Co steered, engine speed, direction of set(current against). 2 bearings of same object & 1 bearing of a second object, all 3 taken at known interval. To find CMG, rate of drift, position of vessel

Q. 22.2 A vessel steering 339°T, at a speed of 12 kn , finds EC-2 bearing 093°T & 108°T at 1700h & 1740h respectively. At 1800h St. Catherine's Pt. light bore 059°T. If current was setting 134°T, find CMG, SMG & position of vessel at 1800h (English Channel)

Hint. This problem is similar to the last one, except that the current is not favourable & thus SMG < Ship's speed.

Procedure:
Plot the three bearing lines & mark them appropriately, indicating the time of observation, viz 1700h, 1740h & 1800h.

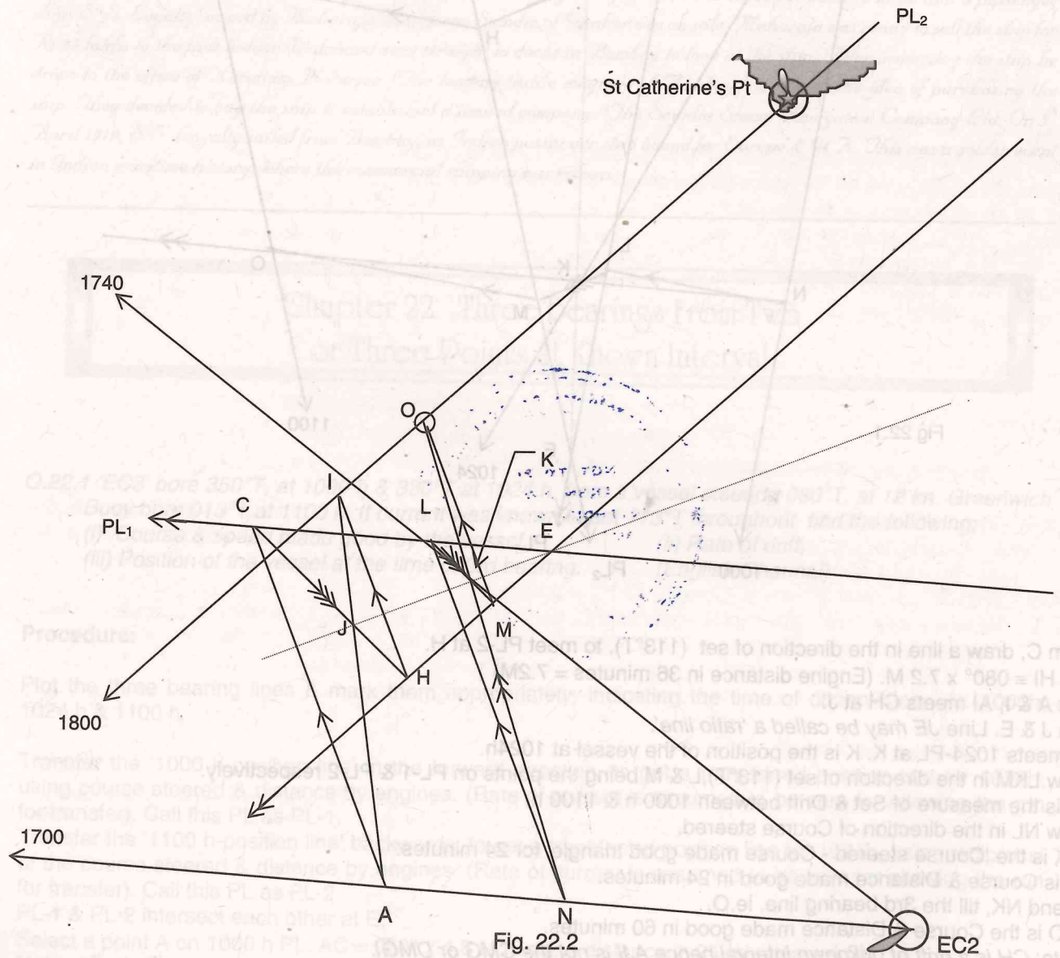


Fig. 22.2

Transfer the '1700 h-position line' to get a transferred position line for 1740 h, using course steered & distance by engines. (Current is not considered for the transfer of PL). Call this PL as PL-1'.
Transfer the '1800 h-position line' backwards, to get a transferred position line for 1740 h, using course steered & distance by engines. (Current is not considered for the transfer of PL). Call this PL as PL-2.
PL-1 & PL-2 intersect each other at E.
Select a point A on 1700 h PL. AC ≡ 339° x 8.0 M (Engine distance in 40minutes = 8.0 M)
Note: 1st & 3rd bearing lines are converging westwards & diverging eastwards. Since the current is against, hence the point A must be selected westwards of E.
From C, draw a line along 113°T, to meet PL-2 at H.
Draw HI ≡ 339° x 4.0 M. (Engine distance in 20 minutes = 4.0 M)
Join A & I. AI meets CH at J.
Join J & E. JE can be called the ratio line.
JE meets 1740-PL at K.
K is the position of the vessel at 1740 h.
Draw LKM along 134°T, L & M being the points on PL-1 & PL-2 respectively.
LM is the measure of Set & Drift between 1700 h & 1800 h.
Draw NL in the direction of course steered.
NL ≡ course steered x distance over water.
NLK is the 'Course steered - Course made good triangle'
NK is Course & Distance made good in 40 minutes.
Extend NK, till the 3rd bearing line. Call this point O.
NKO is the Course & Distance made good in 60 minutes.

Ans **CMG = 347°T**
SMG = 9.7 kn, Rate of drift = 2.8 kn.
Pos at 1800h = 50°23'N 001°49'W.

Kepler: *[1571- 1630] Born in Weil Germany, Keppler graduated from the universily of Tubingen. Earlier a teacher, Kepler formed an association later with Tycho Brahe a noted astronomer. Keppler gave 3 laws of planetary motion & realized that the orbits were not circular but were elliptical.*

[Pic. Johannes Kepler]

Chapter 23 Rendezvous' Calculations

Some times, instead of a fixed position, the destination may be a vessel underway at sea. It may be required to meet the other vessel at earliest or after a certain interval of time. The other vessel may be simply drifting with current & wind or may be making good a certain course.

The calculations may be done geometrically on a radar-plotting sheet or by using a simple principle viz. the ratio between the Sine of any of the internal angle & the opposite side is constant for all the three angles & sides respectively. Following examples will explain the rendezvous calculations

Q.1 A ship in position 51°30'N 012°30'W has to catch up with another vessel bearing 310°T x 250M at earliest. Maximum speed can be 18kn. The target ship for some reason is steaming a course of 210°T @ 6kn. Find the course which needs to be steered by own ship. Also find the time & position of the meeting.

Sol^n

Let us suppose that the two ships meet after x hours. The distance steamed by own ship, (A) = 18x miles & that by the target ship, (B) = 6x miles. The bearing of the target ship = N50°W ∴∠ NAB = 50°. Let the course steered be AC, so that ∠ BAC = θ°. Also ∠ ABS = 50°.

By the sine formula we have,

$$\frac{Sine\,\theta^\circ}{6x}=\frac{Sine\,80^\circ}{18x}=\frac{Sine[180^\circ-(\theta^\circ+50^\circ+30^\circ)]}{250}$$

Solving the first two groups we get θ = 19.16°.
Solving the second & third group, we get x = 13.85 hours & ∴distance 18x = 249.4M.
The position arrived can be found by plane sailing method viz.
D'lat = 1°28.7'N. Final lat = 52°58.7'N. M'lat = 52°14.4'N.
Dep = 233.08' & d'long = 330.4' = 006°20.4'W, gives final long = 18°50.4'W.
Pos ≡ {52°58.7'N, 018°50.4'W}

Method II: Alternately a triangle for 1 hour, BB'C' may be constructed on radar plotting sheet to find course to be steered by own ship.

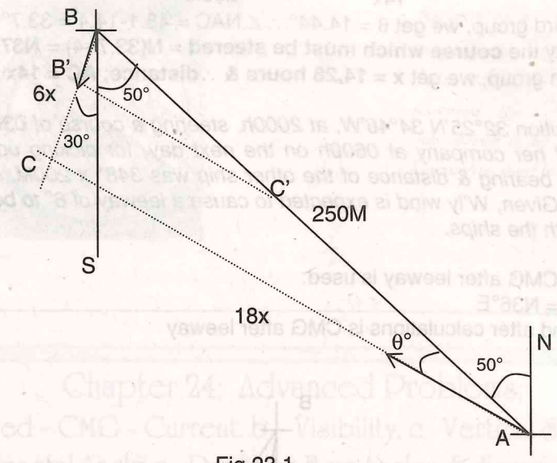


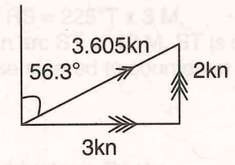
Fig 23.1

Ex 2 A distress message was received from a ship in pos 45°N 020°W. The ship is stopped & the total 'wind-current' drift is estimated to be due east @ 3kn. Own ship position is 42°42'N 016°27'W. An average S'ly drift of 2 kn is expected by own ship, if the rescue is undertaken. Also the W'ly wind is likely to cause a leeway of 4°. Find the course, which must be steered in order to reach the position of vessel in distress by steering a single rhumb line course @14kn. In how many hours will the rescue ship meet the distressed vessel?

Sol^n The bearing & distance from own ship, A to target ship, B is found by plane sailing and is found to be N48.1°W & 206.5M.

Whenever the own ship & the target ship are exposed to two different current rates/drifts, we must find out the resultant direction of set & the rate of drift of target ship using the set & rate experienced by her & the reverse of the set & rate experienced by own ship. The resultant direction of set & the rate of drift of target ship can be found by simple plotting to scale:

CMG = 056.3°T & rate of drift = 3.605kn.



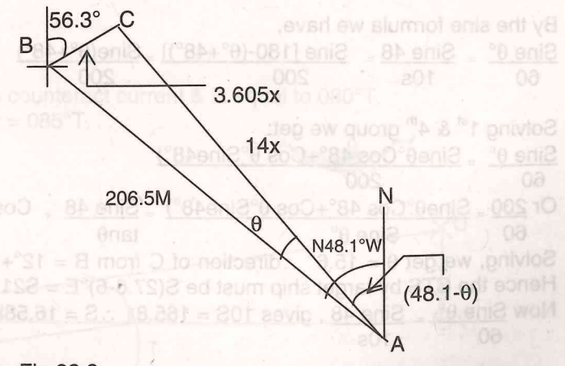


Fig 23.2

By the sine formula we have,

$$\frac{\text{Sine }\theta^\circ}{3.605x} = \frac{\text{Sine}\{180^\circ-(56.3+48.1)\}}{14x} = \frac{\text{Sine } 75.6^\circ}{14x} = \frac{\text{Sine } [180-(\theta^\circ+75.6^\circ)]}{206.5}$$

Solving the first & the third group, we get $\theta = 14.44^\circ$. $\therefore \angle$ NAC = 48.1-14.4 = 33.7°
To counteract the leeway the **course which must be steered** = N(33.7+4) = **N37.4°W.**
Solving the third & fourth group, we get **x = 14.28 hours & ∴distance, AC = 14x = 200M.**

Ex 3 Own ship is in position 32°25'N 34°46'W, at 2000h, steering a course of 030° @ 6kn needs to meet another vessel of her company at 0600h on the next day, for picking up some urgently needed spares. At 2000h bearing & distance of the other ship was 348° x 200M. Advise her the course & speed to steam. (Given, W'ly wind is expected to cause a leeway of 6° to both the ships, current set SW x 2.4kn at both the ships.

For making the triangle CMG after leeway is used.
Thus AC is 30 + 6 = 36 = N36°E
Direction BC that is found after calculations is CMG after leeway

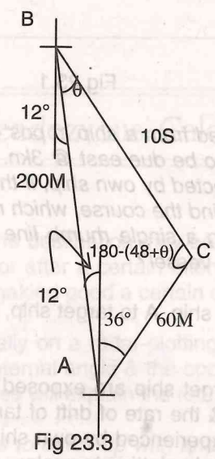


Fig 23.3

Since current is affecting both the ships in the same way, we need not consider the current for our calculations or for plotting purpose.

By the sine formula we have,

$$\frac{\text{Sine }\theta^\circ}{60} = \frac{\text{Sine } 48}{10s} = \frac{\text{Sine } [180-(\theta^\circ+48^\circ)]}{200} = \frac{\text{Sine}(\theta^\circ+48^\circ)}{200}$$

Solving 1st & 4th group we get:

$$\frac{\text{Sine }\theta^\circ}{60} = \frac{\text{Sine}\theta^\circ\text{Cos } 48^\circ+\text{Cos }\theta^\circ\text{Sine}48^\circ)}{200}$$

Or $\frac{200}{60} = \frac{\text{Sine}\theta^\circ\text{Cos } 48^\circ+\text{Cos }\theta^\circ\text{Sine}48^\circ)}{\text{Sine }\theta^\circ} = \frac{\text{Sine } 48}{\tan\theta} + \text{Cos } 48^\circ$

Solving, we get $\theta = 15.6^\circ$ ∴direction of C from B = 12°+15.6° = S27.6°E. This is the CMG after leeway.
Hence the CTS by target ship must be S(27.6-6)°E = S21.6°E.
Now $\frac{\text{Sine }\theta^\circ}{60} = \frac{\text{Sine } 48}{10s}$, gives 10S = 165.81 ∴S = 16.58kn.

Target ship is advised to steer S21.6°E @ 16.58kn.

Astrolabe: *During the age of discovery astrolabe was a most commonly used instrument. Since 150 B.C, i.e., well before compass was invented the Astrolabe was used & was considered to be the most essential equipment. Columbus used both Astrolabe & the quadrant.*

[Pic. Astrolabe]

Chapter 24: Advanced Problems:

[a. Co steered - CMG - Current. b. Visibility. c. Vertical Sextant Altitude d. Horizontal Angle e. Doubling Bow Angles & Special Angles.]

Part A

Note: Questions under this part are based on more complex principles of chart work & do not form the questions for basic grades viz. 2nd Mate & NCV.

CMG is as intended but SMG is not as expected. To find actual set & rate of drift

Q. 24.1 A ship, speed 12 kn at 1600 h, in position with Eddystone Rocks Lt. bearing 286°T x 9 M, wanted to make good 090°T, counteracting wind & current. On shore winds were expected to cause leeway of 5°. Also the current was assumed to set due SW @ 3 kn.
Ship thereafter appeared to move in intended direction. At 1730 h, the longitude of ship was 003°33.5' W. Assuming that the leeway experienced was 5° only, find out whether the assumption regarding current was correct or not.

Hint.
Plot 1600 h- position & call it R.
Plot the intended course of 090°T through it.
Draw RS ≡ 225°T x 3 M.
Cut an arc ST of 12 M. ST is course steered to counteract current & is equal to 080°T.
Course steered to counteract current & leeway = 085°T.

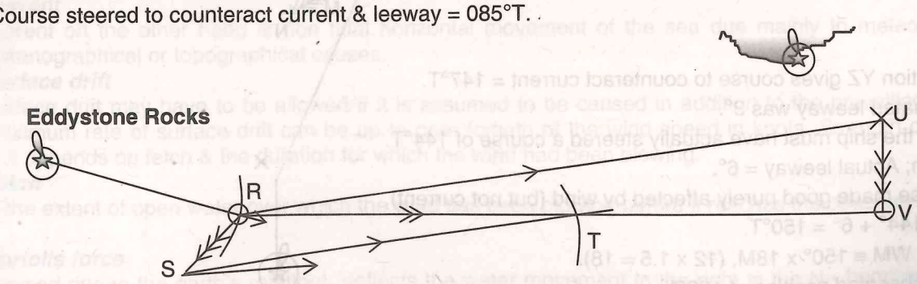


Fig. 24.1

Leeway was estimated correctly, which means that course made good under the influence of wind only was 080°T.
Thus under the influence of wind only but no current, vessel would have been at U, at 1730 h.
But at 1730 h the vessel was found at V, which means that the drift UV is purely because of current.
UV ≡ S'ly x 3 M. ∴ rate of drift = 2 kn.
Thus assumption regarding current was not correct.
Prevailing current was S'ly @ 2 kn.

To find correct set & rate of current from a Co steered-CMG Δ, where leeway & current estimated & applied wrongly.

Q. 24.2 Vessel in position 50°40' N, 006°25' W, at 1100 h intended to steer a course, counteracting current & leeway, to reach the alteration point, 7 M due 'N' of Seven Stones Lt Vessel. However the leeway allowed (3°), was too low for the prevailing winds. A leeway of 6° should have been allowed. The estimation of current was wrong too. If at 1230 h, the vessel was observed to be at 50°22.7'N, 006°6.4'W. Find actual rate & direction of current.
(Given: Estimated current ≡ 220° x 2 kn, Wind E'ly, Engine speed 12 kn).

Hint.
W is position given by GPS receiver at 1100 h
X is intended alteration point.
WX is course to make good, counteracting current & leeway.
WY is estimated current ≡ 220° x 2 M.
Cut an arc YZ = 12 M .

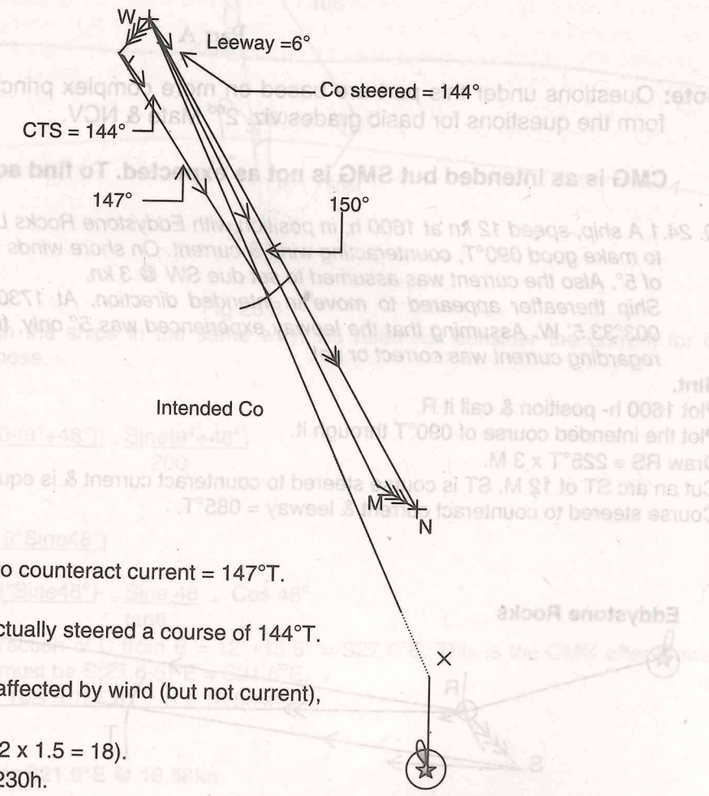


Fig. 24.2

Direction YZ gives course to counteract current = 147°T.
Estimated leeway was 3°.
Thus the ship must have actually steered a course of 144°T.
Given; Actual leeway = 6°.
Course made good purely affected by wind (but not current), was 144° + 6° = 150°T.
Draw WM ≡ 150° x 18M, (12 x 1.5 = 18).
N is observed position at 1230h.

From M to N purely current drifts the vessel.
MN ≡ 120° x 3 M.
∴ current set along 120° @ 2 kn.

To find correct leeway, estimated current & leeway being wrong

Q. 24.3 A vessel in position 50°40'N 006°25'W as given by GPS receiver at 1100 h. A course was steered to reach alteration point 7 M 'N' of Seven Stone Lt Vessel Racon, counteracting current & leeway, (current was estimated to be setting 220° x 2 kn & leeway was estimated to be 3° due E'ly wind). But the current was actually setting 120°T @ 2 kn & leeway of 3° too was incorrect too. If the vessel was observed to be at 50°22.7'N 006°6.4'W at 1330h, find out the actual leeway.(ship's speed 12 kn.) (English Channel)

Hint.
Course steered to counteract current & leeway, was calculated using wrongly estimated current & wind, viz. current,220°Tx2kn & leeway = 3°. Based on which the ship must have actually steered a course of 144°T.
The ship actually steered a course of 144°T from position W.
At the end of 1.5 h vessel was found at N.
Let M be a point so that MN represents the real drift in 1.5h.
Thus from M to N the vessel was taken purely by current.
Since current ≡ 120° x 2 kn, MN ≡ 120° x 3 M.
From W to M, the ship is brought purely by own steering & the leeway (& not current).
Direction WM is found to be 150°T, which is course made good after leeway.
∴ leeway = 150° - 144° = 6°.

Effect of persistent wind blowing over an area. Estimation & application of leeway in knots instead of degrees.Combined effect of surface drift, current & tidal stream

Q. 24.5 A ship in Northern hemisphere steered 000°T, as recorded by the course recorder. Speed over water was found to be 15 kn. Wind blew for past 3 days from SE @ 20 kn. Leeway as practically recorded for similar draft & relative wind condition is 0.6 kn. Estimated tidal stream set 330°x1.5 kn. Estimated current from current chart being 015°x1 kn. Its given that (a) surface drift due to wind is distinct & in addition to prevailing current. (b) Allow 25° as deflection of surface drift due to Coriolis force. Using a scale of 1cm = 1M, plot 'Co steered - CMG Δ' & find CMG, SMG & Resultant drift due to current, tidal stream & surface drift.

Ans.
Tidal stream
Is periodical horizontal movement of sea surface caused by the tide raising forces of sun & moon.
Current
Current on the other hand is non tidal horizontal movement of the sea due mainly to meteorological, oceanographical or topographical causes.
Surface drift
Surface drift may have to be allowed if it is assumed to be caused in addition to the prevailing current. Maximum rate of surface drift can be up to one- fortieth of the wind speed in knots. Strength of surface drift depends on fetch & the duration for which the wind had been blowing.
Fetch
Is the extent of open water over which the wind has been blowing before it reaches the observer.

Coriolis force
(caused due to the earth's rotation), deflects the water movement to the right in the N - hemisphere & to left in S - hemisphere by an angle from 20° to 45°.

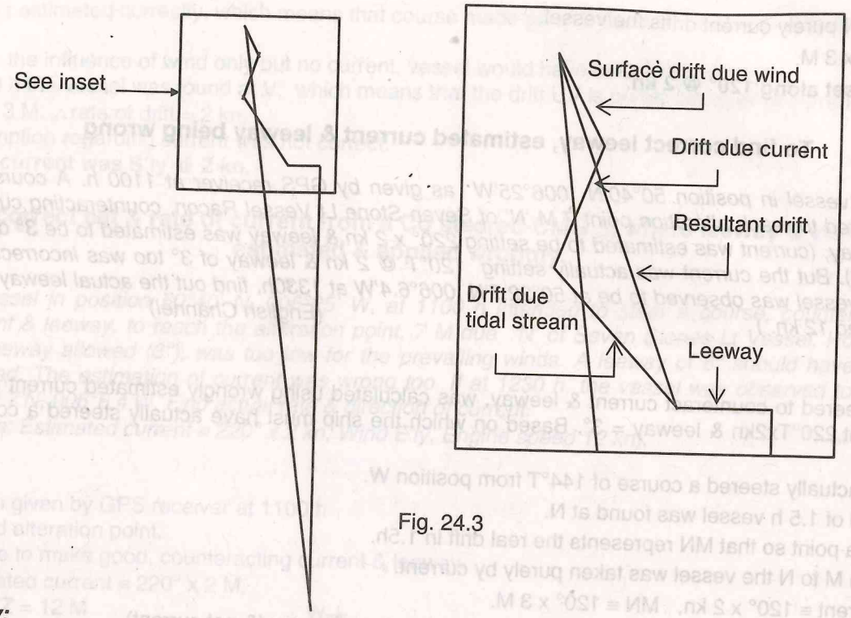


Fig. 24.3

Leeway:

So far, we applied leeway as allowance in terms of degrees of course applied to the windward of course to be made good. Or it is also number of degrees to the leeward of steered course that the ship's CMG will be.

Leeway may also be represented as athwartship speed (due to the ship, bodily moving to the leeward) that the ship will make due to the athwartship component of the wind.

It depends on a number of factors:

(a) Ship's speed. (higher the speed, less the leeway).
(b) Wind component at right angle to the Co steered.
(c) Leeway is greater if the ratio, 'fore & aft area above the waterline to that below' is greater.
(d) Shallower the depth of water as compared to draft, less the leeway.

If leeway caused is equal to 5°, due to wind on a ship whose speed over water is 15 kn , then the leeway in terms of knots = 15 x Tan5° = 1.3 kn.

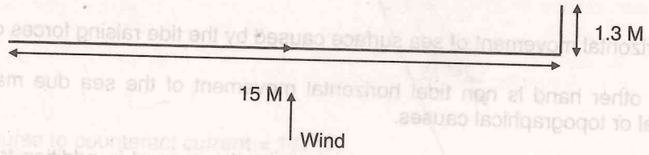


Fig. 24.4

In the problem under consideration:

Wind leeway	=	270° x 0.6 M
Tidal drift	=	330° x 1.5 M
Current drift	=	015° x 1 M
Surface drift due wind	=	340° x 0.5 M

Ans. SMG = 17.95 kn. CMG = 355°T. Resultant drift of water = 345°T x 2.95 kn.

Q.24.6 A vessel in position 002°08.1'N 080°15'E at 1100h, steered a certain course (engine speed = 11.25 kn), in order to enter the traffic lane off 'N' Light float. At 1120 h 'Q' bore 198°. Current between 1100h & 1120h set E'ly @ 3 kn. Find the position of vessel at 1120 h & the course steered by her.

Hint.

Principle: In above case the ship's position at 1100h is given. The following is aplied to this position:

1. *Unknown Co x 3.75M*
2. *Drift 090° x 1M*

The order of application of above factors (vectors) can be changed. E.g. in day's work calculations if we change the order of different courses, the total effective d'lat, dep & hence final position is not going to change. Thus to the initial position, we will apply the current vector first & thereafter the unknown course is applied as an arc of distance over water.

Plot initial position A at 1100h. Total drift may be applied to the initial position itself.

Thus plot AB ≡ 090° x 1 M (drift in 20 min. = 1 M @ 3 kn).

From this position draw a circle of radius = 3.75 M (engine distance in 20min. = 3.75M @ 11.25kn).

Plot bearing line at 1120h. This bearing line cuts the position circle at 2 points, viz. C & D.

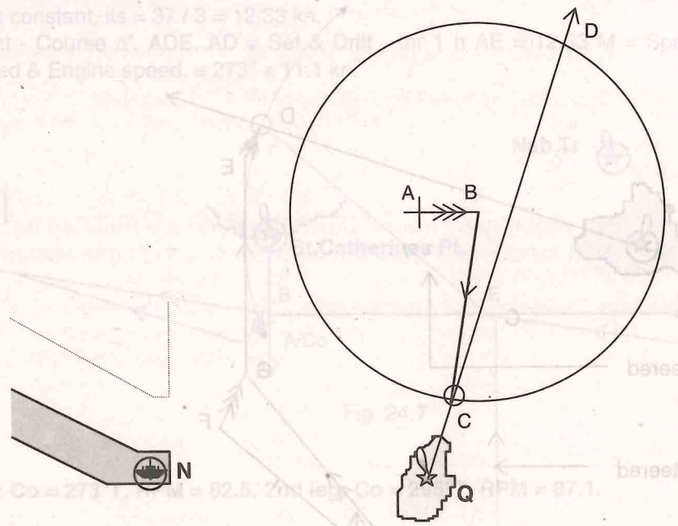


Fig. 24.5

C is the probable position at 1120 h as the vessel intended to enter traffic lane off 'N' Lightfloat.

Course steered is given by BC = 184°T.

Ans. Co steered = 184°T. Position at 1120 h ≡ 02°04.4'N 080°15.7'E

Given; current prevailing in the area. Initial Co not known, ship's speed given, vessel alters Co A PL is known at the end of passage. To find position.

Q. 24.7 A vessel sailed out from 'Z' roads at 1800 h(position 002°00.4'N 080°29.75'E), proceeding on a certain course. She maintained engine speed of 9.0 kn during the first hour. At 1900 h she altered course to true North. Average speed increasing to 12 kn At 1930 'X' light bore 241.5°T. Current set 335°T @ 2 kn. Find;

(a) Position at 1930 h
(b) Initial course of the ship.

Hint.
Principle is the same as last question.
Thus the ship's position is displaced (shifted) due to the following two factors:
1. *Unknown Co x 9M*
2. *000° x 6M*
3. *Drift 335° x 3M*

The order of application of above factors (vectors) if changed will not affect the final position. e.g. in day's work calculations if we change the order of different courses, the total effective d'lat, dep & hence final position is not going to change. The run to the initial point can be applied in the order (3), (2), (1) or in the order (2), (3), (1). In the fig we can see that the current is applied first. Thus to the initial position, the current vector AB is applied first. The known course is applied then & thereafter the unknown course is applied as an arc of distance over water.

Total drift for entire passage is applied.
Thus plot AB ≡ 335° x 3 M (drift in 1.5 h @ 2 kn). Plot BC ≡ 000° x 6M. With C as centre draw an arc of radius equal to 9M. This arc cuts the 1930-bearing line at D. D is the position at 1930h. CD gives the 1st course & distance. Physically the ship makes good the passage through AG & GD.

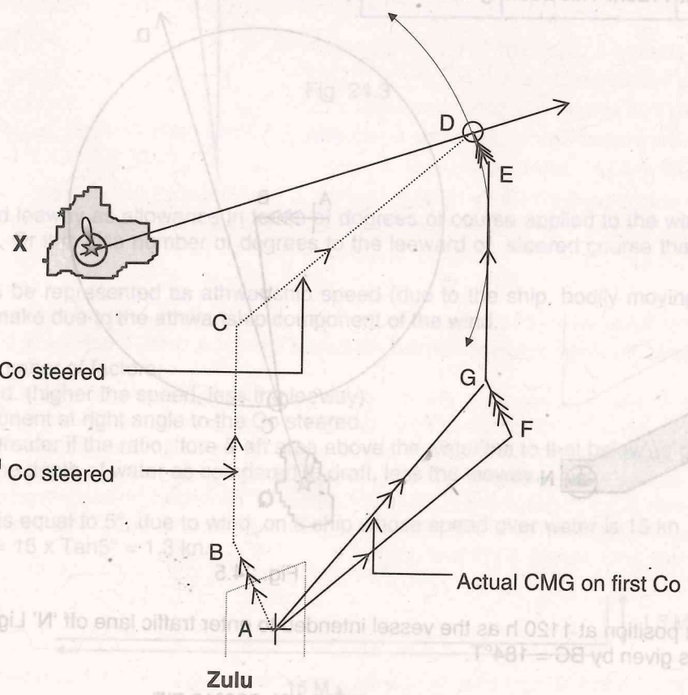


Fig. 24.6

Ans. Position at 1930 h ≡ 02°15'N 080°35.4'E. 1st steered course = 050°T.

To adjust Co & speed over two different Co legs in order to maintain the required ETA, maintaining a steady speed over ground

Q.24.8 A small freighter observes Nab Tr Racon, distance 12.9 M, (radar) & St. Catherine Racon, distance 22.4 M, (radar) at 140200 LT. It is required to adjust course & speed to reach 2 M 'S' of Needle's Point Pilot Station at 0500 h, (to maintain the committed ETA of 0530 LT). Above position is to be reached with only one alteration. The alteration to be in position, 4 M due 'S' of St. Catherine Point Light. Speed over ground must be uniform throughout. Following is for your reference:

(a) Assume that speed over water is strictly as per RPM - Speed table.
(b) ETA - Pilot Station, given 24 h prior arrival was 140530 LT.
(c) Average Tidal Stream expected in next 4 h ≡ 225° x 1.5 kn.

RPM	*70*	*75*	*80*	*85*	*90*	*95*	*100*
Speed	*9 kn*	*9.8 kn*	*10.7 kn*	*11.5 kn*	*12.2 kn*	*12.8 kn*	*13.5 kn*

Intermediate values of RPM & Speed follow linear graph.
Find: Courses & RPMs in 2 legs & time of alteration of course. *(EC)*

Hint:
Plot 0200 h position as A. Plot A/Co position as B.
Join AB. AB is Course & Distance to make good.
Plot 0500 h position, C. Join BC. BC is 2nd Course & Distance to make good.
AB + BC = 22 + 15 = 37 M.
Since SMG is constant, its = 37 / 3 = 12.33 kn.
Make 'Current - Course Δ', ADE. AD ≡ Set & Drift for 1 h AE = 12.33 M = Speed to MG Thus DE ≡ Course steered & Engine speed. ≡ 273° x 11.1 kn.

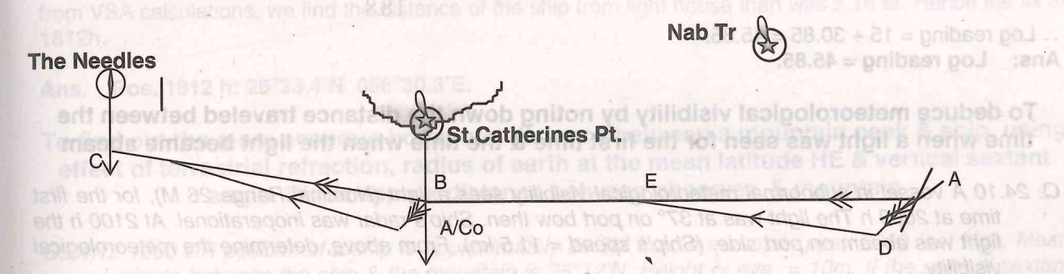


Fig. 24.7

Ans: 1st leg: Co = 273°T, RPM = 82.5. 2nd leg: Co = 295°T, RPM = 87.1.

Q. 24.9 A ship steered 237°T, current set 345°T, Greenwich Buoy was found right ahead at 0400h whilst 20M from it. On this course the beam distance would be 6.5M. Find rate of current (ship's speed 15kn). If the towed log on the ship had read 015, when Greenwich Buoy was 30 M away. What will the Log read, at the time when Greenwich Buoy passes abeam? (English Channel)

Hint:
This Q is based on the principle: 'getting a light right ahead at a given distance'. The triangle is made for the interval = 20/15 hours = 1.33hours.

Abeam bearing = 237 - 90 = 147°. Reciprocal of this = 327°. Plot GM, 327° x 6.5M, as the ship's position at the time when G.Buoy is abeam. Plot 237° through M. From G plot current vector in the direction 345°. This vector cuts the course line at N. GN is the drift in 1.33hours. Complete the triangle NKG of the duration equal to 1.33h.(KG = 20M). KGN is 'Co steered CMG Triangle'. KN = 18.8 M & is DMG in 1.33h. KG is 'distance by engines' or 'Log distance' in the same time. SMG = KM/1.33 = 14.1kn. Hourly rate of drift = GN/1.33 = 4.5kn. Buoy is abeam at 05h 29.4minExtend NK backwards till some point O. OG = 30 M. Ship physically traverses OKNM in above case.

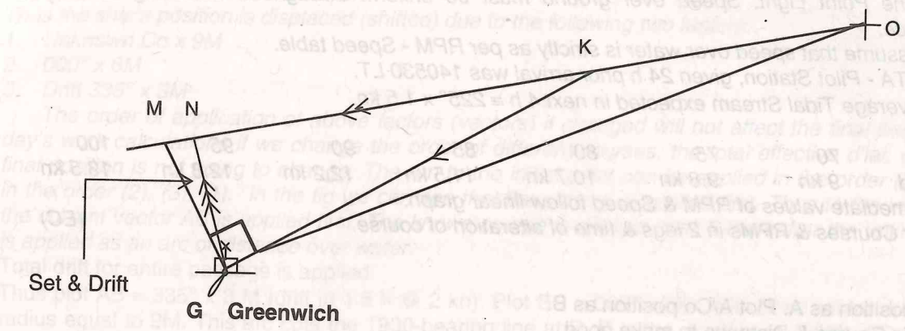


Fig. 24.8

OM = 29.0 M.
For a Log distance, KG = 20 M, the Distance over ground = 18.8 M.

∴ Distance over ground of 29.0 M accounts for a Log distance of $\frac{29x20}{18.8}$ = 30.85 M.

∴ Log reading = 15 + 30.85 = 45.85.
Ans: Log reading = 45.85.

To deduce meteorological visibility by noting down the distance traveled between the time when a light was seen for the first time & the time when the light became abeam

Q. 24.10 A vessel in subnormal meteorological visibility sees a light (Nominal Range 26 M), for the first time at 2000 h The light was at 37° on port bow then. Ship's radar was inoperational. At 2100 h the light was abeam on port side. (Ship's speed = 11.5 kn). From above, determine the meteorological visibility.

Hint.
In right ∠ Δ PAB, AB = 11.5 M. AB/AP = Cos.37° ∴ AP = AB/Cos.37°

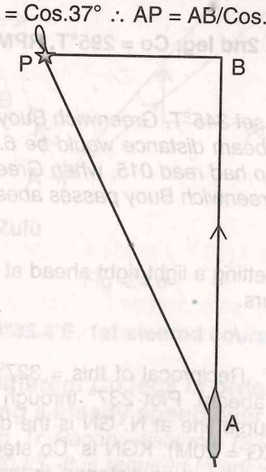


Fig. 24.9

Now Nominal Range = 26 M.
Present Luminous Range = 14.4 M
Referring the Luminous Range diagram it can be seen that Meteorological visibility was 5 M.

Part B

Note: The questions discussed under this part are purely of theoretical interest. The relevant details are dealt in the flow of subject & in the author's opinion are not to form the questions for any of the competency examination.

Using VSA & visible / obscured sector of light to fix the pos

Q. 24.11 What is the Sextant angle to set for Didamar Light House, by an East bound vessel, following TSS in order to keep at least 4 M from Didamar Light House on the Easterly course? On the Easterly course Didamar Light was obscured precisely for 2 minutes & was again visible at 1812 h, when Vertical Sextant ∠ of the light was 21.6'. Find the position of vessel at 1812 h (Ship's speed = 12 kn). *(PG)*

Hint:

Sext ∠ in minutes = $\frac{60x60x57.3}{4x1852}$ = 27.84.

Alternately Sext ∠ in minutes = $\frac{60x1.854}{4}$ = 27.81.

At 1812 h vessel must be on the Eastern limit of obscured sector, passing over East bound lane. Also from VSA calculations, we find the distance of the ship from light house then was 5.16 M. Hence the fix at 1812h.

Ans. Pos. 1812 h: 26°33.4'N 056°30.3'E.

To find out the more accurate horizontal distance between a mountain peak & ship, using effect of terrestrial refraction, radius of earth at the mean latitude HE & vertical sextant angle. Given approx distance between observer & mountain

Q.24.12 1300 DR position of a ship is approximately 29.5M from a mountain peak 6300 feet high. Mean Latitude between the ship & the mountain is 35°12'N. Height of eye = 10m. If the vertical sextant angle between the peak & the horizon was found to be 1°48' (Index error 1.2' off), find out the horizontal distance of the ship from the peak.

Soln. ***Important formulae:***

(a) Terrestrial refraction(in minutes) = 1/13 of the distance of object in miles(aprox.).

(b) Earth's radius at mean Latitude between the observer & object = Equatorial Radius (1 - compression of earth spheroid x Sin mean lat)

(c) Cosine(Distance + True Altitude of object)
= $\frac{Radius + H.E.}{Radius + ObjectHeight}$ x Cosine true altitude of peak
Radius: Radius of Earth at mean Latitude.
True altitude means Apparent altitude corrected for terrestrial refraction.

VSA = 01°48.0'
I.E. = +1.2'

Obs alt = 01°49.2'
Dip = -5.6'
AA = 01°43.6'
Ref. = -2.3' (Terrestrial refraction in minutes = DST of object in miles / 13)
T alt = 01°41.3' = 1.6883°.

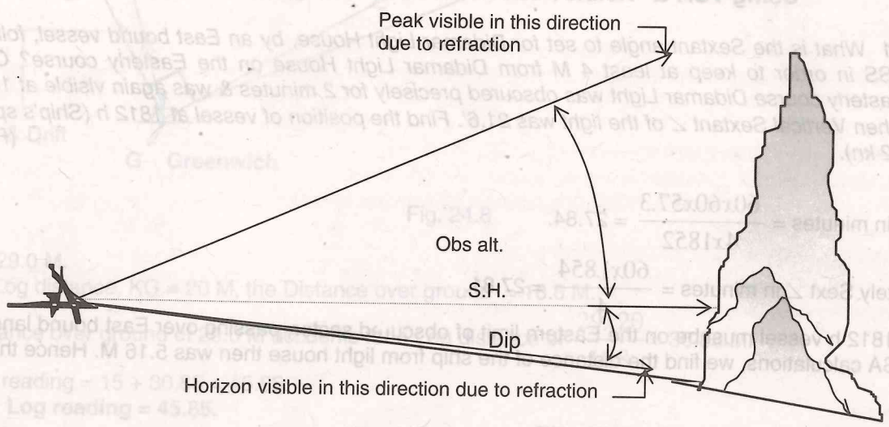


Fig. 24.10

To find equatorial radius:

$$R = 3443.3731 \left(1 - \frac{1}{298.18} \times \text{Sin}^2\ 35.2°\right)$$

= 3439.536 M
Substituting values in formula (c):

$$\text{Cos(dist + 1.6883°)} = \frac{3439.536 + 10/1852.3}{3439.536 + 6300/6080} \times \text{Cosine } 1.6883°$$

(dist + 1.6883°) = 2.1947°
Dist = 0.5064°
Distance = 0.5064 x 60 = 30.384M.
Ans. 30.384 M

To find out the height of a mountain peak, using horizontal distance between a mountain peak & ship, effect of terrestrial refraction, radius of earth at the mean latitude, HE & vertical sextant angle

Q. 24.13 Find out the height of a mountain peak from following data:
Mean Latitude between mountain & ship = 42°. Horizontal distance of observer to peak of mountain = 26.9 M.Height of eye = 12m. Vertical sextant angle = 1°30'

Hint.
Using formulae from last question & replacing the values in formula (c), we get:
Radius of earth at Mean Lat. = 3438.2027 M.

$$\text{3438.2027+Height of peak} = \frac{3438.2027 + 12/1852.3}{Co\sin e 1.79383} \times \text{Cosine } 1.3455°$$

Height of peak = 0.7437869 M
=4522.22 feet.
Ans. Height of Mountain = 4522.22feet

To find a position along the Co line at which 2 objects would appear with maximum angular separation

Q. 24.14 A vessel in position 01°58' N 080°21.5' E, steers a course of 323°T. Find the position on this course line when Quebec light & Romeo light will appear to be maximum (angular distance) apart from each other. (Alpha Lt to Zulu Rds)

Construction:
Plot initial position M. Draw a course line MN along 323°T.
Join Q & R by dotted line.
Draw perpendicular bisector ST on QR. (To draw perpendicular bisector of QR, compass is set for about 70 to 75% of length QR. Arcs of this length are marked on either side of line QR, from Q as well as R. The arcs cut at S & T. Join ST, which is perpendicular bisector on QR.)
By trial & error method find a point 'U' on ST that is the centre of a circle which:
(a) passes through Q & R &
(b) just touches the course line at some point V. This point V is a point at which the two lights Q & R appear maximum apart or are separated by maximum horizontal angle. It is 48° in above case.

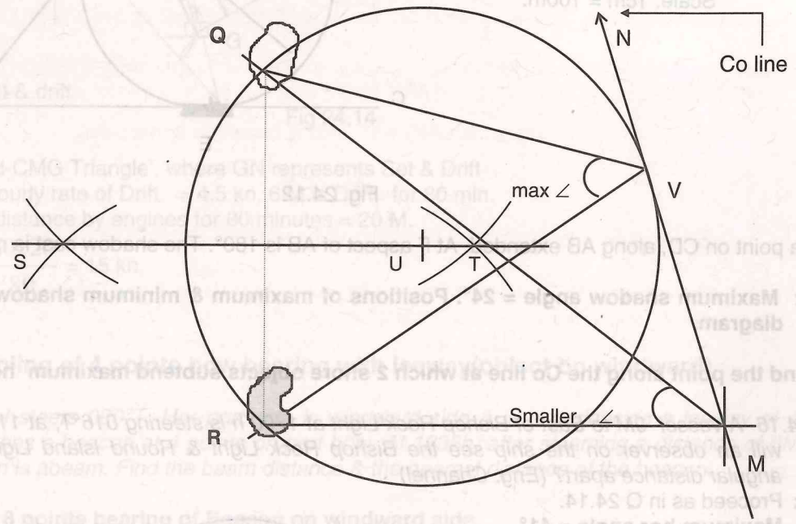


Fig. 24.11

Ans. Max. angular separation = 48°.
Note:
(a) If Q & R are two points on any circle, then centre of the circle always lies on the ⊥ar bisector of QR.
(b) Arc QR (smaller)makes equal ∠ at any point on the larger arc QR. ∠ made at any point that is situated beyond larger arc QR will be smaller ∠ than the one subtended on any point on arc itself. The course line is beyond the larger arc QR. The angle subtended on any point on this line would be smaller than the angle subtended on larger arc QR. The only point on course line, which is on the larger arc QR, is point 'V'. Hence at V the lights will appear to be maximum angular distance apart.

To find the point along the Co line at which 2 shore objects subtend maximum / minimum horizontal angle respectively

Q. 24.15 A bulk carrier AB (LOA = 300m) at her light draft is anchored, at heading of 330°T. Your vessel is steering a true course of 090°T. Extreme end B of the ship is 500m from course line of your vessel as shown in diagram. Find the position on the course line of your vessel, where the anchored vessel casts,
(a) maximum radar shadow area for your Radar,
(b) minimum radar shadow area for your radar.

Ans.
Draw AB along 330°T = 3cm.
Draw CD along 090°T, so that end B is 5 cm from line CD.
Draw perpendicular bisector of AB.
By trial & error method find a point on ⊥ ar bisector, which is the centre of a circle passing through A, B & tangenting the course line CD. Call this tangent point E. ∠ AEB = 24°.

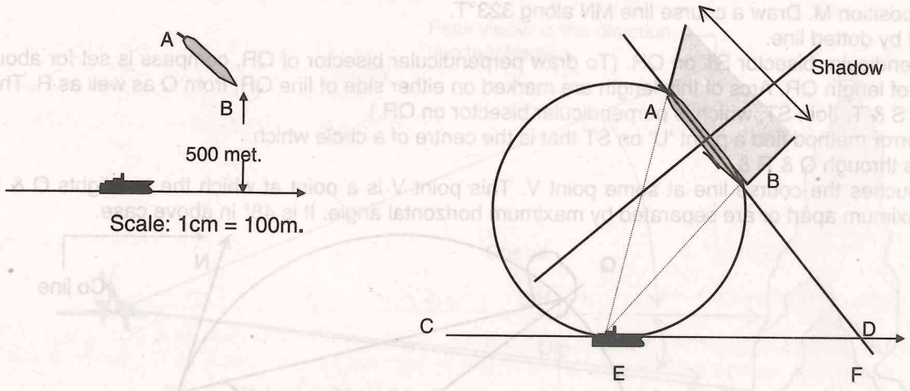


Fig. 24.12

F is a point on CD, along AB extended. At F aspect of AB is 180°. The shadow cast is minimum at F.

Ans: Maximum shadow angle = 24°. Positions of maximum & minimum shadow as shown in the diagram.

To find the point along the Co line at which 2 shore objects subtend maximum horizontal angle

Q. 24.16 A vessel 9M to East of Bishop Rock Light at 1700 h is steering 016°T, at 11.5 kn. At what time will an observer on the ship see the Bishop Rock Light & Round Island Light to be maximum angular distance apart? (Eng. Channel)

Hint: Proceed as in Q 24.14.

Ans. Maximum hor angle = 41°.

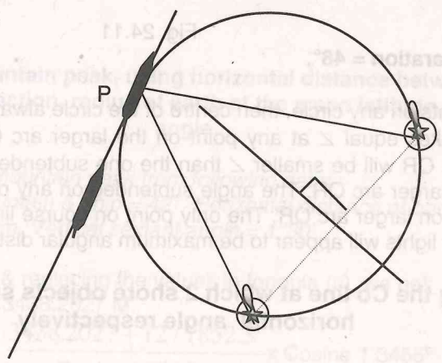
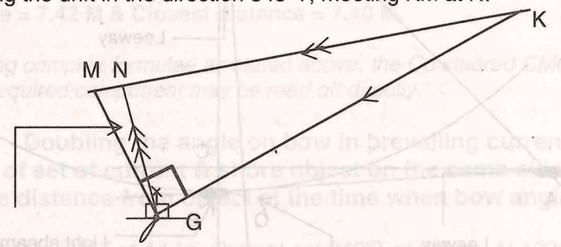


Fig. 24.13

Q. 24.17 A ship steering a course of 237°T, finds Greenwich Buoy right ahead at 0400 h at a distance of 20 M, subsequently passes Greenwich buoy on Port beam at a distance of 6.5 M, at 05h 29.4min. If current prevailing in the area was 345°T x 4.5 kn, find the ship's speed. (English Channel)

Hint:
Draw KG ≡ 237° x 20 M. This is direction of course steered.
Draw GM = 6.5 M, perpendicular to KG.
KM is direction of CMG.
Draw a line representing the drift in the direction 345°T, meeting KM at N.



Set & drift

Fig 24.14

KGN is 'Co steered-CMG Triangle', where GN represents Set & Drift .
GN = 6 M. Since hourly rate of Drift = 4.5 kn, 6 M is Drift for 80 min.
Thus KG must be distance by engines for 80 minutes = 20 M.

$\therefore$ ship's speed $= \frac{60x20}{80}$ = 15 kn.

Ans: 15 kn.

Doubling of 4 points bow bearing with leeway(object on windward)

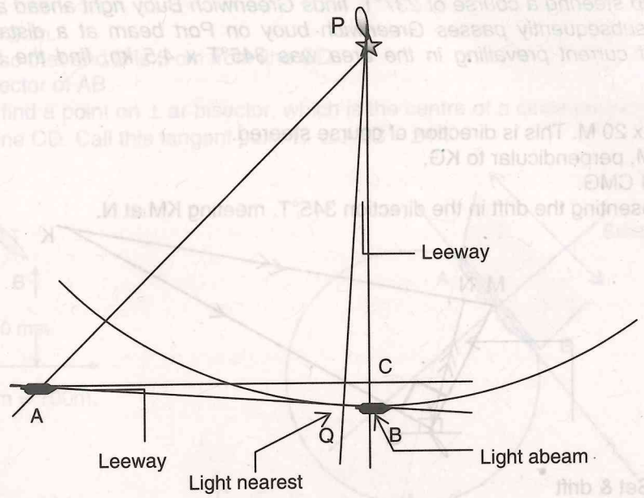
Q. 24.18 A vessel steers 090°T. Her port side is windward side & is experiencing a leeway of 4°. At 1200h she sees a beacon at 4 points on port bow. At 1238h, after steaming a distance of 8M, the same beacon is abeam. Find the beam distance & the nearest distance of the beacon.

Hint:
Case I : 4 points / 8 points bearing of Beacon on windward side.
At A, beacon P is 45° on the Port bow.
AC is the course steered. AB is course made good after leeway effect. AB = 8M. At B, beacon P is abeam.
Beam distance = PB = PC + BC.
In Δ PAC, PC = AC. & in Δ ABC, AC / AB = Cos. leeway. $\therefore$ AC = AB Cos leeway.
Thus AC = PC = AB. Cos leeway.....(1)

In Δ ABC, BC/AB = Sin. leeway. $\therefore$ BC = AB Sin. leeway.....(2)
From equations (1) & (2), Beam distance = PB = PC + BC
= AB Cos. Leeway + AB Sin. leeway = AB(Cos. leeway + Sin. leeway)...(3)
In Δ PQB, ∠ P = Leeway & PQ is perpendicular on Course made good.
Q is the point at which vessel is nearest to P.
PQ / PB = Cos leeway. $\therefore$ PQ = PB Cos leeway...(4)

Thus beam distance = AB [Cos. leeway + Sin. leeway] where AB is the distance steamed from 4 points position till abeam position. & closest distance = Beam distance x Cos. leeway,

Ans: Beam distance = 8.54 M & Closest distance = 8.52 M.



[AB indicates CMG with wind & object on same side]

Fig. 24.15

Doubling of 4 points bow bearing with leeway (object on leeward side)

Q. 24.19 A vessel steers 090°T. Her starboard side is windward side & is experiencing a leeway of 4°. At 1200h she a beacon was found at 4 points on port bow & at 1238 h, after steaming a distance of 8 M, the same beacon was found abeam. Find the beam distance & the nearest distance of the beacon.

Hint: case II: 4 points / 8 points bearing of Beacon on leeward side
In Fig vessel is heading East. Course steered is AC along AC & CMG is AB.
PB is the beam distance.
PB = PC - BC, but PC = AC (isosceles triangle).
∴ PB = AC - BC.

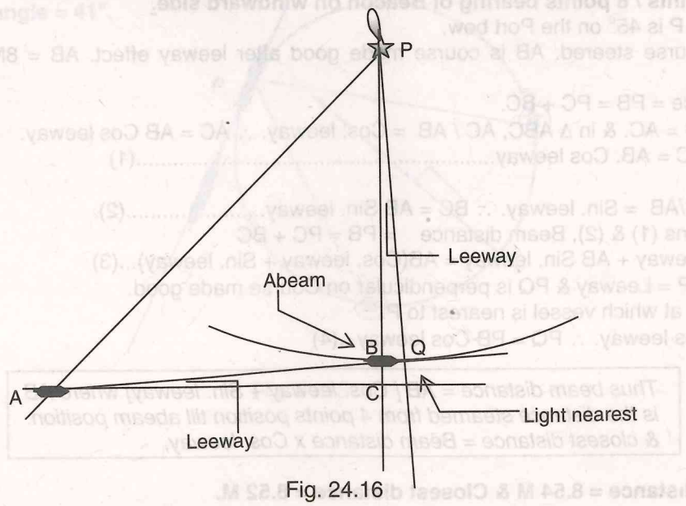


Fig. 24.16

But AC = AB Cos. leeway & BC = AB Sin. leeway
∴ PB = AB (Cos. leeway - Sin. leeway) = 8(0.92781) = 7.42 M.
Similarly it can be seen that Closest distance = Beam distance x Cos. leeway
Closest distance = 7.42 x Cos leeway = 7.40 M.

Beam distance = AB [Cos. leeway - Sin. leeway], where AB is distance steamed from 4 points position to abeam position & Closest Distance = Beam distance x Cos. leeway

Ans: Beam distance = 7.42 M & Closest distance = 7.40 M.
Remark:
Instead of remembering complex formulae as stated above, the Co steered CMG triangle may be actually made on chart & the required component may be read off directly.

Doubling the angle on bow in prevailing current (direction of set of current & shore object on the same side of the ship). To find the distance from object at the time when bow angle is doubled.

Q.24.20 Ship was steering 022°T at 14 kn. Current set 240°T at 3.7 kn. At 1300 h an object was seen to bear 48° on port bow. At 1400 h the same object bore 286° T. Find the distance of ship from object at 1300h.

Hint.
This problem is based on the principle of doubling the angle on bow in presence of current or tidal stream. Object & setting of current are both towards port side. Let β be the ist bw angle & 2β be the 2nd bow angle.
From a rough diagram it can be seen that α > β.
Hence the following formula will be used. (see explanation)

PX = Dist - Drift Sine (α~β) Cosecβ

PX = 9.03 M

Ans. Dist at doubled bow angle = 9.03 M

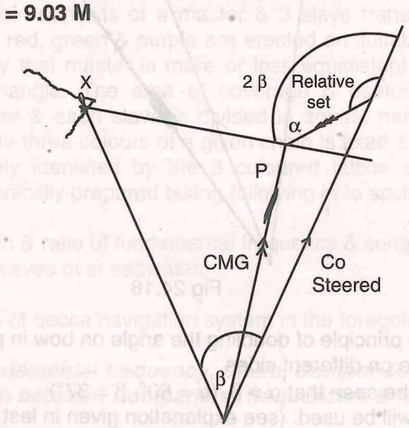


Fig 24.17

Formulae:

Situation I: Setting of current & shore object on the same side of the ship.
PX = Dist ± Drift Sine (α~β) Cosecβ
+ sign used when α < β & - sign used when α > β.
Dist = distance run by engines during the interval when bow angle doubled
PX = Distance of the ship from object at the time of doubled bearing.
β is the bow angle of object X at the time of first bearing.2β is the double of initial bow angle.
α is the direction in which current sets relative to ship's head (port or stbd.)

Situation II:
Setting of current & reference object on different sides of ship.
PX = Dist + Drift Sine (α +β) Cosecβ

Doubling the angle on bow in prevailing current
(Dir of Set & shore object on different sides of the ship)

Q. 24.21 A vessel while steering a course of 030°T, observed beacon X to be bearing 353°T & 316°T at 1800h & 1830 h respectively. If current was known to be setting Eastwards at 4 kn & the ship was 9.7 miles from the beacon at the time of second bearing, find the speed of the ship.

Hint.

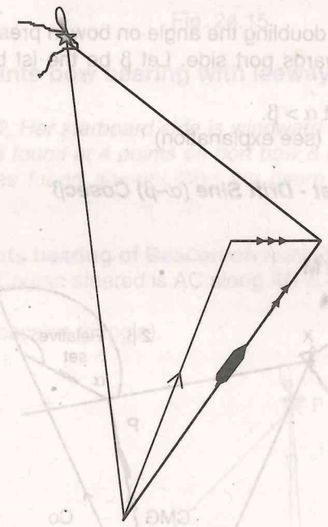


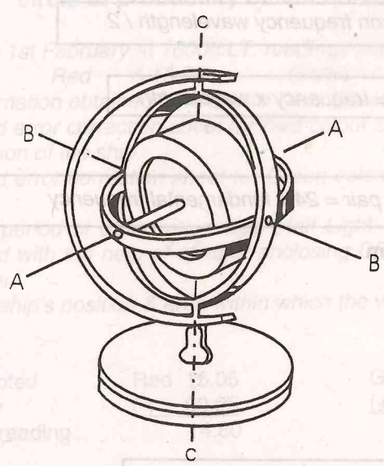
Fig 24.18

This problem is based on the principle of doubling the angle on bow in presence of current or tidal stream.
Object & setting of current are on different sides.
From a rough diagram it can be seen that $\alpha > \beta$. ($\alpha = 60°$, $\beta = 37°$)
Hence the following formula will be used. (see explanation given in last question)

PX = Dist + Drift Sine (α +β) Cosecβ

Dist = 9.7 - 2 Sine 97° . Cosec 37° = 6.4 M.
∴ Speed by engines = 6.4 x 2 = 12.8 kn.

Ans. Ship's speed = 12.8 kn.



Hermann Anschutz: *A German engineer, invented gyro compass in the year 1908. The first gyroscope model however was made nearly 100 years before this invention by a German inventor J. C. Bohnenberger*

[Pic. A Model of Free Gyroscope]

Chapter 25: Decca Navigation System: [Correcting & plotting a bearing]

Decca Navigation System: Is the hyperbolic navigation system. Mainly installed in coastal areas in different parts of world. Decca chain consists of a master & 3 slave transmitters. For installing decca chain, the transmitters viz. master, red, green & purple are erected on suitable locations, close to sea on coast or on islands, in such a way that master is more or less equidistant to slaves & the three slave transmitters form vertices of a triangle. The area of coverage & usefulness of system being very important. The line between master & each slave is divided in zones, named A,B,C etc. from master towards slave. Zone width for all the three colours of a given chain is fixed & is a function of fundamental frequency. A decca chart is easily identified by the 3 coloured lattice seen overprinted on normal navigational chart. Lattice is electronically prepared taking following in to account.

1. Positions of transmitters.
2. Fundamental frequency of chain & ratio of fundamental frequency & comparison frequency.
3. Velocity of propagation of EM waves over seawater.
4. Scale of the chart.

Let us discuss some of the aspects of decca navigation system in the foregoing text.

Decca Navigation system, Fundamental frequency, Chain, Comparison frequency, Lane width, Lattice lay out, relationship between Comparison frequencies & lane width at baseline

Q. 25.1 If Fundamental Frequency used in a chain is 14.2 kHz., find the following:
(a) Width of red lane at baseline.
(b) Distance from D30.0 to E30.0 at baseline in meters.
(c) Width of purple lane at baseline.

Hint.
(a)

Lane width (Red) at B-L = Comparison frequency wavelength / 2

Speed of electromagnetic wave = frequency x wavelength

Also

Comparison frequency for [Master - Red] pair = 24 x fundamental frequency

Gives λ (wavelength) = 880.28 m & **lanewidth = 440.14 m**

(b)

Lane 30 represents Green lattice.
Zone D extends from D 30.0 to E 30.0.
Zone width of all the three colours within a chain is equal.

Width of red zone at B/L = Red lanewidth x 24
= Green lanewidth x 18
= Purple lanewidth x 30

∴ **Width of Green zone** at B/L = 440.14 x 24 m = **10563.36 m**

(c) Width of Purple lane = Purple zone width / 30 = 10563.36 / 30 = **352.11 m.**

Ans. (a) 440.14 m. (b) 10563.36 m. (c) 352.11 m.

To Compare LI readings & Decometer readings to detect possible laneslip & then correct Decometer readings as per LI readings

Q. 25.2 Following readings were obtained from a Mark 21 Decca receiver. What readings will be read by you prior applying fixed correction & why?

	Master	*Red*	*Green*	*Purple*
Lane Identification	*00.1*	*19.80*	*35.10*	*59.20*
Decometers		*A20.10*	*D35.80*	*B60.70*

Hint.
Master LI reading of 00.1 indicates that subsequent LI readings showing the comparisons of phase of Master with 3 slaves measured on the fundamental frequency would be correct.
Centilane part of readings viz. 10, 80 & 70 shown by R, G & P decometers are to be accepted as they are. As far as lane part of reading of the three decometers is concerned, correct value for red may be 20 or it may not be 20 in case of Red. Thus in the present case correct lane may also be 18,19,21,22.
Which means 18.10, 19.10, 20.10, 21.10, 22.10 etc. may be correct readings. The reading closest to LI Red i.e. 20.10 is the reading to be noted for Red.
In case of Green, correct reading = 34.80.
In case of Purple, correct reading = 58.70 or 59.70. Both these readings are equidistant from 59.20, thus there is an ambiguity. An observed position will resolve the ambiguity.

Ans. Red A20.10
Green D34.80
Purple B58.70 or 59.70.

Correcting decca readings for fixed error & then plotting the same on chart. Drawing the circle of probability based on variable errors affecting the decca position

Q. 25.3 On 1st February at 1600h LT, readings noted for Red & Green colours were as follows.
Red A 15.05 Green C 41.80
Information obtained from Decca Data Sheets is as follows:
Fixed error correction sheet for Red colour shows a number 25 within a circle, approximately at DR position of the ship.
Fixed error correction sheet for Green colour shows a number 40, approximately at DR position of ship.
The period of observation was 'Half Light' as per 'Decca period correction chart'. Variable error found with the help of contour enclosing DR position on 'Variable error contour chart' is 0.13 M or better.
Plot ship's position & area within which the vessel must lie in most cases.

Hint.

	Red	Green
Reading noted	15.05	41.80
Fixed Error	(-) 00.25	(+) 00.40
Corrected reading	14.80	42.20

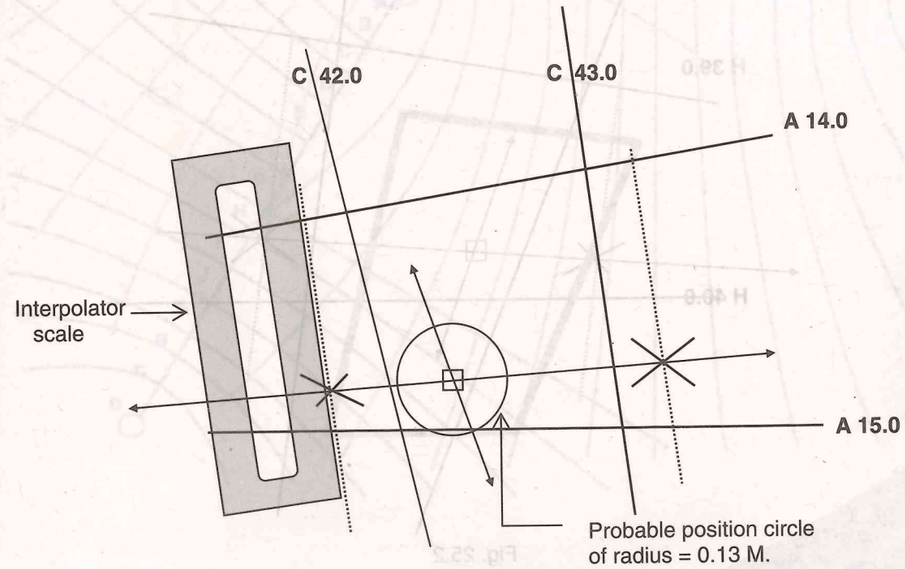


Fig. 25.1

Procedure of plotting:

Ascertain the DR where Decca position is to be plotted.
Draw 2 lines across one set of the coloured lattice, one on either side of DR.(In present case these lines are shown by dotted lines & are drawn across Red lattice).
On these lines, points corresponding to A 14.80 are found with the help of special interpolator scale provided. Upon joining the two points Red PL is obtained.
Portion of Red PL lying between C42.0 & C43.0 is interpolated to get a point corresponding to C 42.20, which is the Decca fix.

Accuracy & reliability of LI readings. Parallelogram of positions

Q. 25.4 LI readings for 2 of the Decca lattice were H 39.8 & C 61.2 respectively. There was no fixed or variable error for either lattice for the position of the vessel at the time of observation. Plot the ship's position & draw the parallelogram of position assuming that the LI readings are accurate within 0.5 of a lane.

Hint.

Decometer readings lie within 50% of lane on either side of LI reading. e.g. if LI reading is 19.4 then Decometer reading will be from 18.9 to 19.9 (19.4-0.5 to 19.4+0.5).Thus probable area band of respective lanewidth (lanewidth in that position & not at baseline) is drawn as shown in diagram.
Readings 39.8 & 61.2 pertain to Green & Purple colour. Readings are plotted as explained in last question.

Area enclosed by gray band approximating to parallelogram is the area of probability.

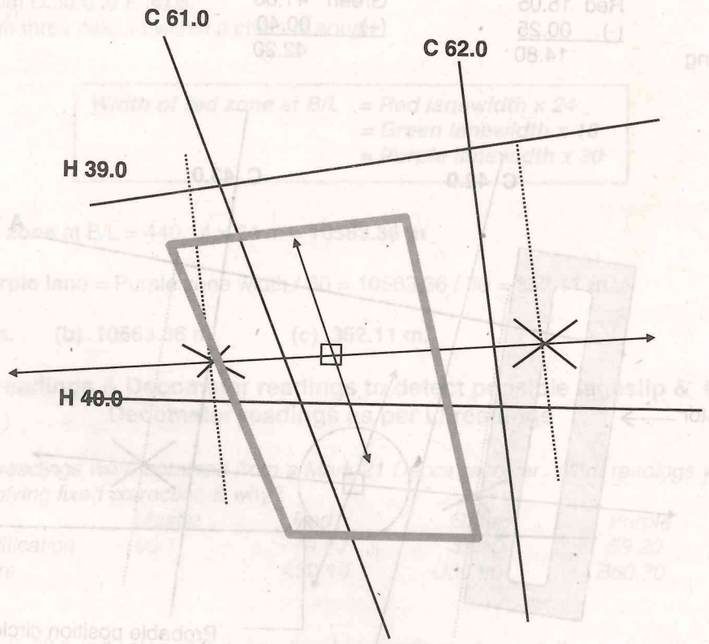
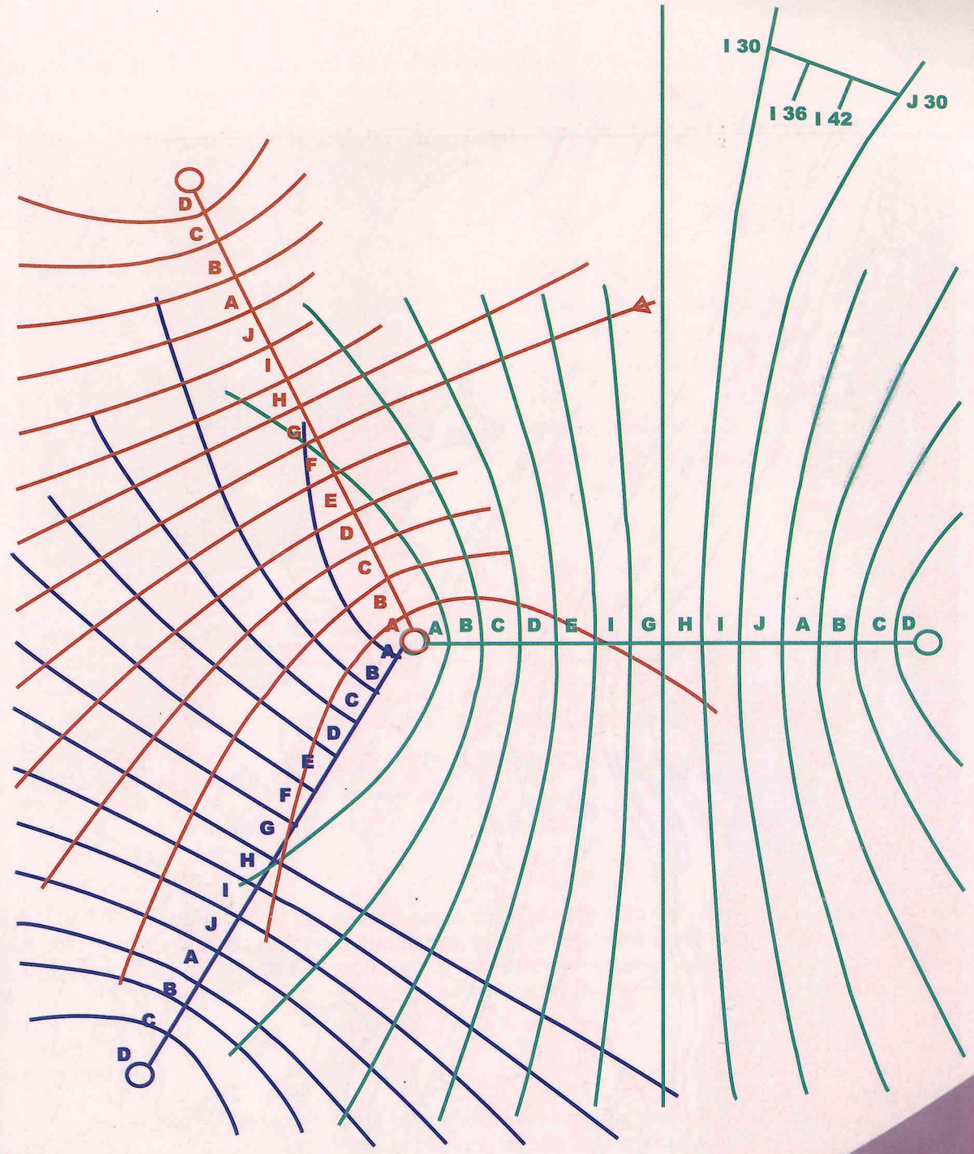


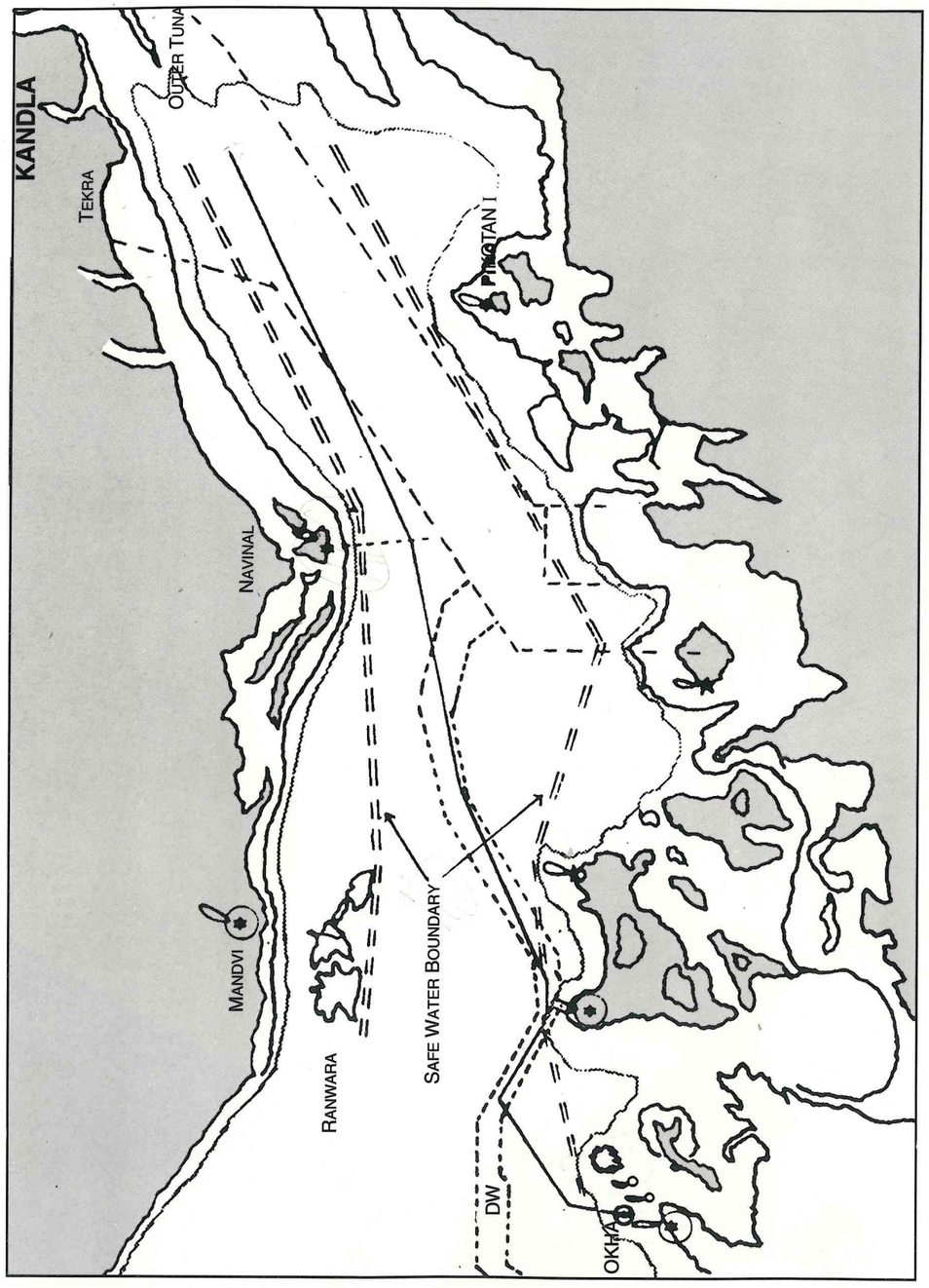
Fig. 25.2

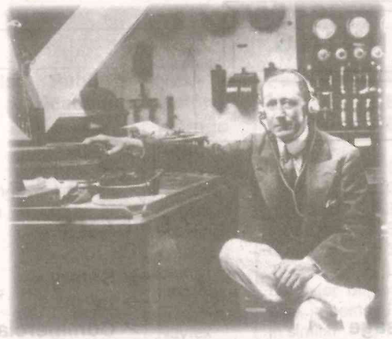


Position plotted with Decometer reading Red G 0.0 & Green G 39.0 (Note: Red lane values will always lie between 00& 24. Similarly Green between 30 & 48 & Purple between 50 & 80. Width of zones in different colours at base line is same)

BA L(D2-D5) 1610 (Decca Chain 2E MP & 5B MP) Means British Admiralty Chart No 1610. L means that its a lattice chart. D means that its a Decca latticed chart. Decca lattice is overprinted over a navigational chart' viz. BA 1610.The Chain whose lattice is printed is 2E/ Multipulse (Holland) & 5B / Multipulse (Englishj), Conventionally A, B, C, D, represent Master, Red, Green & Purple respectively. Thus to show that respective colour 's lattice are shown on a chart, following inscriptions are found at left handed bottom corner of chart.

AB AC AD





Guglielmo Marconi: *1874- 1937 - An Italian inventor born in Bologna, Italy. He was an electrical engineer. In 1896 he became the pioneer in the field of maritime communication by sending the first 'ship to shore' radio signal. Earlier he failed the university entrance examination, he thus decided to pursue the science studies on his own. His equipment helped rescue from many sinking ships including Titanic.*

[Pic Guglielmo Marconi]

Chapter 26: Passage Planning: 'Theory & Practice'

Definition: "Passage planning is practical preparation of ship with the persons, provisions, equipment, charts, publications & appropriate documentation, to carry out an intended voyage, extending from 'pier to pier', using maximum possible information & knowledge, whether charted, published, navigational, meteorological, own ship's data". The plan being suitably viewed from various aspects, viz. safety, commercial & legal..

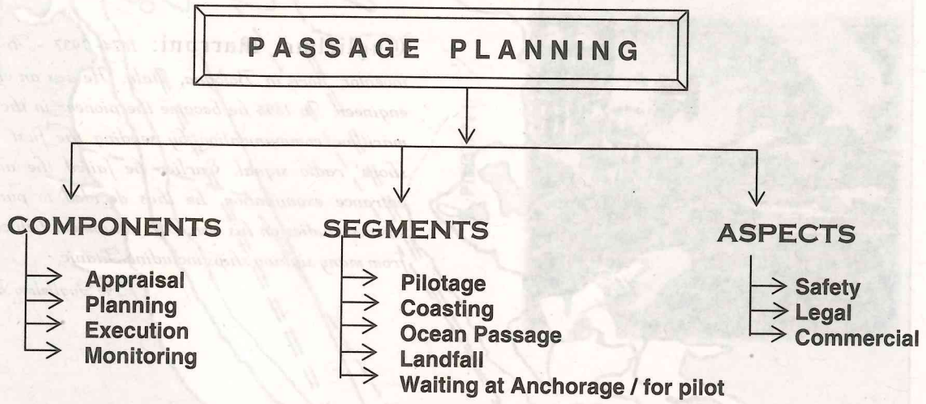
Main advantages:

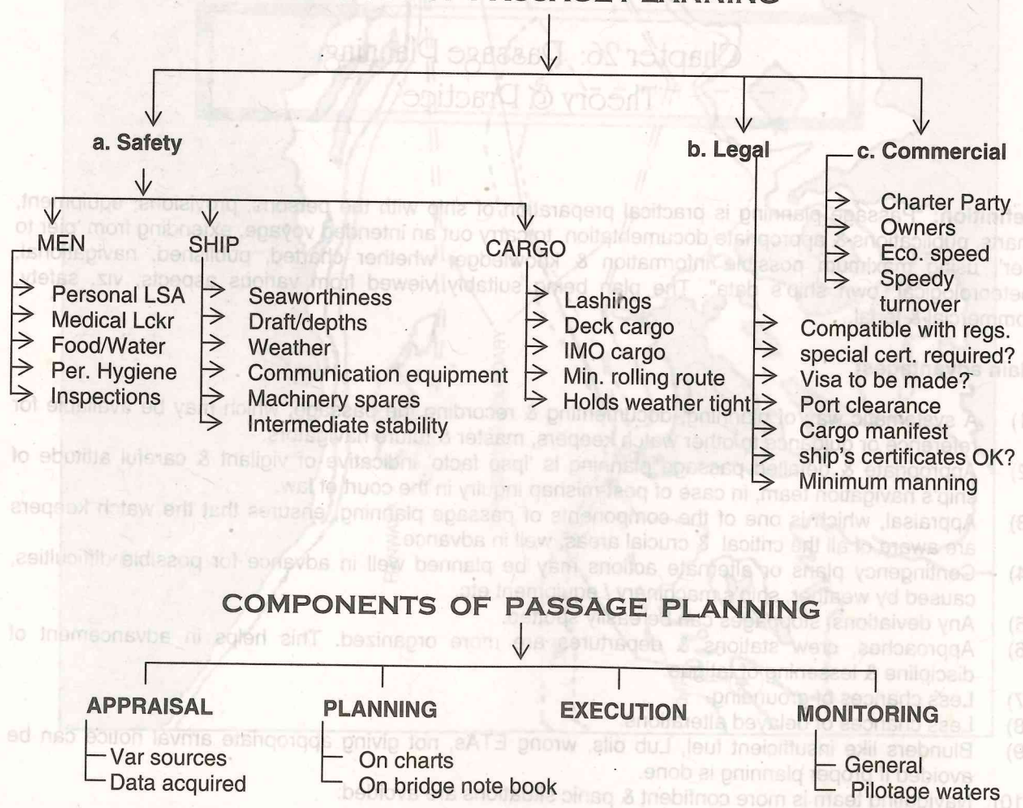
(1) A systematic way of planning, documenting & recording the passage, which may be available for reference or guidance to other watch keepers, master & future navigators.
(2) Appropriate & detailed passage planning is 'ipso facto' indicative of vigilant & careful attitude of ship's navigation team, in case of post-mishap inquiry in the court of law.
(3) Appraisal, which is one of the components of passage planning, ensures that the watch keepers are aware of all the critical & crucial areas, well in advance.
(4) Contingency plans or alternate actions may be planned well in advance for possible difficulties, caused by weather, ship's machinery / equipment etc.
(5) Any deviations, stoppages can be easily spotted.
(6) Approaches, crew stations & departures are more organized. This helps in advancement of discipline & lessening of fatigue.
(7) Less chances of grounding.
(8) Less chances of delayed alterations.
(9) Blunders like insufficient fuel, Lub oils, wrong ETAs, not giving appropriate arrival notice can be avoided if proper planning is done.
(10) Navigating team is more confident & panic situations are avoided.

Various components, segments & aspects of Passage Planning

Q. 24.1 Discuss various components, segments & aspects of passage planning.

Ans:





APPRAISAL

Var sources

Charts	Publi-cations	Navi-gational Warngs Notices	Past Log Abstracts	Past Experi-Ences	Own Ship Particulars	News Broad-Casting
1. Routing charts 2. Small scale charts 3. Navi-gational charts 4. Large scale Charts 5. Passage plnning charts	1. Admiralty Chart Catalogue 2. Admiralty Sailing Directions 3. Ocean Passages Of World 4. Admiralty Tide Tables 5. Admiralty Tidal Atlas 6. Admiralty Distance tables 7. Reed's Distance Tables 8. Admiralty List of Radio Signals 9. Admiralty List of Lights 10. Tidal Streams 11. Nautical Almanac 12. Ship's Routing 13. Local Tide & Pilot booklets	1. Valid & current Warnings 2. Safety messages 3. Navtex **Notices** 1. Annual notices to mariners 2. Cumulative notices to mariners 3. Weekly notices to mariners 4. T & P notices	1. Behavior of particular ship in bad weather 2. Behavior of ship in past in similar season 3. Similar ports, voyages made in past 4. Some times first hand information is very important	1. Officers 2. Seamen 3. Logbooks 4. Record of messages	1. Manoeuvring data 2. Sophistication & Limitation of Navigational Equipment 3. Efficiency of staff 4. Available hands 5. Draft & trim 6. Windage Area 7. GM of ship	1. Political Situation in next Port 2. Civil war, Strikes etc 3. Discuss With Owners Chartrers If need to

Data acquired

1.	Route at a glance
2.	Different type charts
3.	Shore features, under water dan gers, Navigational aids
4.	Shelter areas, anchorages
5.	Recommended routes
6.	Details of lights / L.houses
7.	Traffic Sep. Scheme details
8.	Distances between ports
9.	Current editions of charts
10.	Current ed^{n}. of publications
11.	Meteorological information
12.	Predominant currents
13.	Ice limits
14.	Isobars & Isothermal lines
15.	% of gales / fog observed
16.	Past storm tracks
17.	Direction & rate of currents
18.	Probability & strength of wind in given month
19.	Navigational warnings
20.	Details regarding Radio beacons, RACONS, RAMARKS
21.	Standard & Legal times
22.	Meteorological Observation Stations
23.	Radio weather service
24.	GMDSS
25.	VTS, VTMS, Port operations& Pilot services
26.	Length of wharf, Depth at wharf, channel, Cranes
27.	Hospital, Bunkers, F.W.,
28.	Airport, De-ratting, Repairs
29.	Passage planning chart
30.	Various notices to mariners
31.	T & P Notices
32.	Radio / current news
33.	Own manoeuvring data
34.	Own men, certificates etc.
35.	Ship's particulars
36.	Type of cargo aboard
37.	Navigational equipment

PLANNING

On Chart	On bridge note book
1. Mark dangers	**A. Normal Planning**
2. Mark margin line or safe water channel	1. Port, pilot VHF ch.
3. Tentative course aprox. in centre of channel	2. Arrival / departure port tide predictions
4. Alteration of course at beam bearings	3. Total cargo, deck, holds, IMO
5. Floating navigational aids & marshy lands not relied for alt/co	4. Distance to go from Alt/Co point
6. Advise soundings- check if cross. sdg contour at Right ∠	5. Reference chart list
7. Raising/dipping distances marked	6. Remarks from pubs.
8. Check Co line clear of wrecks/ shoals	7. HW to which tidal streams referred to
9. Long distance Co/ distance found by Mercator formula	8. Meteorological conditions expected
10. Coastal Co/distances found by // ruler & latitude scale	9. VTMS: Advise to ref. to ALRS
11. Mark final Co/dist. Nr. &changeover pt.	10. Co & Distances
12. next chart marked	11. Anticipated tidal streams / currents
13. Caution highlighted	12. Alteration points or Way points
14. Advise 'see large scale chart' if required.	13. Any special remark re. pilotage embarkation procedure
15. Advise referring to a publication	14. // indexing details
16. U/keel clearances	15. Voyage chart list
17. Clearing bearings	16. Remarks form Routing charts
18. Mark pos where	**B. Contingency Planning**
19. to take anchor lashing	1. Navigational deviations
20. to notify Eng-room	2. Loss of speed due weather
21. to open anchor lashing	3. Loss of speed due break down
22. to call extra lookout	4. Safety based deviation
23. to call anchor station	5. Breakdown in crucial areas
24. to call fore & aft station	
25. to start altering for an alteration	
26. transit bearing may be taken	
27. Variable range marker may be checked	
28. Port control or pilots to be called	
29. Anchorages along route highlighted	

EXECUTION

(Re executing the ref. MERCHANT SHIPPING NOTICE Nr. 854 & annex v of the notice)

Reliability & condition of v/l's navigational equipment.	ETA critical points, considering tide etc.	Meteorological conditions, particularly areas prone to low visibility.	Daytime versus night passing of danger points.	Effect on position fixing of the same.	Traffic conditions especially at traffic focal points.

MONITORING

General

A. POSITION PLOTTING METHODS

1. Lat. & Longitude
2. 2 Bearing Lines
3. 2 Pos-N Circles
4. 1 Bearing-1posn Circle
5. Hyperbolic Lattice
6. 2 Celestial Posn Lines
7. Celestial + Terrestrial
8. Sounding Contour + Celestial Or Terrestrial Pl
9. Radar Distance
10. Vertical Sextant Angle
11. Horizontal Angle
12. Raising / Dipping Range
13. Luminous Range

B. PARALLEL INDEXING

1. Continuous monitor
2. Course alteration

C. LOOKOUT, ROR DUTIES

Rule number 5,6 of ROR considered in planning in respect of deployment of men & meeting the waypoints.

D. UPDATING THE PASSAGE PLAN

1. Owner-Instructions
2. Chartrer Instructions
3. Weather Router's instructions
4. Current Weather
5. Navigational Warnings
6. Day-Night Position plotting conditions
7. ROR Deviations

E. COMPLY WITH STANDING ORDERS

1. Regarding Set-Leeway Application
2. Regarding Engine Status, RPM.
3. Regarding Extra Lookouts
4. Regarding Fix Intervals
5. E/R & Self Notice

F. LOGBOOK 'READ & WRITE'

1. Log Book Read to Study The Ship's Movement In Last 12hours,
2. Behavior of Current, Weather & Status of Engines Studied
3. Record Positions Periodically
4. Log Positions of A/Co Points.

Pilotage Waters

A. NO PAPER WORK

Ood to continue doing position monitor even in pilotage waters & not to divert attention towards filling of arrival papers viz, crew list, immigration, health, customs papers etc.

B. PILOT- MISTAKES & LANGUAGE

1. Extra caution regarding coning orders, if pilot does not speak the language understood by helmsman, especially when the accent is awkward.
2. Master to discuss the pilotage-manoeuvre with pilot, explain the same to ood.
3. In addition to frequent plotting , // indexing may be done during the pilotage passage.

B. GRAY AREAS

1. Of responsibility between Master & Pilot
2. Master not to take it easy when pilot is on board'
3. Pilot to be aware of ship's manoeuvring characteristics & limitations if any.
4. Ood not to hesitate in raising any doubt thinking 'Master &/ or Pilot are there'

Various publications used for Passage Planning

Q. 24.2 Before planning the passage, a navigational officer must get familiarized with various information provided in different publications. List such information along with the publications that is the source of such information.

Ans.

01.	***Route at a glance***	Adm Chart Catalogue, Routing Chart, Ocean Passages of the World, Small Scale Chart.
02.	***Numbers & limit of different charts.***	Adm Chart Catalogue.
03.	***Diagrammatic index of Adm Sailing Direction.***	Adm Chart Catalogue.
04.	***Detailed topography, Shore side dangers, Navigational Aids, Sounding contours.***	Navigational scale & Large scale charts.
05.	***Under water rocks, wrecks, Shoals***	Nav. scale charts, Large scale charts, Adm Sailing Direction.
06.	***Shelter / Safe anchorages.***	Nav. scale charts, Large scale charts, Adm Sailing Direction, Anchorages within & around the harbour are described in Guide to Port Entry.
07.	***Recommended route.***	Ocean Passages of the World, Ship's Weather routing, Navigational scale chart & Routing chart.
08.	***Details of Lights.***	List of Lights, Large scale chart
09.	***Traffic Separation Scheme.***	Admiralty Routing, Large scale chart
10.	***Distance between ports.***	Adm Distance Tables, Reed's Distance Tables, Ocean Passages of the World, Routing Chart, Brown's Almanac
11.	***Current New Editions dates of charts.***	Cumulative notices to mariners(6 monthly) Admiralty Chart Catalogue(annual)
12.	***New Edition dates of Admiralty publications.***	Weekly notices to mariners numbers, 13th, 26th,39th & 52nd., Adm Chart Catalogue. Cumulative Notices to Mariners.
13.	***Meteorological information***	Adm Sailing Direction, Routing chart, Weather reports.
14.	***Major predominant currents of the world.***	Routing chart.
15.	***Ice limits***	Routing chart, Pilot chart(US), Radio Ice Reports.
16.	***Isobar / Isothermal lines***	Routing chart, Pilot chart (US)
17.	***% probability of gale winds & fog observed in a particular area***	Routing chart, Pilot chart (US)
18.	***Details regarding wharf***	Guide to Port Entry, Admiralty Sailing Direction, Plan chart of port.
19.	***Information regarding Hospitals, Bunkering facility, Fresh Water, Airport, Departing facility.***	Guide to Port Entry, Admiralty Sailing Direction.

20.	***Wind rose (probability of force & direction of wind blowing in an area).***	Routing chart, Pilot chart & Adm Sailing Direction.
21.	***Navigational Warnings.***	a) Navarea Warnings by WWNWS for 16 NAVAREAS & Navtex in some NAVAREAS + Section III of Weekly notices to mariners. b) Coastal warnings by a country for particular region. c)Local warning from Port or Coastguard.
22.	***Coverage, description of electronic position fixing systems, Radio beacons, Racons, Ramarks, Radio Time Signals.***	Adm List of Radio Signals Vol. 2.
23.	***Standard / Legal Times.***	Adm List of Radio Signals Vol. 2, Almanac
24.	***Meteorological Observation Stations.***	Adm List of Radio Signals Vol. 4.
25.	***Particulars of Radio Weather Service, Ice reports, Radio Nav. Warnings***	Adm List of Radio Signals Vol. 3
26.	***GMDSS***	Adm List of Radio Signals Vol. 5
27.	***VTS, VTMS, Port Operations, Pilot Services.***	Adm List of Radio Signals Vol. 6 (Part 1 to 5)
28.	***Past storm tracks in a particular month.***	Routing / Pilot chart.
29.	***Port, Pilot, Quarantine information & Arrival notice.***	Guide to Port Entry, Adm List of Radio Signals Vol. 6, Charter Party (sometimes).
30.	***Latitude, Longitude of a port.***	Nourie's Tables, Guide to Port Entry, Adm List of Lights, Adm Sailing Direction.
31.	***Satellite pos fixing details & errors***	ALRS vol 8
32.	***Maritime Safety Information & Services***	ALRS vol 3 (part 1 & 2)

Passage planning from Okha to OTB Kandla

Q. 24.3 Your ship drawing a draft of 9m, has to reach the anchorage off Outer Tuna buoy From a position, 5 cables WNW of Okha Pilot station. Explain how will you go about planning a safe passage.

Ans.

As soon as the next port is known, Navigation officer must provide the master with following information:

01. 'Sea speed distance' or details of 'open sea passage' to next port.
02. Pilotage & harbour motoring or distance which would be traversed at reduced speed.
03. Open sea passage distance + reduced speed passage after next port to reach the subsequent port after next port or till bunkering port, if known.
04. Fuel, diesel, fresh water & lub oils remaining on board.
05. ETA next port at say 11.5 kn, 12 kn & 12.5 kn, where 12 kn is the normal general average speed of the ship.
06. Requisition for charts, harbour plan or nautical publication if required for the voyage.

Appraisal

01. Adm chart catalogue is consulted, to pull out charts, harbour plan & Sailing Direction for the current voyage.

02. Latest cumulative notice is checked to find if the editions of voyage charts are valid. In other words, it is confirmed that all charts on board are of current edition.
03. Latest quarterly Weekly Notices to Mariner or Cumulative notice is checked to ensure that, all the Admiralty publications (with supplements) relevant to the current voyage are of the latest edition.
04. The voyage charts & connected publications are then corrected to the latest weekly 'Notices to Mariners' on board.
05. Relevant Adm List of Lights is consulted to know more details regarding position, characteristics of any Light or construction of any Lighthouse.
06. From Adm Sailing direction find:
    (a) Weather or meteorological information of the passage area or the climatic conditions at destination port.
    (b) Information regarding waters close to shore, underwater dangers etc. with relevant caution for a watchkeeper if any.
    (c) Information regarding approaches & anchorages.
    (d) Information regarding shelter anchorages & important ports along the route.
    (e) Information regarding the tidal streams.
07. From ALRS vol. 2, get the information regarding Navigational Aids available in the passage area.
08. From ALRS vol. 6, get the port, health & pilotage information.
09. Similarly Guide to Port Entry, Routing Chart of the area for the current month, navigational & large-scale charts etc. are studied carefully.
10. Scale of chart, new edition date, dates of survey etc are considered while evaluating reliability of a chart.

Thus in respect of the **passage under consideration**, the navigational officer may, while going through various charts & publications, pick up useful information & note the same down in **Bridge note book** for himself, for other officers & for future reference, as follows:

(1) **Voyage charts**: BA 673 - Port of Okha & Approaches (1:50000). BA 43 - Gulf of Kachchh. BA3466 - Approaches to Kandla (1:40000) & Kandla Creek. Indian charts 2059 & 203.
(2) **Approaches to Kandla** Creek & their buoyed approach channels are very irregular & liable to frequent changes, the buoyage is moved accordingly.
(3) Masters using **Deep Water Route** should take in to account possible changes in depth due to meteorological & other effects since the last survey.
(4) A Vessel unless constrained by her draft should, as far as possible avoid using the Deep Water Route.
(5) **Flood stream** sets strongly round 'S' end of **Samiani Island** (5 cables NE of Okha Pt.), in a S'ly & E'ly direction & from there sets S'wards through Okha harbour, curving in E'ly direction round 'S' end of Beyt Island (E of Okha Pt.). It has a rate of from 1.25 - 1.5 kn at Neaps & 2 kn at Springs.
(6) **'Shelter Anchorage along the route'**: During SW Monsoon, in depth of 18.3 m, anchorage lies 3/4th of mile 'N' wards of entrance inlet under lee of Karumbhar Is.
(7) **Tidal stream** over **Ranwara Shoal** attain a rate of 5 kn at Springs & 3 kn at Neaps, causing heavy tide ripples & overfalls over uneven ground in vicinity & W-wards.
(8) **Important Port along the route:** Mandvi is very important commercial town in Gulf of Kachchh, connected by road to Bhuj.
(9) **Conspicuous position fixing Lights, Points etc:** Mandvi Light with elevation of 37m from Masonry tower lies at SW portion of fort. Pirotan I. lies 6.5 M NE of NW end of Dera & is a good land mark. Pirotan light is over a white circular tower with black bands.
(10) **Important radar detection ranges:** Balachiri Rk. (SSE of OTB anchorage). gives good echo at 19M Samiani Is. (5 cables NE of Okha Pt.) give good echo at 12 M.
(11) **Kandla Pilotage:** is compulsory from OTB. A vessel should embark a pilot close SW of OTB with Tekra Light bearing 011°. Loaded vessels can cross bar only during HW. Agents to be losely kept advised of ETA. Vessels can contact Kandla Tower through VHF ch. 16. Pilot station is 16 M from port.
(12) **Tides:** Both Okha & Kandla are secondary ports, listed in ATT 2, with Bombay as Standard Port. Tidal streams at selected positions in Gulf of Kachchh chart may be found out using Tidal stream table given on the chart & the knowledge of HW timings at Bombay.
(13) **Extracts from Shipmaster's report:**

(A) Pilot advised that anchorage is 2 M from OTB. Inside the harbour anchorages, are allotted by port authorities & pilots anchor there. Night navigation has been introduced & restricted to vessels upto 189m LOA & upto 8.23m draft. Tankers handled only in daytime.

(B) Report, October 1993: Approaching Gulf of Kachchh from SW the promontory of "Okhamandal" shows up well on radar with all Racons operating. Large swell in SW Monsoon. Anchorage quite crowded. Inner anchorage is by pilot with tug's assistance. There was rule that if you anchored over 2 M from OTB, a double pilotage fees would be charged.

Kandla Tower gives out berthing information around 2100 h & 0900 h Maximum security required. At anchorage, thieves roam around at night in high-powered boats.

Planning:

Subsequent to appraisal, planning commences. Planning is done on chart as well as bridge note book, keeping in mind all the aspect of passage under consideration.

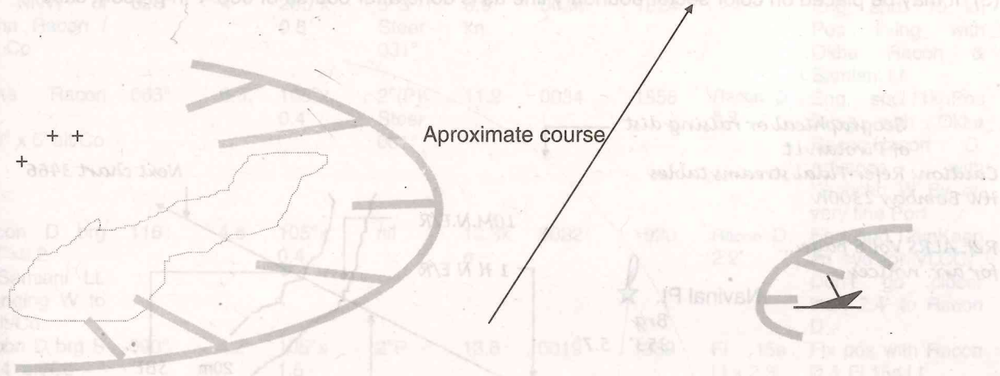


Fig. 26.1

(A) Largest scale chart, extending from departure port till destination port is picked up first. In present case it is BA 43. In most cases it may be a very small scale chart. Plot a course on this chart, which is not the final course but only a general rough course line or guide line for plotting the final course.

(B) Now take the largest scale chart of departure port. This would normally be approaches chart. Plot initial position, 5 cables WNW of Okha Pilot Station. On the Approaches chart & the navigational scale chart course lines are plotted as follows.

(C) Highlight the danger areas, showing areas dangerous for vessel, on either side of rough course line. Shade these areas with slanting edge of chart pencil (2B), as shown in fig 24.1.
Safety margin lines on either side of this course line is drawn tangenting the highlighted zones, to make a safe water band for the vessel.

(D) Course line is laid approximately midway of the safe water band. This has following merits:
    (1) Course is laid in safe depths.
    (2) Emergency alteration on either side may be done without having to go in the chart room to check present position.
    (3) In cases of negligence, delay or mistake in altering course or in resuming the original course after altering for another vessel, vessel will have some margin of safety.
    (4) Successive alteration to Starboard for head on traffic will not put the vessel in shallow waters.
    (5) In case of machinery or steering failure, more margin of safety on either side.

(E) Some times approaches & departure courses are along transit bearing lines. The set of lights (Inferior / superior light), is most reliable & efficient way of guarding against cross channel currents

& ensuring that the vessel is in the middle of approach channel. All that one has to ensure is that the two lights are maintained in vertical line.

(F) Once the courses are decided, the alteration points need to be placed. Following points should be remembered in selecting the alteration points ;

(1) Floating marks, buoys etc not relied as exclusive pos fixing aids, in order to alter course.

(2) Beam bearing of a light house preferred for alter course position. This has following merits.
(AA) Light flashing or lighthouse on beam warns you, "Don't forget you have to alter".
(BB) Light, beacon etc. while abeam is normally nearest, hence position error for a given error in bearing is minimum.
(CC) '// indexing distance' is equal to 'alteration point distance', helping one to check any possible clerical error.
(DD) Light being nearest, more chances of being visible in reduced visibility cases.

(3) It may be placed on color sector boundary line as is done after course of 063°T in present case.

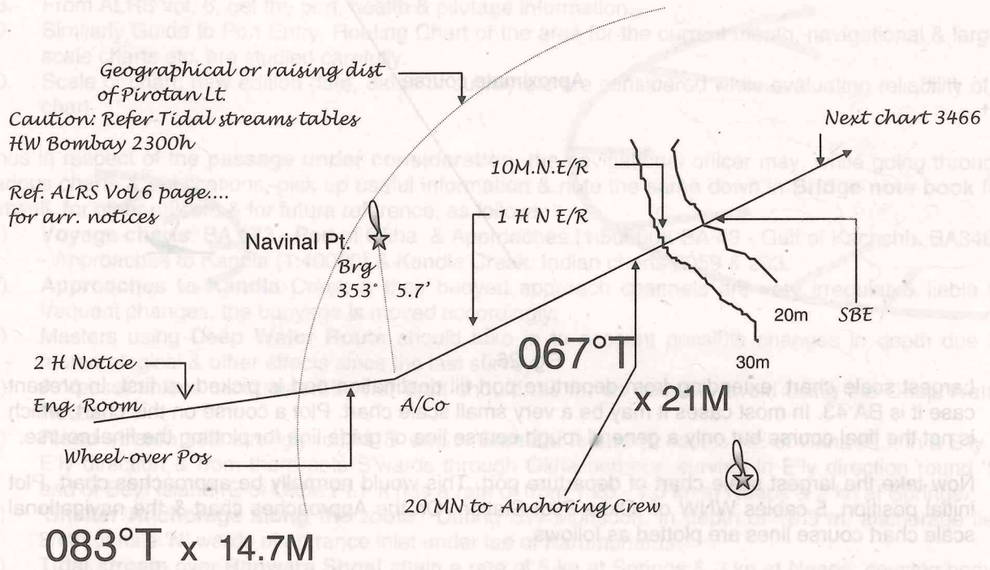


Fig. 26.2

(4) Depth contours perpendicular to course line can be used to cross check position. In present case note, '10 min. notice' & 'Standby Engines' given at crossing of contour. (Caution: Soundings are extremely reliable means of ascertaining safe depths, helping to confirm the position already determined by other means but should not be used as sole & primary means of fixing up position.)

(5) 2 Racons, 2 conspicuous points of land etc. with suitable angular separation (close to 90°), may be suitable means of position fixing.

(6) Alt/ course positions may be synchronized with Transit bearing lines, eliminating any chances of compass error.

(G) A few adjustments may be required in course lines to suit positions of alteration of course. Nevertheless , course lines at this stage are more or less final.

Bridge Note Book

M.V. Purple Rain
From Okha
To Kandla
Maximum Draft 9m.
Trim 1.1 m by stern

Date & Time of Departure
18th Aug.,1800 h LT
Sea Speed 12 kn
Manoeuvre F.Ahd. 10 kn
HW Bombay 2300 h
Master Capt. Joe D'Souza

In Position with	Co to make Good	Distance	Tidal stream/ Current	Allowance to Co	Expected Spd Over Grnd	Steaming time to next W/Pt.	ETA next W/Pt	// index Pt./ CPA	Remarks
	°	M	° x kn	°	kn	mins.			
5" NNW of Okha Racon / Set Co	026°	4	285°x 0.8	5°S Steer 031°	9.9 kn	0024	1824		Eng. spd. 10 kn Pos fixing with Okha Racon & Samiani Lt.
Okha Racon brg. 193° x 6' alt/Co	063°	6.3	105°x 0.4	2°(P) Steer 061°	11.2	0034	1858	Racon D 5.9'	Eng. spd.11knPos fixing with Okha Racon,Racon D. Advance with Kachchh 'W' By. on very fine Port
Racon D brg 137°x6.2 & Samiani Lt. changing W to R alt/Co	116°	4.6	105°x 0.4	nil	12.3kn	0022	1920	Racon D 2.2'	Eng. spd.12knKeep an eye for VLCCs'. Don't go closer than 2.4' to Racon D
Racon D brg S x 2.4 alt/Co	090°	4.2	105°x 1.5	2°P	13.6	0019	1939	Fl 15s Lt x 2.3'	Fix pos with Racon D & Fl 15s Lt.
Racon D brg 239°x4.7 alt/Co	074°	6.6	105°x 1.7	5°P Steer 069°	13.6	0029	2008		Racon D, Fl 15s Lt. & Mandvi Lt. available
Fl 15s Lt. brg 214°x5 Dhani N By. abeam S alt/Co	083°	14.7	105°x2 & var. later	5°P	13.9 kn	0106	2114	Navinal Pt. x 5.6' P	2 h notice to be given at marked pos Mandvi Pt. & Navinal Pt. Lt. visible
Navinal Pt. brg.353°x5.7 alt/Co	067°	4.8'	var.	var.	12.5	0023	2137	Pirotan Lt.x 7.4' S	
1 HN Pt.	067°	8.6	var.	var.	11.5	0045	2222 x-ing 30 m		Eng spd 11kn
10MN Pt.	067°	3.3'	var.	var.	10	0020	2242 X-ing of 20 m		Eng spd 10kn

(H) Courses are marked adjacent to the course lines. In marking the courses, following points should be remembered.
(a) important navigational chart information are not obscured.
(b) Markings to be clear from course line so that there is enough space to plot the ship's Courses & distances marked should be as bold & clear as practicable.
(c) Nothing else to be marked in a similar way as it may cause confusion.
(d) The bearing & distances to be writtenin smaller size & in different style than that used for Co & distances.

(I) The voyage charts are then placed in the order of appearance. Mark the first voyage chart viz. BA 673 as OK-1, at the thumb label on the reverse of folded chart. Thus OK-2 marked on BA 43 would mean 2nd chart of passage between Okha & Kandla. Reference charts & very small scale charts are kept separately. In the passage under consideration the charts will be marked as follows:
BA 673 as OK-1
BA 43 as OK-2
BA 3466 as OK-3

(J) Once the charts are suitably marked with the information required for a safe passage, the summary of the passage & relevant information can be written down in the Bridge note book. Bridge note book is an important document & must be filled up carefully & in proper sequence. Ensure that;
(a) It is neat & systematic so that any other person may refer back to it.
(b) Information is adequate so that identical courses may be laid on a new chart without help of original chart.
(c) It is possible to make reference to this note book, during any inquiry in future even if the courses on the chart are erased off.

Manoeuvring:

2242: Standby engine & H/ahd
2248: Engines stopped.
2254: Engines tried out on astern propulsion & ahead manoeuvring resumed.
Distance to go from here is expected to be 3M till anchorage position.
ETA at Anchorage point = 2320 h.

Anchorage:

Following facts are noted regarding anchorage at Kandla:
(a) Congested anchorage.
(b) Double port dues on anchoring over 2 M from OTB.
(c) Buoyage & channel liable to shift.
(d) High powered boats may be seen at anchorage. Efficient deck patrol & anti pilferage caution must be exercised.
(e) Good holding ground. Scope used is adjusted accordingly, considering duration of stay & congestion of anchorage.
(f) Engines to be at very short notice or handy as required by the situation.
(g) State of tide, tide timings, must be calculated for the stay.

Pilotage:

Maximum possible information is gathered regarding different aspects of pilotage passage, such as regarding tidal streams, currents, conspicuous shore objects, tricky areas etc., through Adm Sailing Direction. Guide to Port Entry, Tide tables, Harbour Plans, Tidal / Current atlases etc. In case of Kandla, limited information only is provided owing to changing channel position, compulsory pilotage etc.

Nevertheless best possible course is laid till the wharf. The courses & distances of pilotage courses are marked on chart.

Soon after pilot enters the wheelhouse, there is exchange of information between Master & Pilot. Master, Pilot & OOD must not indulge in any activity which may disturb their attention from normal navigation e.g. 'arrival port paper work'. Manoeuvring data is always displayed on the wheelhouse. Yet the Master must tell the pilot, essential details of manoeuvring. e.g. type of propeller whether single or twin, type of engines whether diesel or steam, length over all, beam etc.

Pilot normally will take over the control for all practical purposes immediately & it may not be correct to bombard the pilot with lot of questions. However considering that pilots are very familiar with home pilotage waters, Master must show the intended course plan till wharf, to the pilot & discuss the course of

action as soon as practicable. Pilot would normally find it very easy to amend the existing course lines with required modifications where required.

Following must form the subject of Master - Pilot discussion, where applicable.

(a) Tidal streams / current
(b) Wharves if unsafe, depth there at. Whether sufficient number of fenders is provided at wharf.
(c) Any correction to be made on harbour plan regarding functioning of lights, change in depths, new dangers, insertion or deletion of wreck etc.
(d) Peculiar manoeuvre while passing a vessel on reciprocal course. (e.g. such manoeuvres are carried out in different ways in river transit while going to Houston, transiting River plate, transiting Suez or Kiel).
(d) Tips to make changes in plotted course. Though it is not expected that pilot will reveal all the tricks of trade to the Master but at least the necessary details in the case under consideration may be given by the pilot, in order to make the passage safer.
(e) VHF channel to be monitored.
(f) Position where the tugs to be made fast & time when crew should be ready on stations.
(g) Portable fender if needed at some specific position on deck.
(h) Anchor or anchors, if will be used to manoeuvre the vessel.
(I) Wind, current at wharf, procedure of making fast etc.

Master must then instruct the OOD accordingly, explaining him the course of action. Second Mate or the OOD then amends the courses. In any case frequent position plotting is done on chart. Passing of buoys, bridges, conspicuous shore features etc. is recorded on chart, and logged down in movement book & logbook.

Execution & Monitoring:

Refer to answer to the earlier question. Upon completion of planning, 2nd mate will show the charts & courses along with Bridge Note Book to Master. Master will check various stages of passage, with particular reference to distance at which dangers, shoals etc. are passed. Weather expected at crucial areas considered. It is also checked up whether a critical passage will take place in day time or night time. The level of sophisticated equipment the vessel has is also considered. Master will then approve the passage with little or no amendments.

OODs during the execution of voyage must follow the passage plan with all the caution. Present & next courses should actually be checked, instead of just relying on the written figures. Same thing applies for wheelover position bearings. Proposed plan must be used as a guideline & more importance should be give to on scene developments. One cant say that he cant afford to frequently alter Co as per the ROR, as the same will upset the ETA or planned passage. Steaming time may change between different waypoints due to new weather developments. A watch keeper may find mistakes in original plan or may need to follow a different course for a particular leg owing to some reason. The watch keeper must call Master & discuss the problem with him & seek his approval for the amendment.

Contingency:

No passage plan is complete without 'contingency or alternate planning' for alternate conditions. One can not possibly make contingency plan for every problem, but must at least make contingency plans for more probable difficulties, e.g. delay due to reduced visibility(If there is a probability of visibility becoming poor in a given area).
In the present case let's consider that somewhere along the route, engines may have to be stopped. Following factors will have to be considered by the passage planning team:

(a) In what direction would the vessel Drift!
(b) Continuous position fixing would be there or not.

(c) Time available before anchoring or before it is too late or if she's forced to anchor in a spoil ground.
(d) Expected delay before resumption.
(e) Amended ETA as per new speed over ground.
(f) Probability of balance passage in day time, hence studying day time features instead of banking on visible ranges of light.

A planning officer may use the following Appraisal & planning chart in order to record & use the information in a systematic way.

APPRAISAL CHART

[A] Navigational Charts for the passage

No.	Title	Scale	Status of Chart	Remark

[B] Small Scale, Reference, Plan charts etc.

No.	Title	Scale	Status of Chart	Remark

[C] Reference Publications

Name	Title/ Volume / Edition	Whether latest Ed^{n} /Updated
Sailing Direction		
O.P.W.		
A T T		
List of light		
ALRS		
Cumulative N M		
Weekly N/M		
T & P Notices		
Distance Tables		
Guide to Port Entry		
Tidal Streams Atlas		

[D] Departure Port Information

Drafts for'd & aft	
Time Zone	
Pilot Stn (VHF)	
Port Control (VHF)	
VTS (VHF)	
Information required for Reporting	
Tidal Data obtained from ATT, SHM software, Local predictions	

[E] Departure Directions / Cautions

Adm Sailing Directions	
Pilot's Advice	
Other source	

[F] Arrival Port Information

Drafts for'd & aft	
Time Zone	
Pilot Stn (VHF)	
Port Control (VHF)	
VTS (VHF)	
Any special pilot boarding procedure	
Information required for reporting	
Tidal Data obtained from ATT, SHM software, Local predictions	
Any requirement regarding draft, ETA, anchorage pos., Day & night signals	

[G] Pilotage Water Navigation Information

G.P.E.	
Sailing Directions	
Past Experience	
Local Information Booklet	
Past log abstract	

[H] Arrival Port facilities

Facility	Available Y/N	Remarks
Hospital		
Bunkers		
FW		
Air Port		
Repairs		
De-rating		
Surveys		

[I] UK clearance at bar

Name of the bar	U/keel clearance Required.	Ship's Draft	Tot. Depth Required. (1) + (2)	Charted Depth at Bar	HOT required (1)+(2) - (4)	Interval During when crossing is not Safe.

[J] Tidal stream at Bar During the transit

Ebbing	Flooding	Remarks

[K] Value adding data from past experience of master officers, crew of similar passage.

Sr Nr	

[L] Useful Information in Brief (coastal voyage)

Segment of voyage	Tidal stream info.	Nav Warning	Imp. Ports in Vicinity	Racon	Caution regarding sudden wind gust	Conspic Lt /object characteristics	Anchorages	Ref Way Pt (To be filled up after planning).
Departure								
Restricted Passage 1								
Restricted Passage 2								
Restricted Passage 3								
Arrival								

[M] Ocean Passage / long sea Passage

Routing done by	Shore based Org^{n}	Ocen Passages	Routing Chart	Other Source

[N] Notes from Routing chart for present Ocean / Long Sea voyage

1	Current	
2	Ice	
3	Gale Winds	
4	Storm tracks	
5	Sea Temp	
6	Air Temp	
7	Currents	
8	Wind roses	

[O] Own Ship Information

1	Mean Draft / Displacement / trim			
2	Deck Cargo, containers, windage			
3	GM Dep / Inter / Arrival			
4	Sea Spd / Maneouver F ahd / min spd			
5	Important characteristics			
6	Air draft / beam / LOA			
7	Dangerous Cargo			

PLANNING ON CHART [Check List]

SrNr	Items to Check	Y	N	Remarks
1	Charts uptodate & largest scale ch. Used			
2	Dangers Marked			
3	Navigable safe water channel marked			
4	Tentative course in centre of channel.			
5	More than 1 method of reliable pos fixing at all alterations			
6	More than 1 method of reliable pos fixing on all courses			
7	Appropriate use of sounding contours			
8	Raising distance of powerful light noted especially for land fall			
9	Careful check along navigable channel / course line of wrecks/shoals			
10	Long distance courses calculated by R.Line form line			
11	Next chart positions marked			
12	Notations regarding references to other chart, large scale chart, nav. warning marked			
13	Course line marked for notifying E/R, Crew, opening anchor lashings etc			
14	DTG & DMG marked at A/Co positions.			
15	Wheel over positions marked.			
16	Notation marked re reporting to VTMS, port pilots etc			
17	Alter Co reference bearings stated on chart			
18	Parallel Indexing provision made for coastal passage			
19	Courses & Distance which are stated on chart are cross checked			
20	Reform to appraisal chart made wherever required.			

CONTINGENCY PLANNING [Check List]

SrNr	Items to Check	Y	N	Remarks
1	Crucial Navigation areas identified			
2	Restricted visibilty areas identified			
3	Places where extra lookouts assistance would be needed, noted.			
4	Areas where position fixing would be difficult identified			
5	Areas which must be passed in day time identified			
6	Point at which controls / steering must be checked noted			

Various Calculations

1. Rhumb line calculations
2. Great Circle calculations
3. Parallel Sailing
4. Squat Calculations
5. Tidal Stream calculations
6. Wheel over line calculation
7. Rate of Turn calculations
8. Calculations re bar & overhead clearances

In Position with (A/Co reference)	Co to make good	Dist	Tidal stream/ Current	Allowance to Co	Expected Spd Over Ground	Steaming time to next W/Pt.	ETA next W/Pt	// index Pt./ CPA	Remarks

Passage Planning Charts Or Routing Guide For Certain Areas

Planning of passage is not mere drawing of a course line across the way points. In earlier times smaller ships could have done that & got away with it but today one feels that passage through some of the busy areas like Singapore Straits & English Channel etc especially by a deep drafted vessel without previous planning is like crossing a busy road with a band tied around eyes.
Today's navigational activities are more complicated due to;

a. The increased commercial pressure
b. The ships with deeper draft.
c. More traffic.
d. More knowledge of hydro-dynamic interaction.
e. Mandatory positive compliance to ISM code
f. Mandatory company's policies
g. More requirements from ports & VTMS

A planning officer must get thoroughly familiarized with passage planning information provided for such special areas. He must also duly consult ALRS vol. 6 & Admiralty routing for more information. Some of the guide publications are;

1. Passage Planning chart for English Channel (Admiralty publication).
2. Mariner's Routing guide for Malacca & Singapore straits (Admiralty publication)

3. A guide to planned Transit by Deep Draught vessels (an ICS/OCIMF publication).

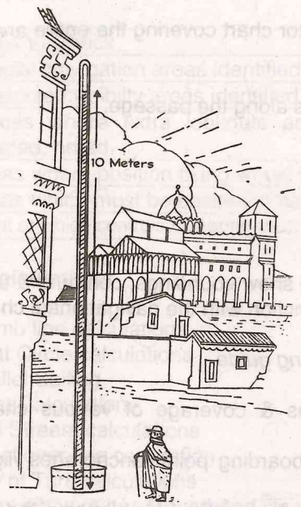
Passage planning guide is normally a medium scale Mercator chart covering the entire area to which the guidance is intended, showing;

a. Traffic separation schemes.
b. Cautionary remarks & local regulation at different locations along the passage.
c. Precautionary Areas
d. Position reporting points
e. Pilot boarding stations
f. Anchorage limits
g. Some important lights & coats Radio stations

Routing chart is not a navigational chart. If normally will not show soundings, contours & under water dangers. But it is recommended that this chart be used in conjunction with the navigationaal charts.

Following information is generally provided on a passage planning guide.

1. *Boundaries*: Diagrammatic representation of Boundaries & coverage of various charts, giving number of each.
2. *Distance table:* Giving distance between different pilot boarding points/anchorages /light houses etc.
3. *List of publications*: Gives list of publications, which may be required for planning the passage & during the voyage.
4. *Routing Measures*: Diagrammatic representation of various routing measures, with key to the symbols used for such routing measures.
5. *Radio service Available:* Names & locations of various coast radio stations Navarea zone, Safely information, Navtex, availability, transmissions of DGPS transmitting beacons. (Fuller details regarding any broadcast, GMDSS, Navtax etc. must be found from ALRS vol.5).
6. *Aids to Navigation:* Provides the position of lights & beacons & advices to refer appropriate publications viz. AIRS-2 & ALL for fuller details.
7. *Pilot service*: States whether the pilotage is mandatory or optional, provides position of pilot boarding stations. Though ALRS will be consulted for fuller details
8. *Radio reporting & VTS:* Planning guide states if any position reporting system is in force within the area of coverage & whether the system is IMO approved / mandatory etc. Also it may indicate the type of ships which must participate. Guide also indicates the numbers of useful VHF channels while in this area. The channels may be for navigational information broadcast or any other safety related message. Any information which is transmitted on Navtex is indicated too. Also guide states whether radar surveillance is carried out by port. For fuller details ALRS must be consulted.
9. *Tidal information:* Guide may provide co-tidal / co-range details of the area covered by guide with instructions or procedure for finding height & time of tide at a position within the area covered.
10. *Various components or stages of passage planning:* This is a very important part of the guide. It appraises a mariner of special local rules, meteorological situation & navigational tips & requirements of the area. One must very carefully read the recommendations & guidance regarding appraisal, planning, execution & monitoring as provided by the guide.
11. *Routing & usage of ROR*: Guide provides useful tips regarding the compliance of rules of road while following the DW route, TSS. etc. the mariner is benefited with the information as locally there may be areas of traffic concentration, fishing vessel concentration, ferry crossing etc.
12. *Transit the Area with minimum delay:* This makes use of trend of tidal streams & guides as to what time one must start the west bound / East bound transit so that the transit is fastest & at the same time safe.
13. *Guidance to Deep drafted vessels:* Guide may provide recommendation for the benefit of special type of vessels viz. deep drafted vessels, sailing vessels etc.
14. *Special hazards*: Guide also warns a mariner about a special navigational hazards to a mariner that must not be over looked while navigating through the area.



Torricelli Evangelista:

[1608 – 1647] Was born in Italy. He was a mathematician & Physicist. He is most known for his discovery of principal of barometer in 1643. Barometer plays a very important role in making atmospheric predictions & hence making the shipping safer.

[Pic Torricelli & his experiment Barometer]

Chapter 27: Ocean Passage Planning

Once the 2nd mate knows the name of the next port, he must find distance from the 'distance tables' & present a note to the master stating ETA at two or three different speeds. River motoring & expected delay also must be indicated. This is very important because master & chief engineer can start planning from their sides, at earliest. Thus future procurement of stores, provisions, lubs, crew change, surveys, inspection etc may be planned out.

More correct distance & ETA must be presented to master as soon as practicable.

Under the present discussion we will limit our scope only to ocean passage planning. The planning officer must refer to the following charts / publications

1. Ocean passages of world.
2. Routing charts for the relevant period & area.
3. Small scale charts.
4. Voyage log abstract of similar voyage in past, preferably under similar conditions of loading, in same season etc.
5. Currents.
6. Charter party if available, checking if there is any mandatory provision for using guidance of commercial weather routing.

Let us first discuss a few meteorology-based things related to passage planning.

Synoptic chart is of great importance to a mariner. It provides summary of various weather elements, over a large area at one glance. An experienced mariner can relate these different elements to identify various air masses, fronts & general movements of weather patterns. For standardization & uniformity the fixed synoptic hours to be used by all meteorological offices are 0000, 0600, 1200 & 1800h of GMT. The development & movement of Lows, troughs, ridges, high pressure centres & fronts can be found through

successive synoptic charts. In fact the meteorologists have synoptic charts for various pressure layers i.e. 700mb, 750mb etc. The temperature, humidity, actual height & wind data being indicated at different data points. The weather instead of being for a particular height layer is for a particular surface, which has same atmospheric pressure everywhere. A set of such charts is very useful to a meteorologist to establish horizontal as well as vertical relationship between weather prevailing over a large area.

The series of synoptic charts is studied, the trend of weather system is closely considered. It is then related to the period of the year, time of day, terrain features in the way of advancing patterns & of course the experience of the individual meteorologist will matter. After this a prognosis or a forecast chart is drawn up for 6 or 12 hours after the latest synoptic chart.

Thus a fine weather may be said to prevail at the centre of an anticyclone & a belt of about 150 miles, of low clouds with rain may be said to move ahead of an advancing warm front. A barograph is a very useful instrument. A falling pressure can show a crested or troughed pressure graph. It does not mean that one has actually hit the centre of a High or a Low. Pressure can say fall due to two reasons. One, due to movement of pressure system relative to the ship & two, due to intensification of a Low.

An accurate analysis of past & present weather is very important for a good prognosis or forecast. Positions of depressions, anticyclone, pressure systems, air masses, fronts, precise isobars etc must be carefully drawn & the analysis must be logically related to earlier analysis. A meteorologist ashore uses much more data than what is available to a mariner to analyse a weather situation.

Geostropic wind is said to exist when isobars run parallel & friction to wind is assumed to be nil. It depends on the spacing of isobars or pressure gradient & the latitude of a place.

$$V_{[GEOSTROPIC]} = \frac{G}{2\omega \, Sine\, \phi . \rho}$$

Where ω is the angular velocity of earth, ϕ the latitude & ρ the density of air. Geostropic wind can also be read off from a geostropic wind diagram. This diagram is entered with the distance between the isobar, which are placed 4mb apart & the latitude. The wind that is actually found at sea will be reduced to 66% due to friction. The direction of wind will be such that the isobar of lower pressure is to the left in northern hemisphere.

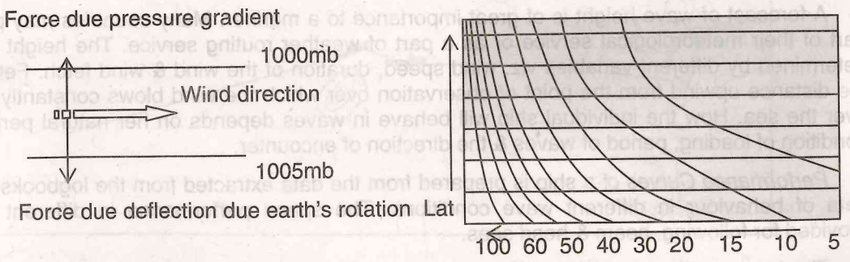


Fig 27.1 Geostropic wind speed.

The wind, which blows along the curved isobars in case of cyclonic motions, is weaker than the geostropic wind found as above & stronger than the Geostropic wind in case of anticyclonic motions. The wind, which blows along the curved isobars, is known as gradient wind. The direction of wind is curved 10

to 15° to the direction of isobars. The friction due to land etc further modifies the direction. The gradient wind speed V is found from the quadratic equation as follows:

$$(+/-)\ \rho V^2 + Gr - r\rho KV = 0$$

[-ve sign is for cyclonic winds & +ve sign is for anticyclonic winds. $K = 2\omega \sin\phi$]

OCEAN PASSAGE PLANNING BY A SHIP'S OFFICER:

To start with, let us assume that there is no provision for commercial weather routing. The navigating officer may proceed as follows:

1. In the relevant *routing chart* check if any recommended passage is advised. Also try to reason out the justification of such route on the basis of information given on routing chart. The information provided on a routing chart is extremely valuable & is an out come of rich experience from the past

2. In the '*Ocean Passages of the World*', check if any route between the ports of interest is recommended for the current season. If not the neighboring ports of interest may be used instead of ports of interest. Routes between Mumbai and Aden recommended for summer & winters which are quite widely separated.

3. Navigating officer may seek the guidance from experience of similar voyage in past.

4. Weather forecast & present distribution of 'Lows' & predicted movement is studied. Some times the present weather situation is so crucial that the commencement of the voyage & initial course has to be adjusted to suit the prevailing weather. Some times even the entire passage has to be adjusted to suit the present conditions. A mariner must therefore be able to understand the different weather maps. Weather bulletins for the use of ships are available in most areas in the world. Details regarding their transmission & contents can be found in appropriate ALRS volume.

A weather map drawn ashore by an expert is automatically reproduced on board with the help of a facsimile recorder. Prognosis charts of one, two & three days also can be received by fax.

On a working meteorological chart, the prevailing weather & the ship's intended course line can be viewed together. Height of waves & direction of swell is an important data to determine the speed loss or ship's behaviour in a particular region.

A forecast of wave height is of great importance to a mariner. Many countries may provide this as a part of their meteorological service or as a part of weather routing service. The height of sea waves is determined by different variables viz. wind speed, duration of the wind & wind fetch. Fetch is defined as the distance upwind from the point of observation over which the wind blows constantly & uninterrupted over the sea. How the individual ship will behave in waves depends on her natural period of roll, pitch, condition of loading, period of waves & the direction of encounter.

*Performance Curves o*f a ship is prepared from the data extracted from the logbooks & compiling the data of behaviour in different wave conditions. The speed performance in different wave height is provided for following, beam & head seas.

The forecast of waves (height / direction) is applied to ship performance curve to determine how far the ship will travel in the next 12-hour period, over different courses originating from initial point. The '12h points' are joined by a smooth curve, a locus. The radiating courses are plotted in steps of 12 hours If only the meteorological factors were to be considered then above plot can give the least time track.

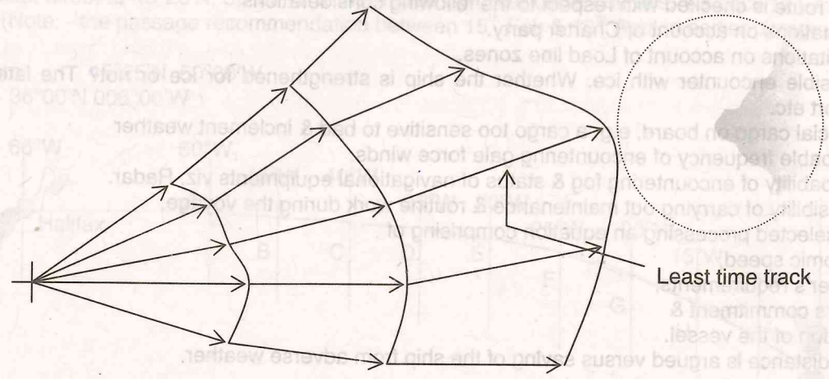


Fig 27.2

Following is a classic example of the weather deviation by a ship's master, way back in October 1949. Capt J.D.B. Fisher of 'The Newbergh Castle' was enroute from Liverpool to Newfoundland. The normal great circle track was followed till 30°W. At this point the ship received the analysis broadcast for the Atlantic Ocean. It was seen that there was a small but deep depression moving in a NE'ly direction, so that if the ship had continued on her course the centre of the depression would have passed just ahead of the ship, giving storm force NW winds. The master therefore changed course to a NW'ly direction until about 150M north of the normal route, then followed a great circle track to Cape Race. This secured the advantage of the E'ly & NE winds on the northern side of the depression.

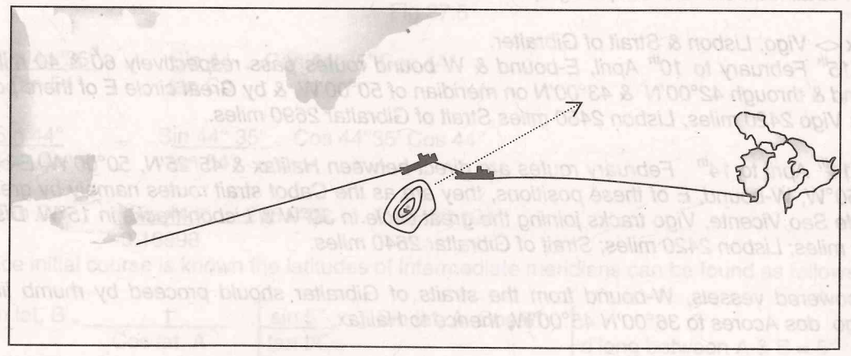


Fig 27.3

5. With information available till now navigation officer is prepared to meet the master. He presents the most appropriate route & the alternate route if any along with the weather forecast & movement of Lows. He also puts his reason for selecting the route.
After a detailed discussion with master finally the most appropriate route is agreed upon.