CHARTWORK

Chartwork numericals are a combination of one or more concepts. So it is necessary to understand these concepts.

Position Line (PL) means ship is anywhere on this line.
Position circle (PC) means ship is anywhere on this circle.

Position fix can be obtained by

- Intersection of 2 or more such PL or PC at the same time.
- Lat/long
- Position can be given by chart datum depth on chart, e.g. 9m.

I) Position Lines(PLs) or Position circles (PCs) can be found by one of the below concepts.

The following concepts give a PC

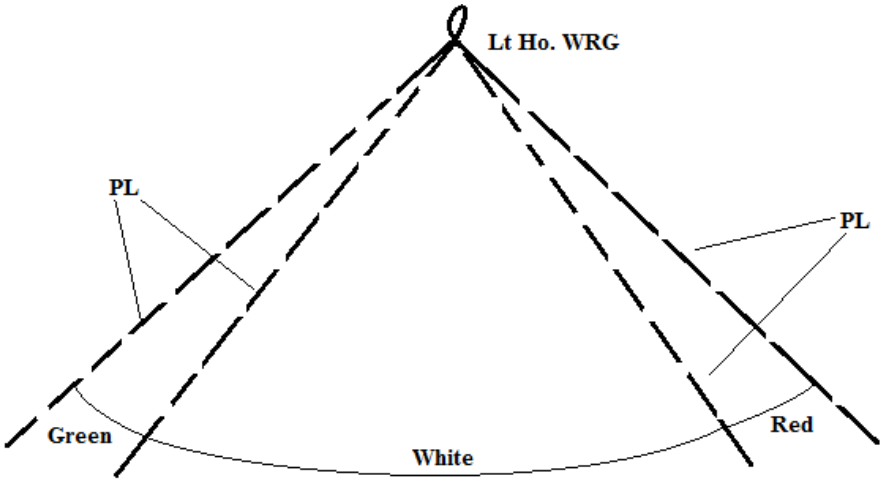
1. HSA(Θ)= 90° or HSA(Θ)= <90° or HSA(Θ)= >90°
2. VSA
3. Radar distance (Distance off)
4. Doubling the angle on the bow –
   i)PC at time of 1st angle ii)PC at time of double the angle iii)PC when Lt is abeam
5. Special angles
   i)PC at time of 1st angle ii)PC at time of 2nd angle iii)PC when Lt is abeam
6. Raising or Dipping
7. First sighted or Last sighted

The following concepts give a PL

1. Bearing of a Lt Ho. or Object.
2. PL of a celestial body (Lat by mer. Alt., Long by chron, Intercept, Ex-meridian, Polaris).
3. Transit bearing of Lights.
4. HSA = 0° (Same as transit bearing).
5. HSA = 180° (PL is in between both the Light Houses or Objects).
6. When a light has different sectors of lights e.g. WRG
7. When a light has an obscured sector.
8. When 2 lights are equidistant.
9. Depth contour on chart

a) When a light has different sectors of lights e.g. WRG

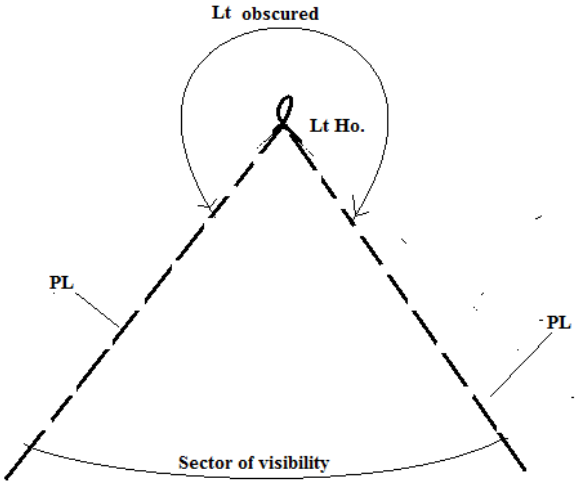
i) **PL** is when Lt changes from W to R or R to W or W to G or G to W,
ii) **PL** is when R Lt becomes visible or when G Lt becomes visible.



b) When Light has an obscured sector.

i) **PL** is when light was obscured & now becomes visible.

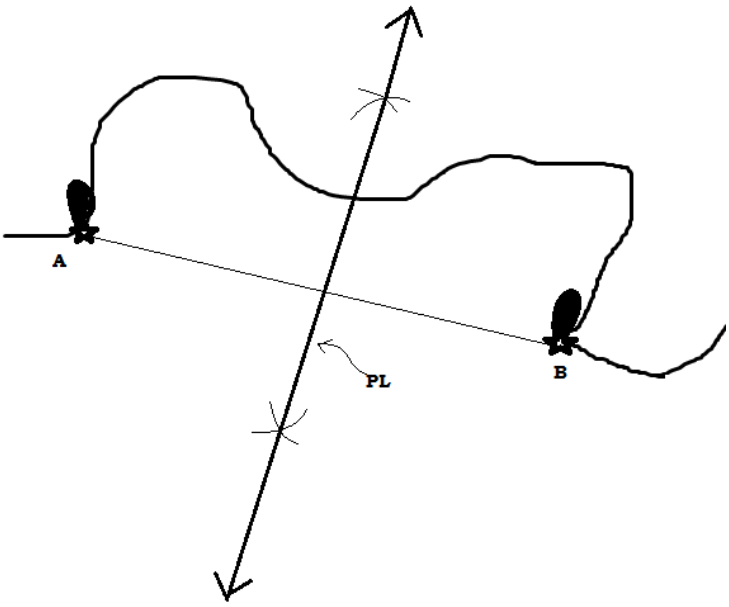
ii) **PL** is when light was first visible & now becomes obscured



c) When 2 lights are equidistant.

- **The perpendicular bisector is the PL.**

(Take a distance of more than ½ between the 2 lights & cut on each side. The line joining the 2 intersections is the perpendicular bisector i.e. ***the PL)***



d) Horizontal Sextant Angle (HSA)between 2 Lt Ho or objects gives us a PC or PL

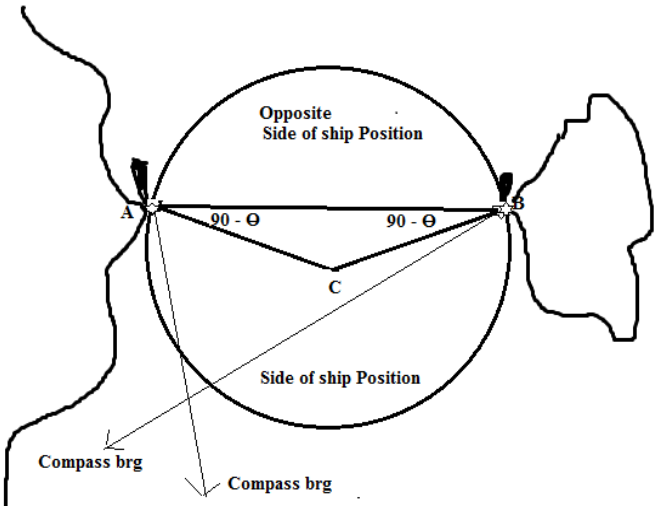
1. **When Compass bearings of Lt. Ho. are given**

a) If the **Ship's Compass Heading/course** is **NOT given** and the **Compass bearings of Lt. Ho. is given,** it is a **HSA method.**

- The **side of the Ship's position** can be found by roughly plotting the compass bearings or is opposite to land.
- When 3 compass brgs are given. First arrange the Lt Hos. compass bearings from port to Stbd (clockwise) with respect to position.
- Then find the difference (i.e. HSA) between the 1st & 2ndCompass bearings.
- Join the 2 lights.
- Do the same for the 2nd & 3rdCompass bearings

i) **If HSA(Θ) < 90°,**

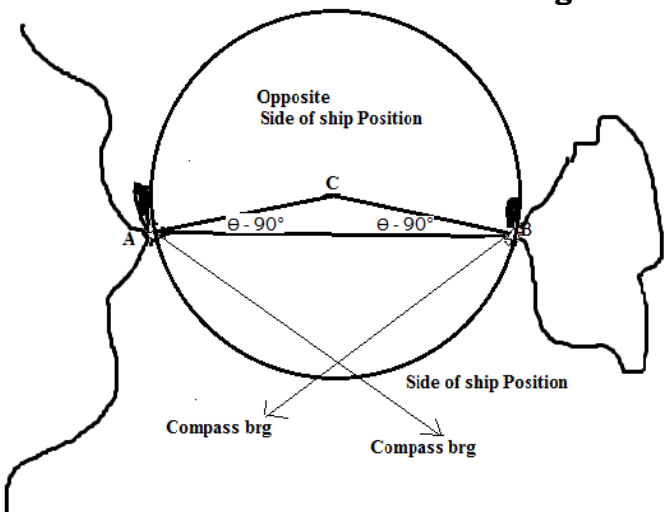
Draw **Angle = (90° – Θ)** towards side of ship's position or opposite to land and **centre of PC** will be the **intersection of the 2 angle lines at C**,



ii) **If HSA(Θ) > 90°,**

Draw **Angle = (Θ - 90°)**on the opposite side to ship's position or on the same side as land &

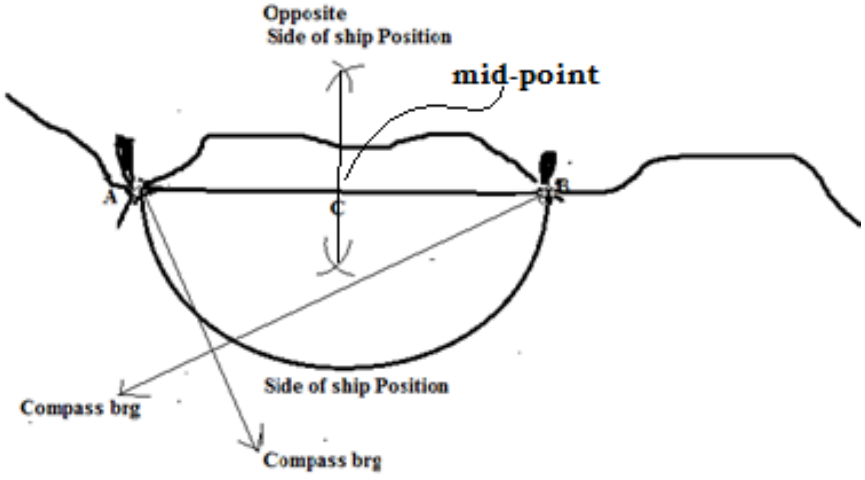
centre of PC will be the **intersection of the 2 angle lines at C**.



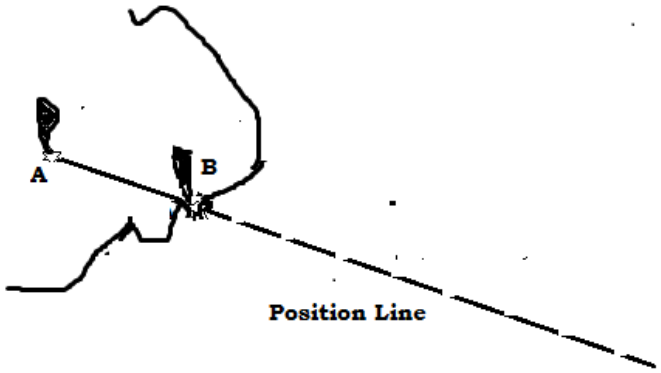
iii) **If HSA(Θ) = 90°,**

centre of the PC is the **mid-point(C)** between the 2 lights found **by using perpendicular bisector method**.

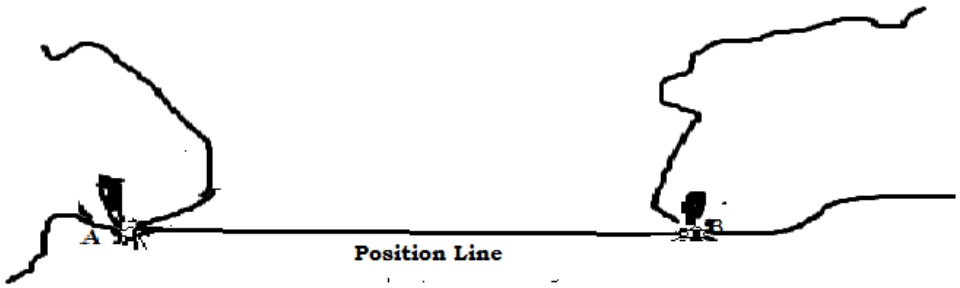
- Take a distance of more than ½ between the 2 lights & cut on each side. Joining the 2 intersections will give us the mid-point(C).



iv) **If HSA(Θ) = 0°,** We get a **PL.**
e.g. brg of A is 300°(C) & of B is also 300°(C)
The compass error can be obtained by comparing the True brg from the chart and compass brg.



v) **If HSA(Θ) = 180°,** We get a **PL**
e.g. brg of A is 270°(C) & of B is also 090°(C)



b) **If** the **Ship's compass heading** is **given**, and the compass bearings of the 2 Lt.Ho.is given, then it is **NOT HSA** method.
- First find the compass Error using the ship's Compass heading, then convert compass brgs to true brgs and plot directly on the chart. The intersection of the PLs will give the ship's position.

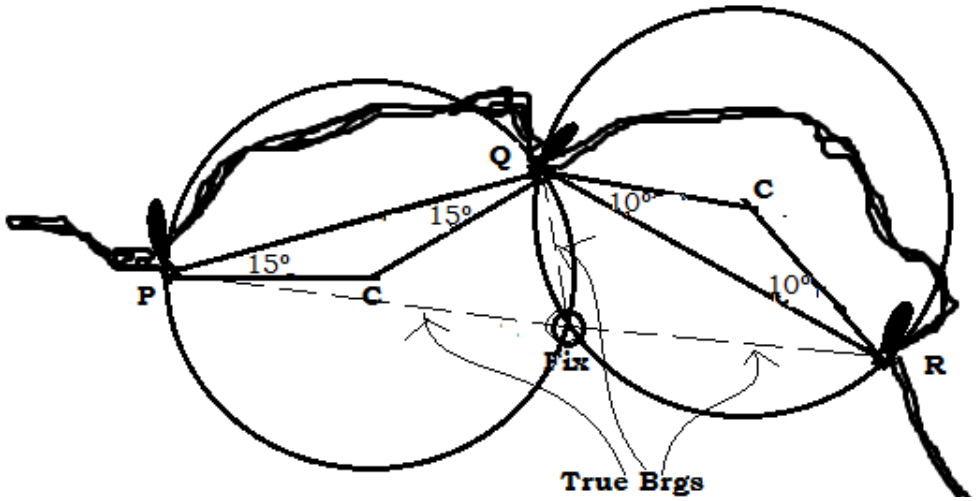
2. **When Gyro bearings of Lt. Ho. are given**
If the **Gyro brgs** of 2 Lt Hos. **are given** and **Gyro error is NOT given,** then we have to use the above HSA concept.
e.g. Gyro brg of A is 160°(G) &of B is 230°(G), so HSA(Θ) = 70°

3. **When Horizontal Sextant Angle (HSA) between Lt. Ho. are directly given**
e.g. HSA between Lt A & Lt B is 60°, so HSA(Θ)=60°

e.g. Vessel at anchor, 3 Compass brgs of Lt Hos. are given:
P – 280°(C), Q - 355°(C), R - 095°(C). Find Compass Error.

Solution: P – 280°(C)
Q - 355°(C),
R - 095°(C).

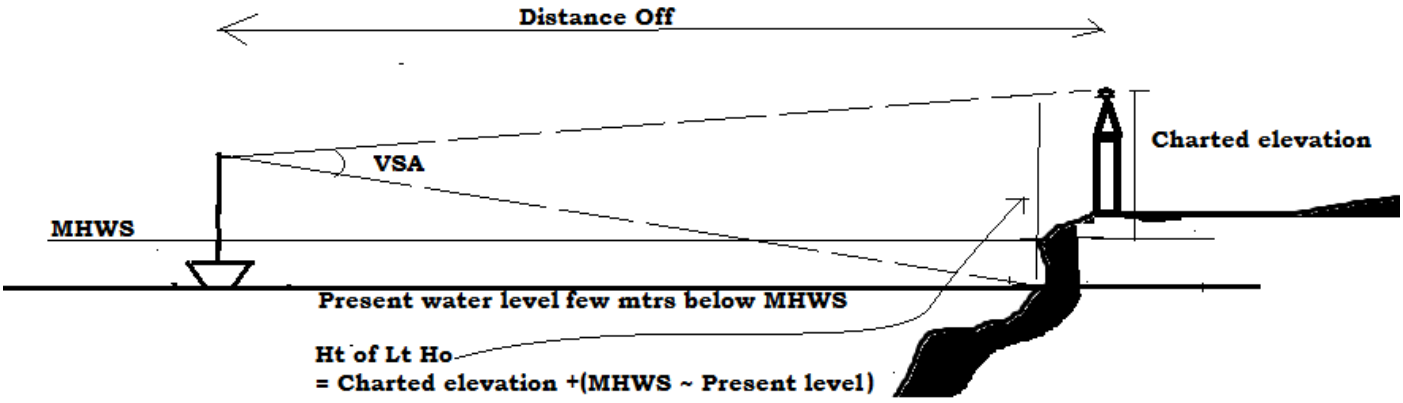
P – 280°(C)
Q - 355°(C),
HSA(θ) = 75°
As HSA(θ) < 90°, Angle = 90°- θ = 90°-75° = 15°
Q - 355°(C),
R - 095°(C).
HSA(θ) = 100°
As HSA(θ) > 90°, Angle = θ - 90° = 100° - 90° = 10°



Compass brgs	P = 280°(C),	Q = 355°(C),	R = 095°(C).
If from plot T. brgs of	P = 282°(T),	Q = 358°(T)	R = 096°(T)
Compass Error of	P = 2°E	Q = 3°E	R = 1°E

Average Compass Error = $\frac{(2° + 3° + 1°)}{3}$ = 2°E

e) Vertical Sextant Angle (VSA), gives PC



Distance off in n.miles = $\frac{\textbf{Height of Lt House} \times \textbf{1.854}}{\textbf{VSA} \text{ in minutes}}$

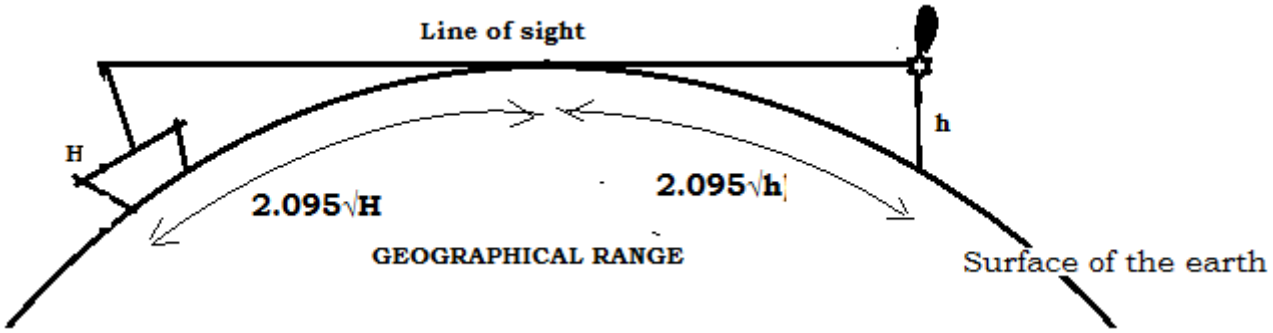
Ht of Lt Ho= the ht of Lt Ho given on the chart +/- the diff betwn MHWS & Present water level
*(**+ve** if present level is below MHWS & **-ve** if present water level is above MHWS)*
VSA = Sextant angle +/- I.E (Off/on)

f) Raising or Dipping (Geographical Range – G.R), gives PC

As the earth is a sphere, the line of sight depends upon the Ht of Eye (H) &ht of Lt Ho (h).
When the light is raised, the light will be just in the line of sight (vessel goes towards the light).
When the light is dipped, the light just about goes out of line of sight(vessel goes away from light).

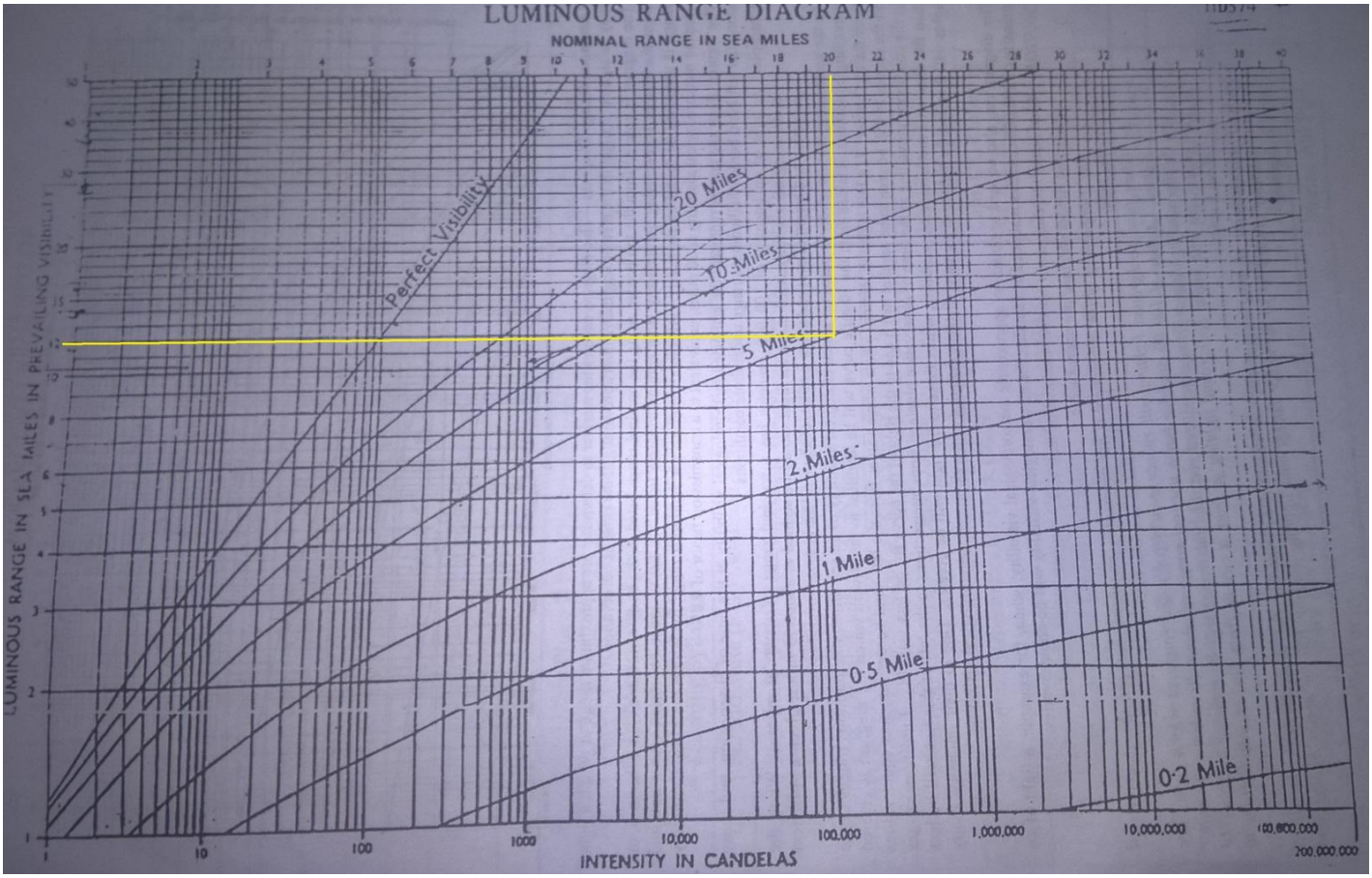
G.R*(distance from Lt Ho)* **= 2.095√H+2.095√h**

Where **H -** Ht of Eye**, h –** ht of Lt Ho.

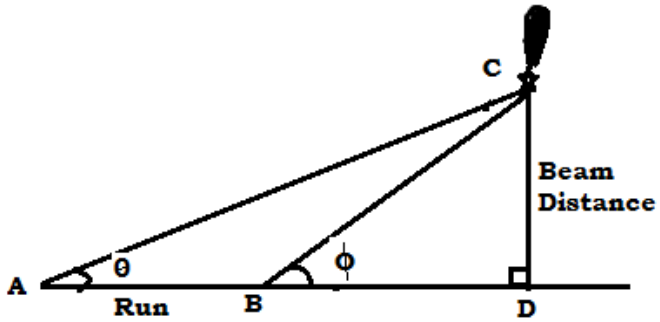


g) First sighted or Last sighted, gives PC

- **Find Geographical Range (G.R),** if H = 12m & h = 25m
  G.R = 2.095√H + 2.095√h = 2.095√12 + 2.095√25= 7.3 + 17.7 = **25nm**
- **Find Luminous Range (L.R)** from the Luminous Diagram using Nominal Range (given for 10nm met. Visibility) from chart (e.g. NR of Lt Ho. is 20M) and present meteorological visibility curve (e.g. 5M met. Visibility)
  From LR diagram, LR = 11.8nm
- Compare the G.R & L.R and use whichever is less to draw the PC
- LR < GR, **so draw PC for LR = 11.8nm**



h) Special angles(Θ&Φ)



AC - Distance off at the time of 1st angle (Θ), gives a PC
BD–Beam distance
AB – distance run between A & B

By Trigonometry,
When **Cot Θ – Cot Φ = 1,** where **Θ** =1st angle on the bow & **Φ**=2nd angle on the bow
Then **Run = Beam distance, i.e. AB = CD**

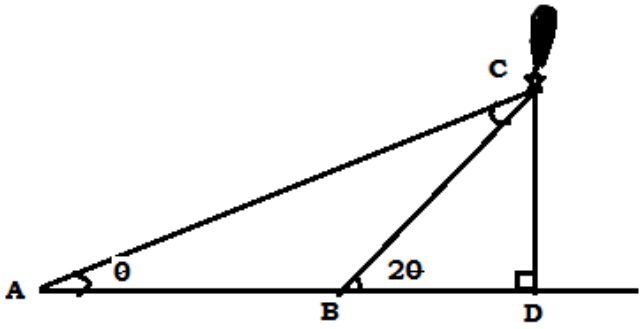
i) PC at the time of 1stangle
Distance off (AC) = Beam distance/ Sin Θ

ii) PC at the time of 2ndangle
Distance off (BC) = Beam distance / Sin Φ

iii) PC when light is abeam
Distance off (DC) = Beam distance

i) Doubling the angle on the bow, gives PC

i) PC at the time of double the angle
BC - Distance off at the time of double the angle (2Θ), gives a PC
AB – distance run between A & B
AB = BC *(doubling the angle on bow method)*



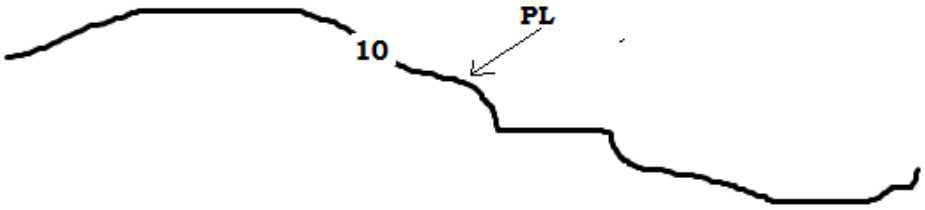
ii)PC at the time of 1st angle
AC – Distance off at the time of 1st angle (Θ), gives a PC
CD - Beam distance
AB – distance run between A & B

AB = BC *(doubling the angle on bow method)*

CD = BC x Sin 2Θ
AC = CD / Sin Θ= BC x Sin 2Θ / Sin Θ

AC = (Run x Sin 2Θ) / Sin Θ

j) **Depth contour on chart, gives a PL** e.g. When a ship crosses a10m contour



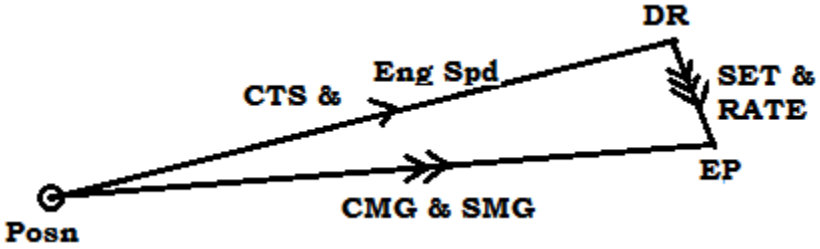
II) Allowing for Current and/or Leeway

The size of the triangle depends on the time in the question

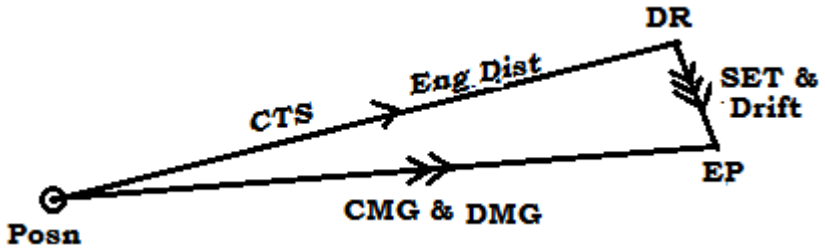
a) Allowing for Current (when CTS, Eng Spd, Set & Rate given)

E.g. a 1 hour triangle

- Plot the CTS from the posn & Cut the Eng spd
- From the DR plot the Set & Rate gives EP
- Join the Posn & EP gives us CMG & SMG

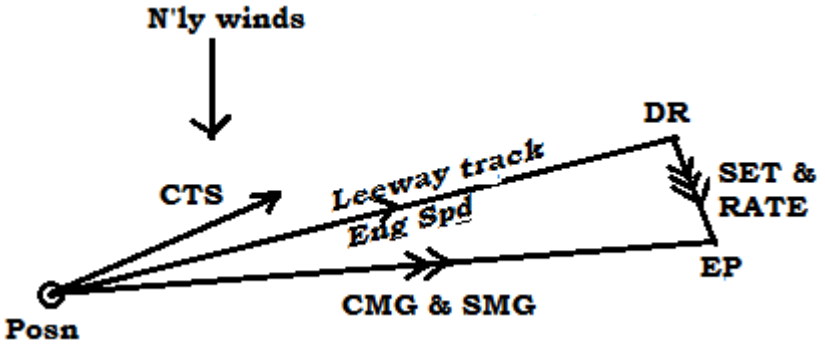


- If triangle is for > or < 1 hour we use Eng dist & drift.
- Eng dist = Eng spd x $\frac{\text{(Time interval in mins)}}{60}$
- Drift = Rate x $\frac{\text{(Time interval in mins)}}{60}$

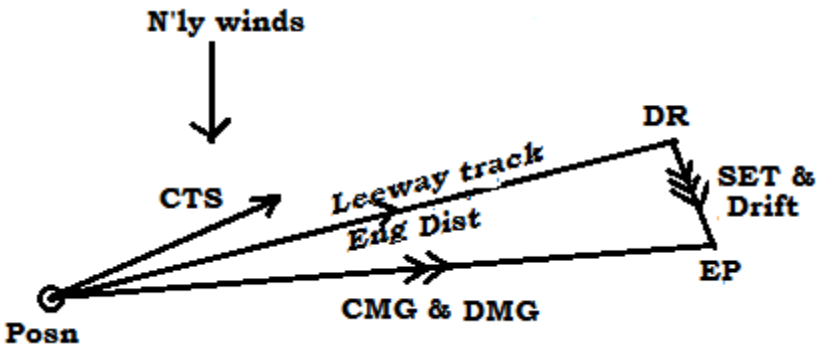


b) Allowing for Current & Leeway (CTS, Eng Spd, leeway, Set & Rate given) E.g. a 1 hour triangle

- First plot the CTS
- Then apply leeway track opposite to wind direction
- Cut Eng spd on the Leeway track
- From DR apply Set & Rate, gives EP
- Join the Posn & EP gives us CMG & SMG



- If triangle is for >1 or <1 hour than we use Eng dist& drift.
- Eng dist = Eng spd x $\frac{\text{(Time interval in mins)}}{60}$
- Drift = Rate x $\frac{\text{(Time interval in mins)}}{60}$



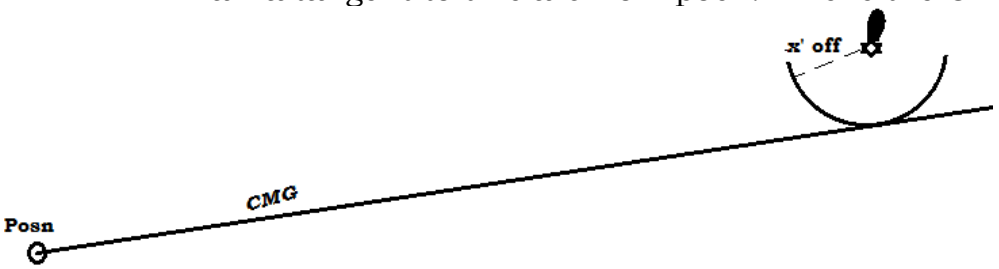
III) Counteracting Current and/or leeway

- This concept is used **to find the CTS when CMG is given**.

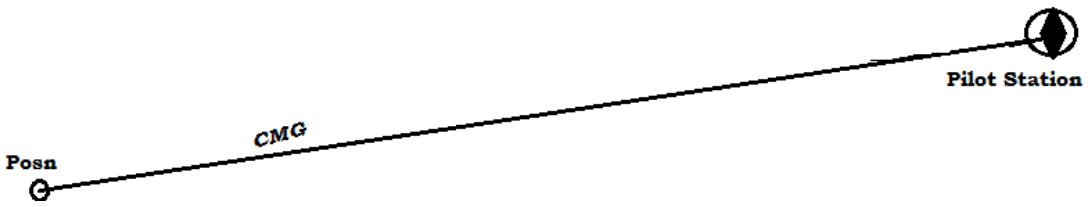
CMG may be given by one of the methods.

i. Vessel needs to pass 'x' miles off a Lt Ho. or object from a posn.

- Draw an arc x' miles from Lt Ho.
- Draw a tangent to this arc from posn. This is the **CMG**



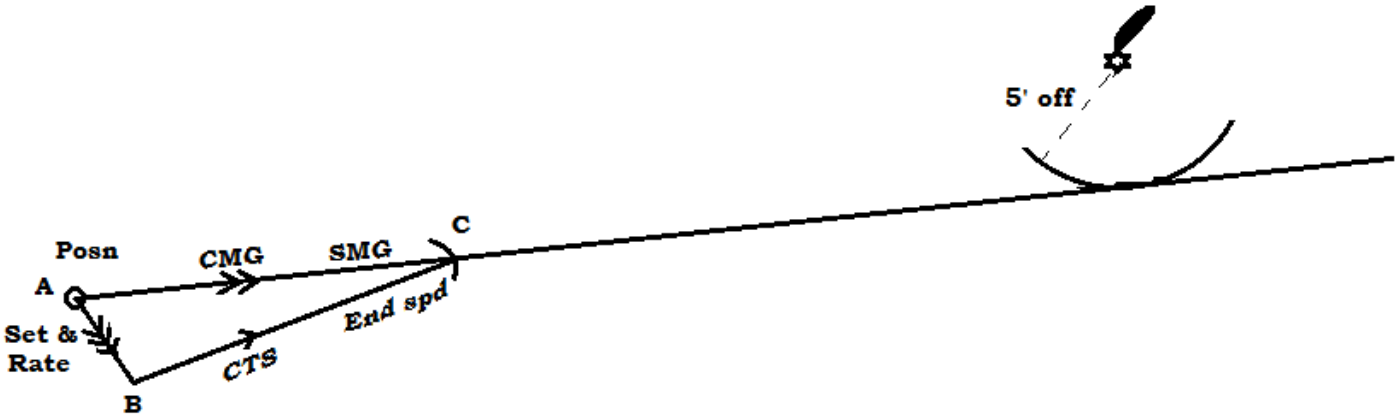
ii.From present posn vessel needs to go to another posn e.g. A pilot station.



iii. Three point bearings.

a) Couteracting for Current(Eng spd, set & Rate given)

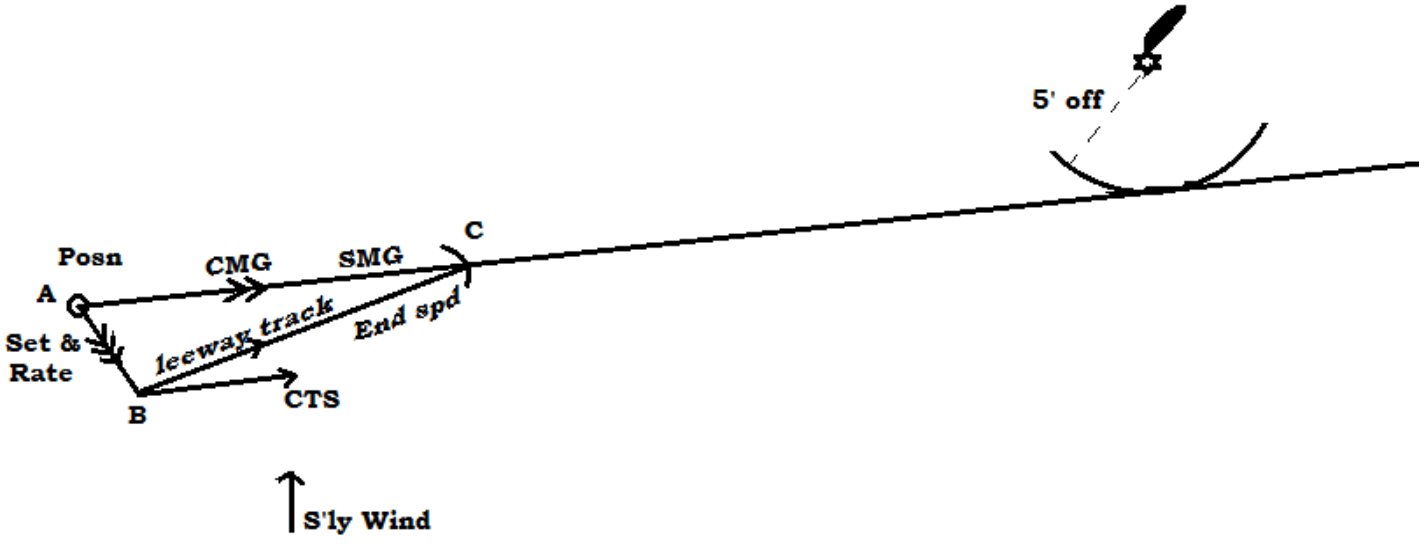
- Find CMG
- First from present posn 'A' apply Set &cut Rate at 'B'
- From 'B' cut Eng spd on the CMG at 'C'
- Join 'B' & 'C', BC = CTS.
- 'AC' is the SMG
- ABC is a 1 hour triangle



b)Counteracting for Current & leeway

(Eng spd, leeway, set & Rate given)

- Find CMG
- First from present posn 'A' apply Set & cut Rate at 'B'
- From 'B' cut Eng spd on the CMG at 'C'
- Join 'B' & 'C', BC = LEEWAY TRACK.
- 'AC' is the SMG
- From 'B draw apply leeway & CTS towards the wind
- ABC is a 1 hour triangle

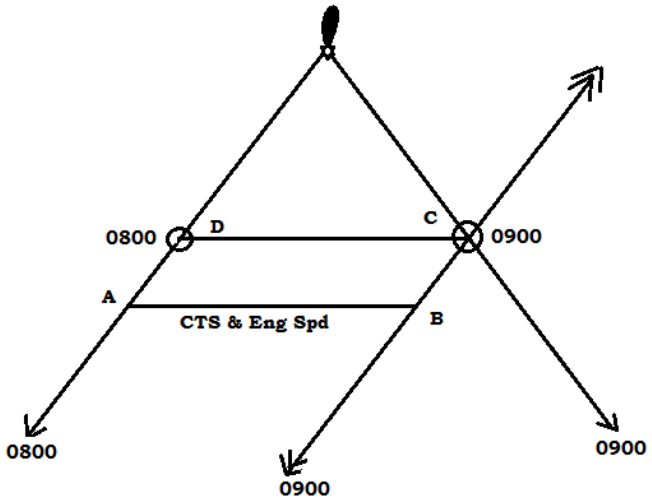


IV) Transfer of PL or PC (Running Fix)

- **When 2 or more brgs from a Lt Ho/ Lt houses are given and CTS, Eng Spd, Set & Rate of current is given.**
- **A PL can be transferred from any point along the line.**
- **A PC can be transferred only by transferring the centre of the circle**

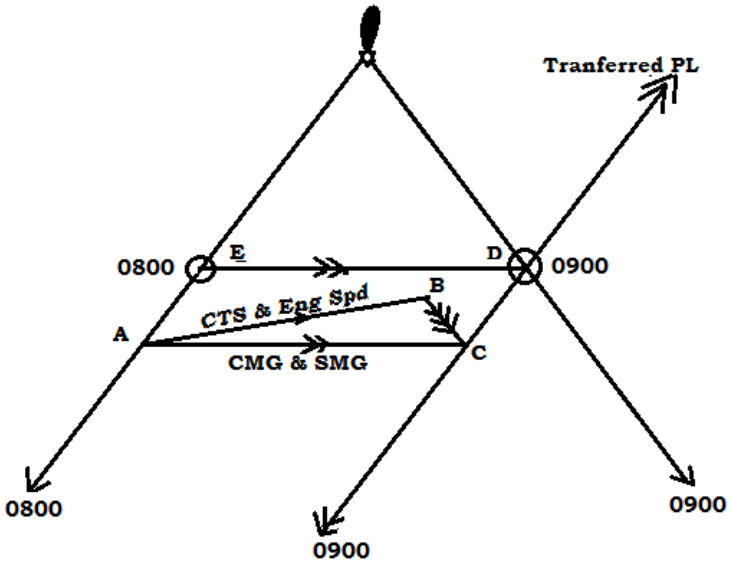
a) Transfer of PL without current, when 2 brgs given at different times from the same Lt Ho.

- Draw both PLs from the Lt Ho
- Anywhere along the 1st PL, from 'A' draw the CTS & cut Eng spd at 'B'.
- Transfer 1st PL to 'B'
- The PLs will intersect at 'C', this is the 2ndposn
- Reverse plot the CTS from 'C'
- CTS intersects at 'D', this is the 1stposn



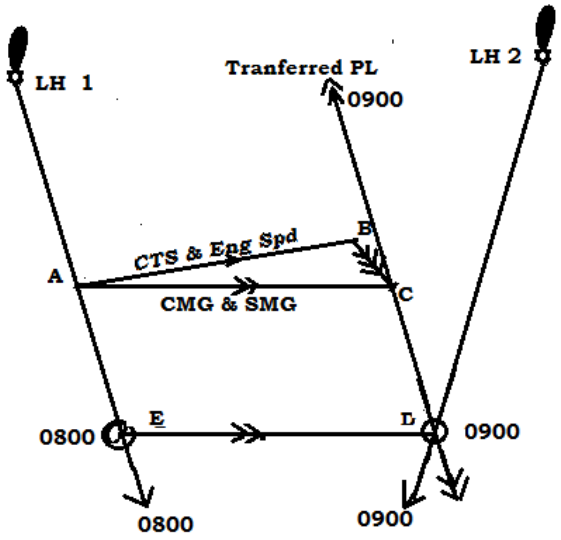
b) Transfer of PL with current, when 2 brgs given at different times from the same Lt Ho.

- Draw both PLs from the Lt Ho
- Anywhere along the 1st PL, from 'A' draw the CTS & cut Eng spd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Transfer 1st PL to 'C'
- The PLs will intersect at 'D', this is the 2ndposn
- Reverse plot the CMG from 'D'
- CMG intersects at 'E', this is the 1stposn



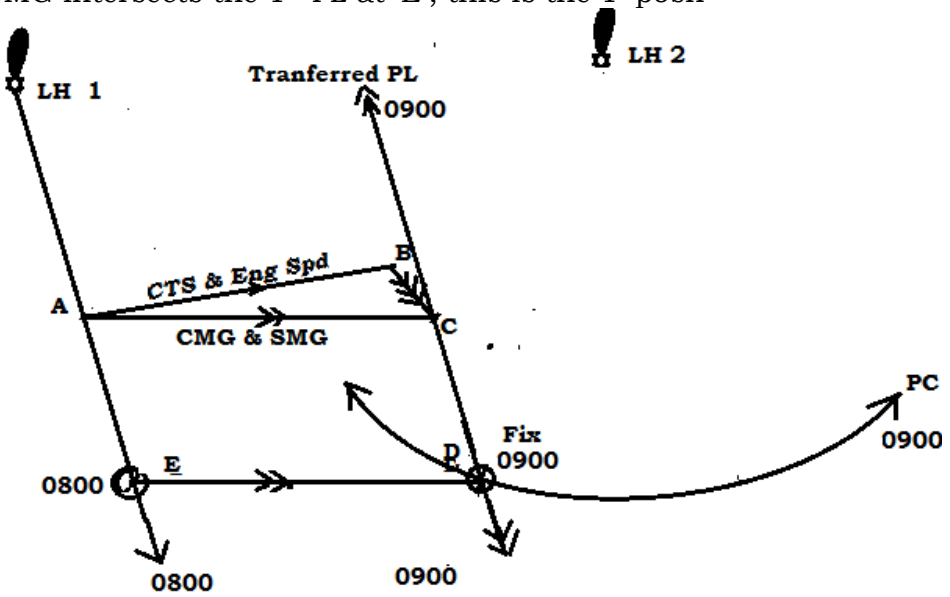
c) Transfer of PL with current, when 2 brgs given at different times from the different Lt Hos.

- Draw the PLs from Lt Ho.1 & Lt Ho.2
- Anywhere along the 1st PL, from 'A' draw the CTS & cut Engspd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Transfer 1st PL to 'C'
- The PLs will intersect at 'D', this is the 2ndposn
- Reverse plot the CMG from 'D'
- CMG intersects at 'E', this is the 1stposn



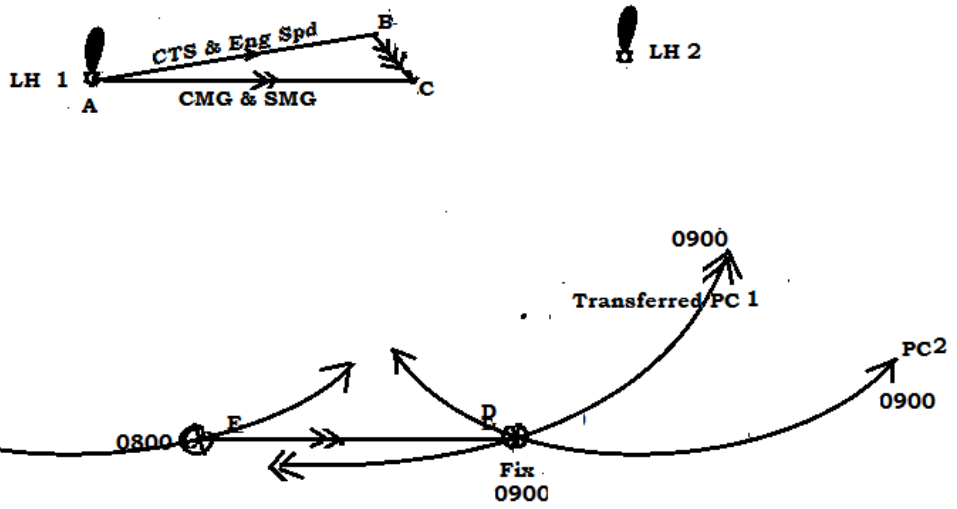
d) Transfer of PL with current, when 1 PL & 1 PCgiven at different times from the different Lt Hos.

- Draw the PL from Lt Ho.1 & PC from Lt Ho.2
- Anywhere along the 1st PL, from 'A' draw the CTS & cut Eng spd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Transfer 1st PL to 'C'
- The transferred 1stPL will intersect the PC at 'D', this is the 2ndposn
- Reverse plot the CMG from 'D'
- CMG intersects the 1st PL at 'E', this is the 1stposn



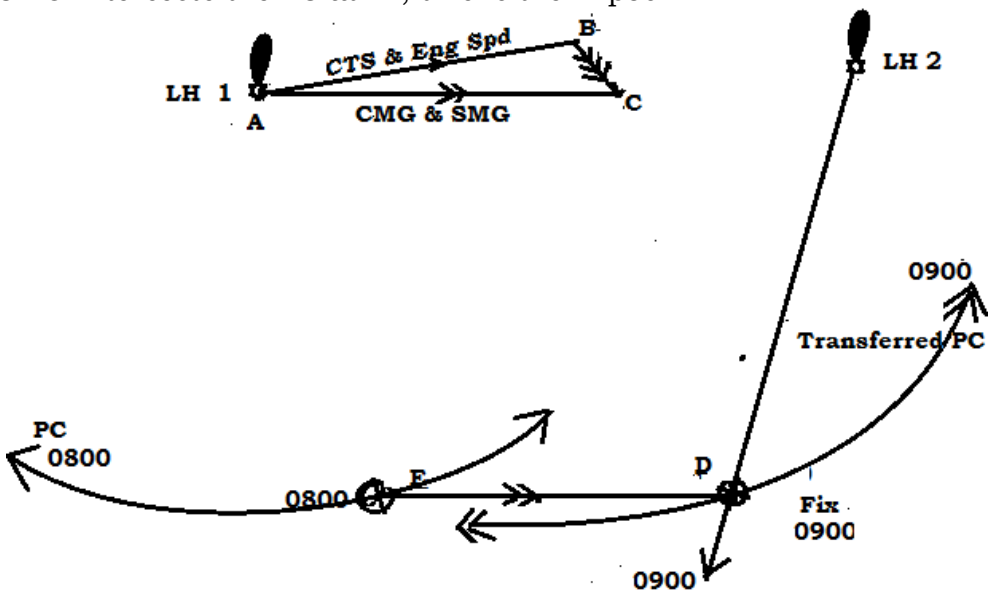
e) Transfer of PC with current, when 2 PCsare given at different times from the different Lt Hos.

- Draw the PC from Lt Ho.1 & PC from Lt Ho.2
- From the centre of the PC 'A', draw the CTS & cut Eng spd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Take the radius of PC1 and draw from 'C' the transferred PC1
- The transferred PC1 will intersect the PC2at 'D', this is the 2nd posn
- Reverse plot the CMG from 'D'
- CMG intersects the PC1at 'E', this is the 1st posn



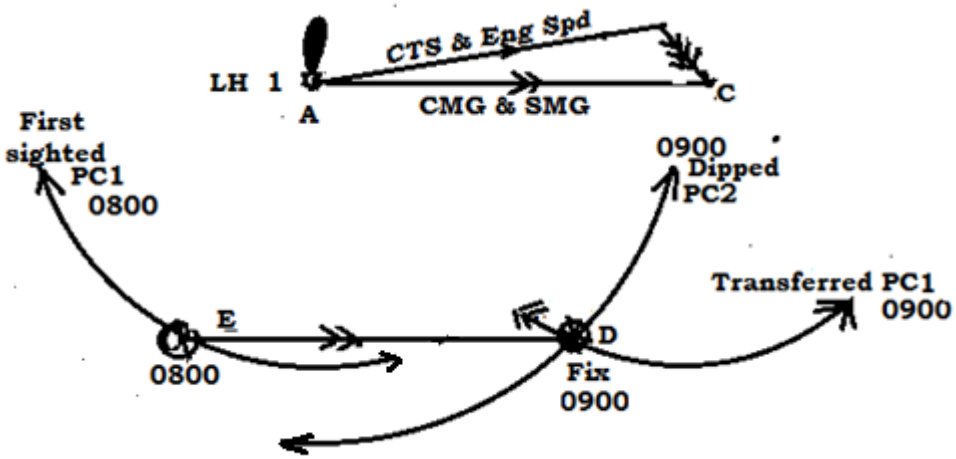
f) Transfer of PC with current, when1 PC & 1 PL is given at different times of different Lt Ho.

- Draw the PC from Lt Ho.1 & PL from Lt Ho.2
- From the centre of the PC 'A', draw the CTS & cut Eng spd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Take the radius of PC and draw from 'C' the transferred PC1
- The transferred PC will intersect the PL at 'D', this is the 2nd posn
- Reverse plot the CMG from 'D'
- CMG intersects the PC at 'E', this is the 1st posn



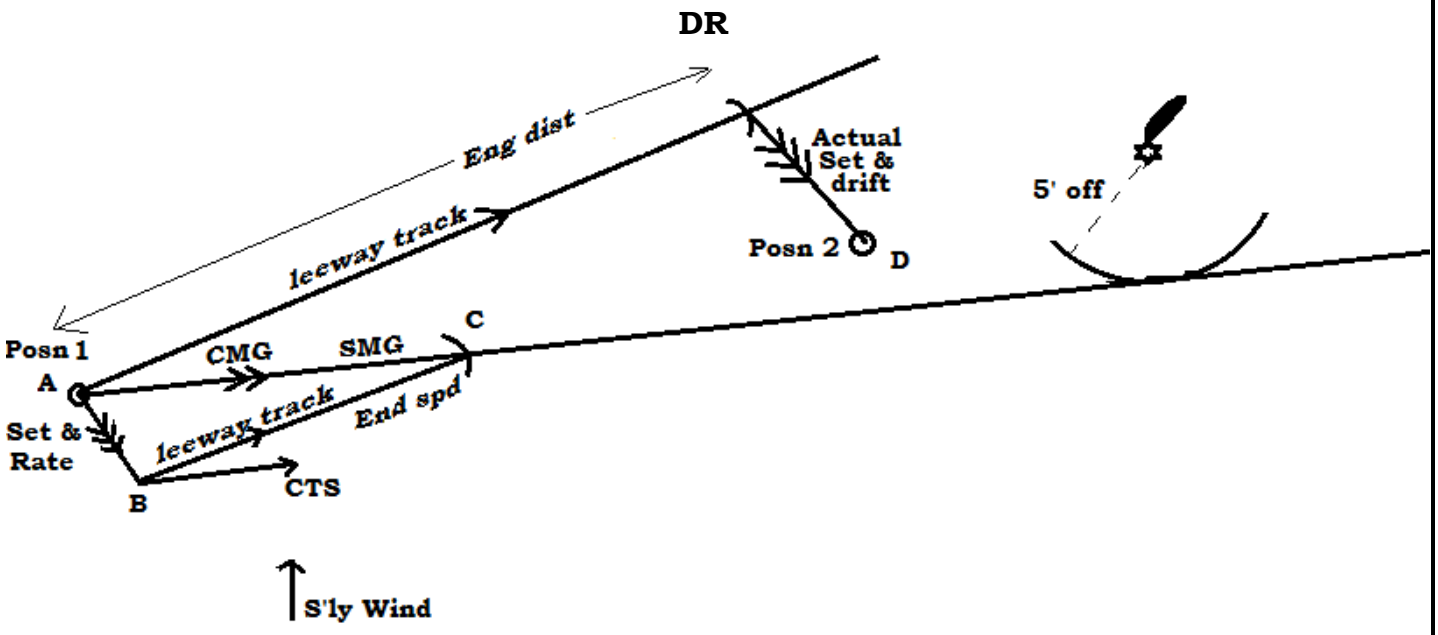
g) Transfer of PC with current, when PC1 (first sighted)& PC2 (Lt Dipped) is given at different times of same Lt Ho.

- Draw the PC1 & PC2 from Lt Ho.1
- From the centre of the PC 'A', draw the CTS & cut Eng spd at 'B'.
- From 'B' draw the Set & Rate to 'C'
- Take the radius of PC1 and draw from 'C' the transferred PC1
- The transferred PC1 will intersect the PC2 at 'D', this is the 2nd posn
- Reverse plot the CMG from 'D'
- CMG intersects the PC1 at 'E', this is the 1stposn



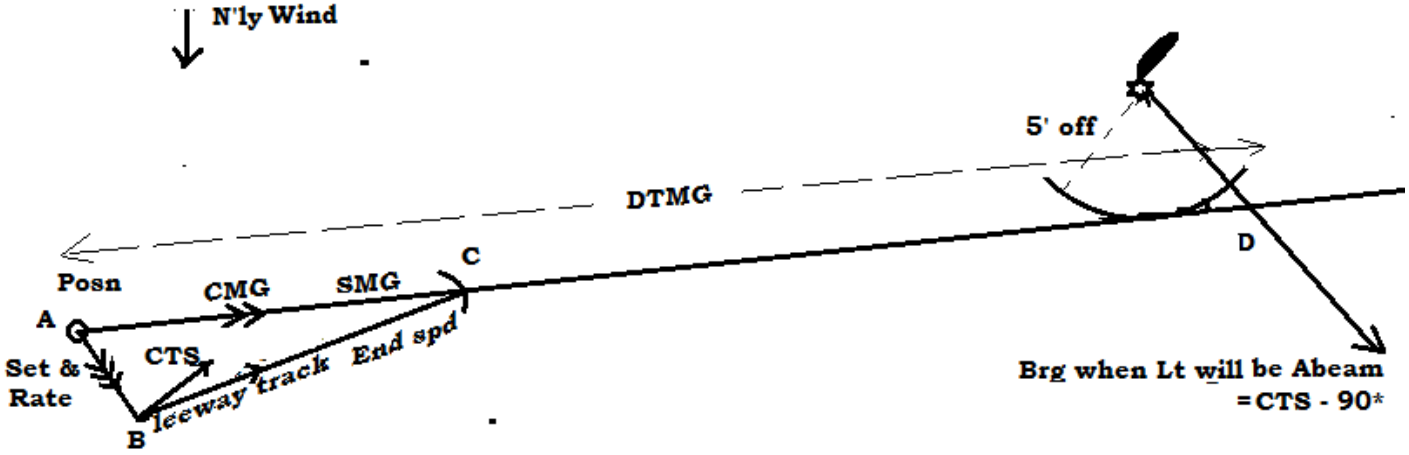
V) Find the Actual Set & Drift when actual posn (D) after sometime is not on the CMG.

- First by Counteracting method find the CTS
- Then draw the planned leeway track from A & cut the Eng dist for the required time interval.
- Join the DR & the Posn2 'D'. This is the Actual Set & Drift.



VI) Find the posn & time when the light will be abeam.

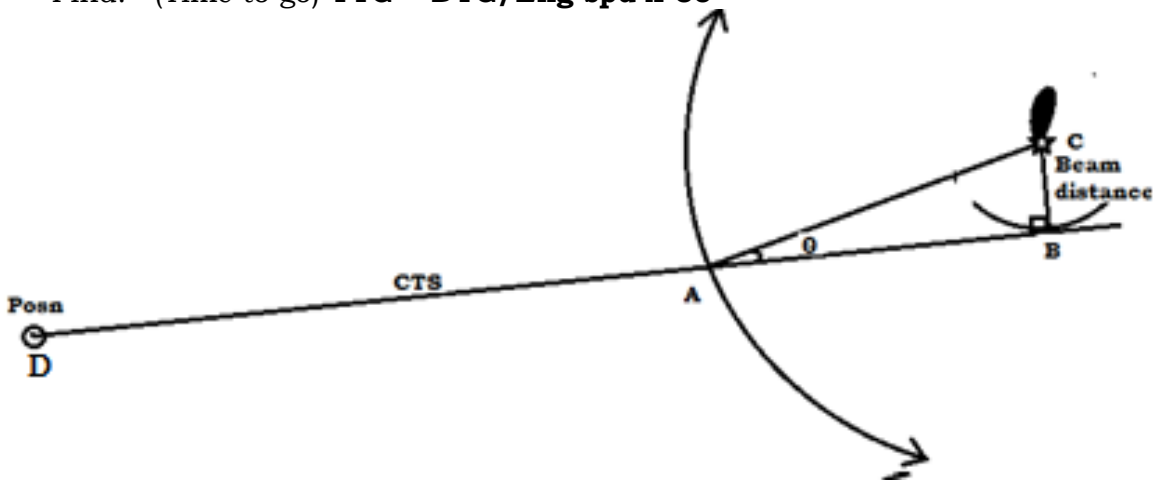
- First by Counteracting method find the CTS
- Then from the Lt Ho draw the beam bearing (=CTS +/- 90º).
- The beam Brg will intersect the CMG at 'D'.
- Measure AD = DTMG
- TTG = DTMG/SMG x 60'



VII) RAISING or FIRST SIGHTING or DISTANCE OFF – THE LIGHT θ° ON THE PORT or STBD BOW

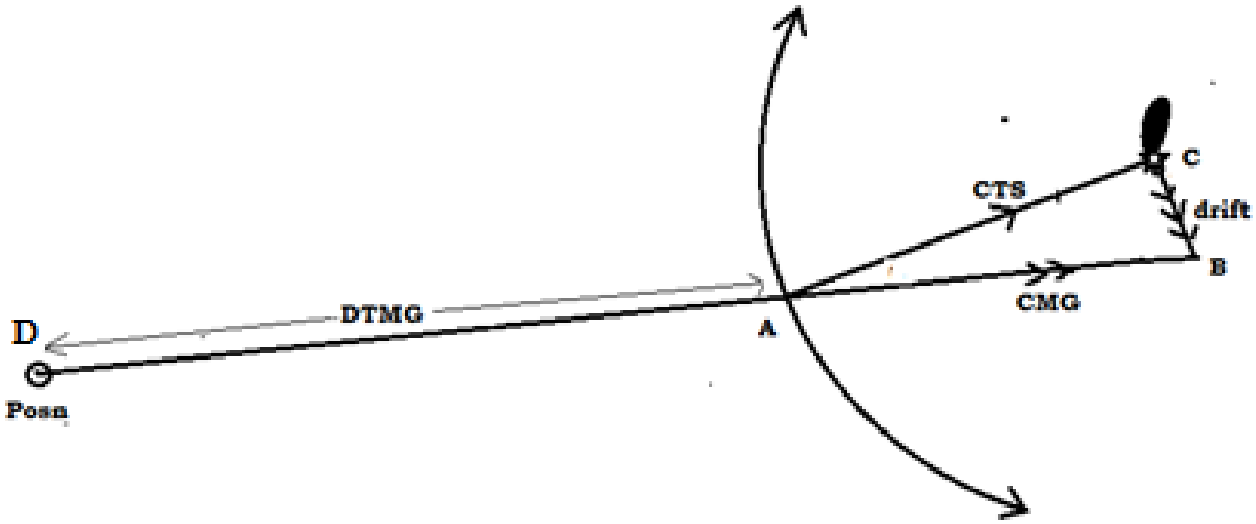
(when Engine Speed is given & without current)

- **Find: AC** = (GR- Raising)or (GR or LR whichever less - First Sighting) or (Distance off)
- Draw the Posn Circle from the Light with AC as radius.
- Find: **Beam distance(BC)= AC x Sin θ**
- Draw a tangent to the beam distance arc, from present position. This is the **CTS**
- At posn 'A', the light will be θº on the port bow.
- Measure **DA = DTG**
- Find: (Time to go) **TTG = DTG/Eng spd x 60'**



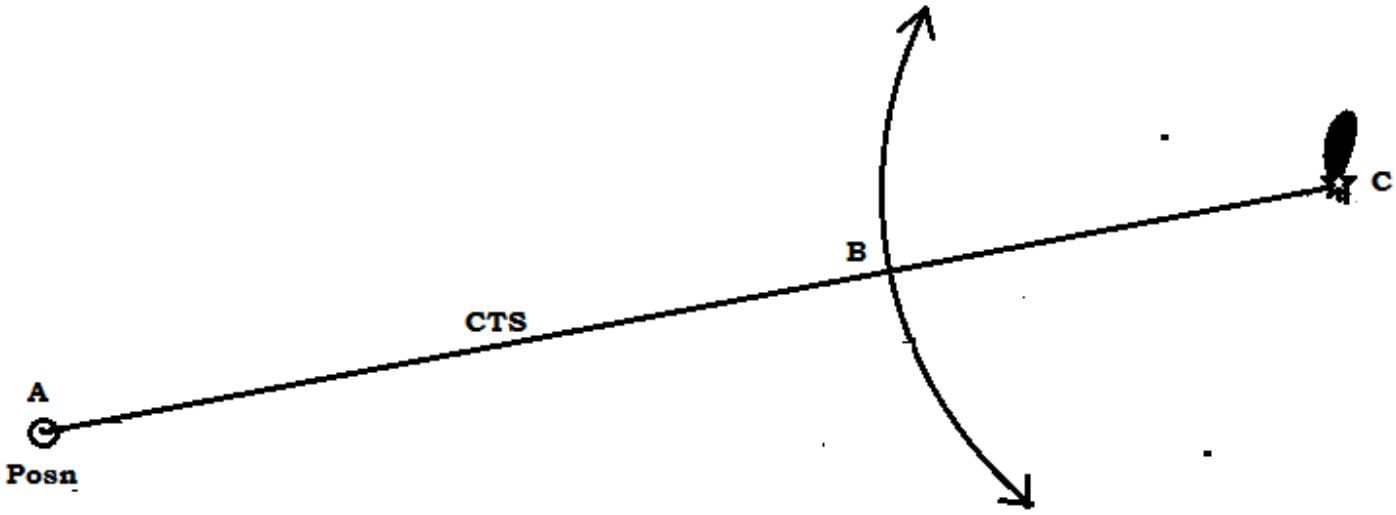
VIII) Raising or First Sighting or Distance Off, the Light RIGHT AHEAD with current)

- Find: **AC** = (GR - Raising) or (GR or LR whichever less - First Sighting) or (Distance off)
- **Draw the PC** from the Light with AC as radius.
- Find: **Drift (BC)** = AC x (Rate / Eng spd)
- **Mark the Drift on the Set at B.**
- Draw a line from posn to 'B'. This is the **CMG**
- Measure **AB= DMG**
- Find: **SMG = AB x (Rate/Drift)**
- Measure **DA = DTMG**
- Find: (Time to go) **TTG = DTMG/SMG x 60'**



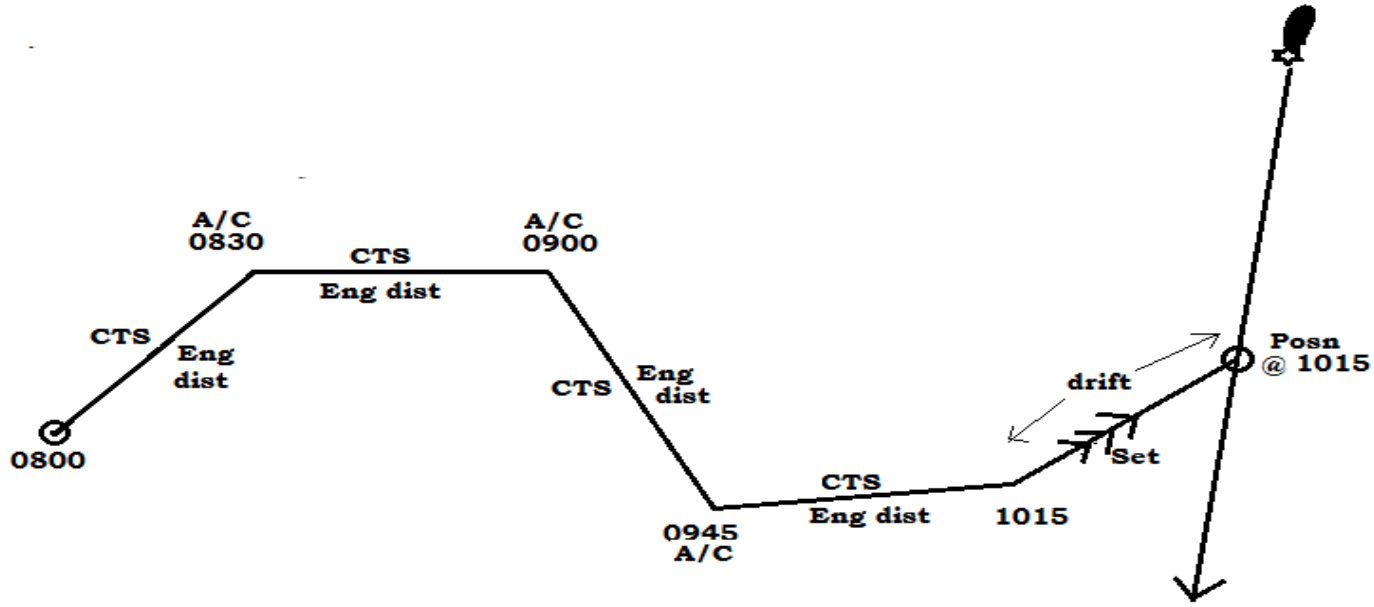
IX) Raising or First Sighting or Distance Off, the Light RIGHT AHEAD without current)

- Find: **BC** = (GR - Raising) or (GR or LR whichever less - First Sighting) or (Distance off)
- Draw the Posn Circle from the Light with BC as radius.
- Draw a line from 'A' to 'C'. This is the **CTS.**
- Measure distance **AB = DTG**
- Find: (Time to go) **TTG = DTG/Eng spd x 60'**



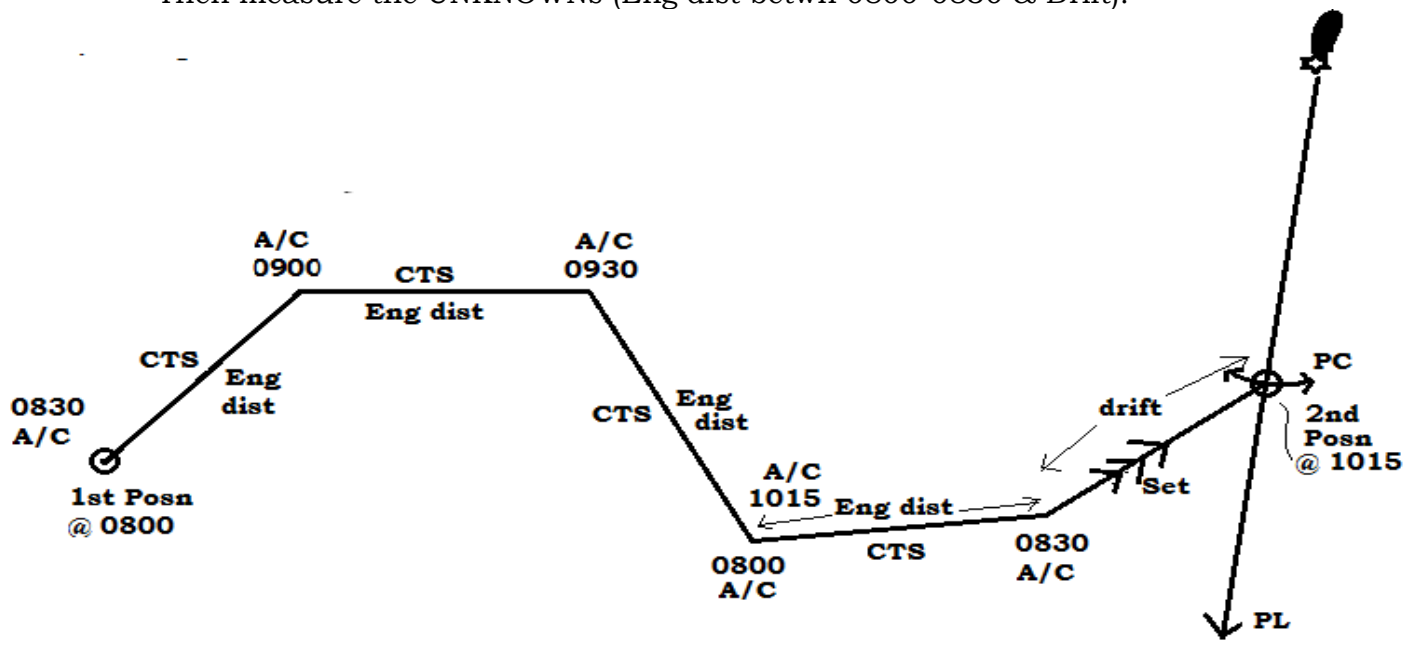
X) Find the Unknown, when from a posn various alterations of courses&/or current and a PL/PC are given (1 unknown)

e.g. various A/Cs & set is given. Find drift.
- First plot all the KNOWN Courses & Set from the present posn.
- The UNKNOWN should always be plotted at the end.
- Then plot the PL/PC from the Lt ho.
- Where the Set& PL/PC intersect the UNKNOWN (Drift) can be found.
- The 2nd Posn is the point of intersection.



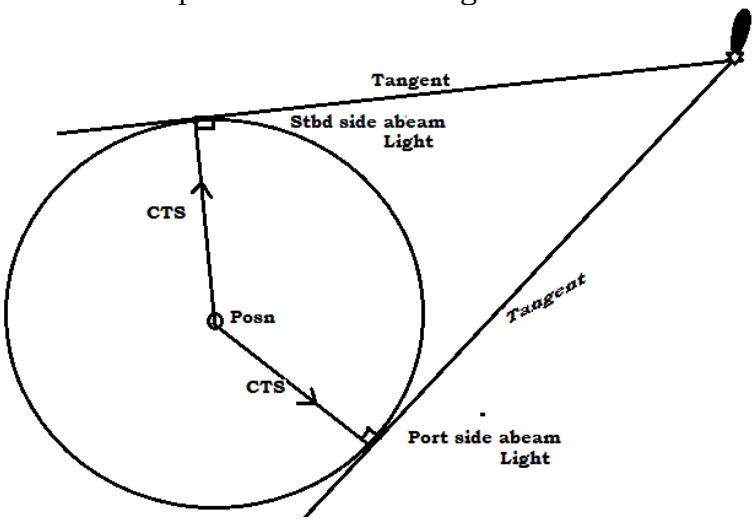
XI) Find the Unknown, when from a posn various alterations of courses&/or current and 2nd posn is given (2 unknowns)

e.g. various A/Cs & set is given. Find drift& End Spd between 0800-0830.
- First plot all the KNOWN Courses from the 1st posn.
- Then plot the 0800-0830 Course
- Then plot the PL & PC from the Lt ho to obtain the 2nd Posn.
- Plot Set, reverse from 2nd Posn.
- Then measure the UNKNOWNs (Eng dist betwn 0800-0830 & Drift).



XII) Find the CTS after a interval of time to have a Light Abeam on the Port or Stbd side, without current

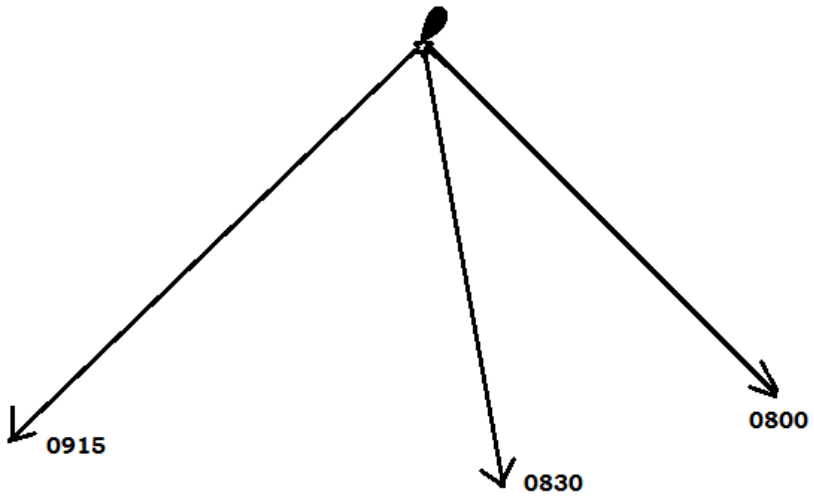
- First draw a circle with radius of Eng dist for the time interval.
- Then draw tangets on either side of the circle from the Lt Ho.
- Join the Posn & tangent pts on either side. **These are the CTS** to have the Lt abeam on port or stbd side of the ship as shown in the figure.



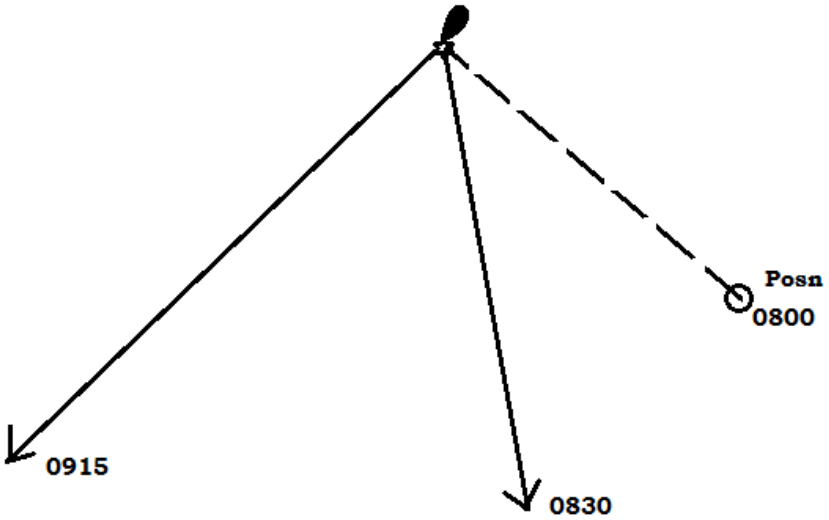
XIII) Three – Point bearings from Lt Ho./Point/object

- This concept gives us the CMG
- We can find 1 unkown & the 3 Positions
- OR When a position is given, we can find 2 unknowns & the other 2 positions
- If Ship's Compass heading and 3 Compass brgs of Lt Ho are given at different times. **Find Compass Error & convert to true brgs and do the question by 3 point bearings method**
- There are 5 types of 3–point brgs
-

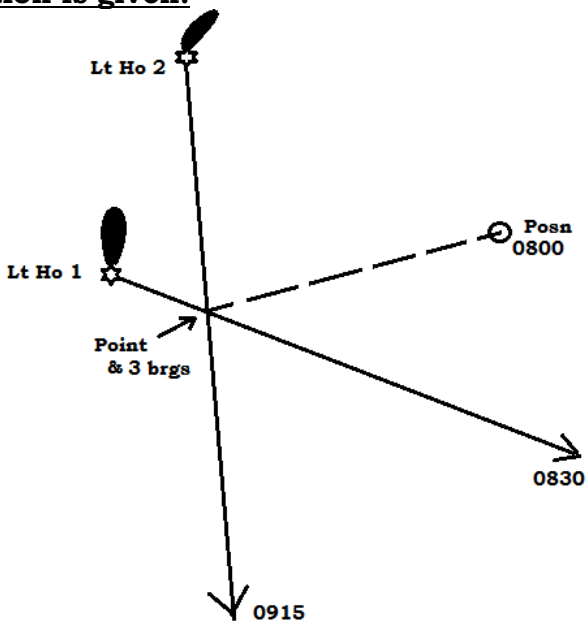
a) When 3 brgs at different times are given from a single Lt Ho./Point/object.



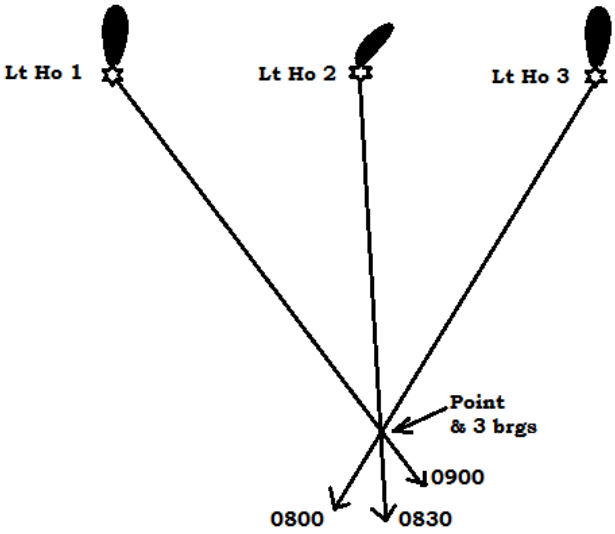
b) **When 2 brgs at different times are given from a single Lt Ho./Point/object & a position is given.**



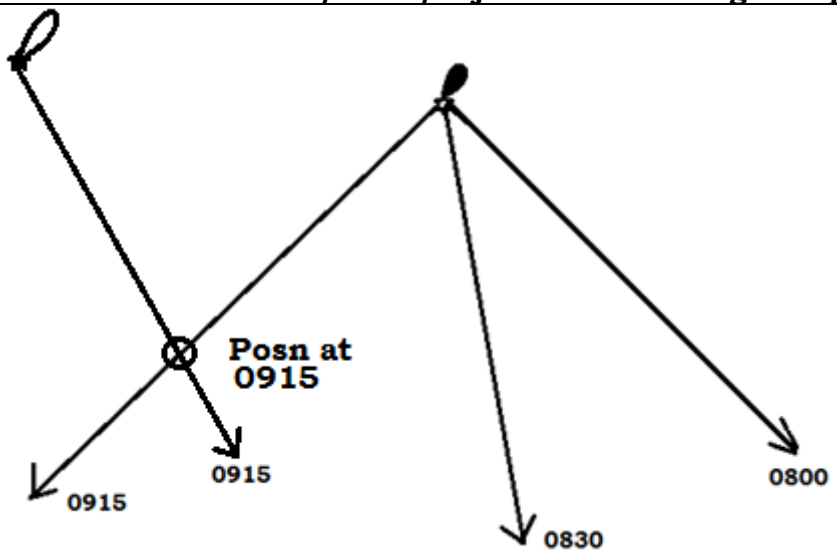
c) **When brgs are given at different times from 2 different Lt Hos., intersect at a point & a position is given.**



d) **When brgs from 3 different Lt Hos. are given at different times intersect at a point.**



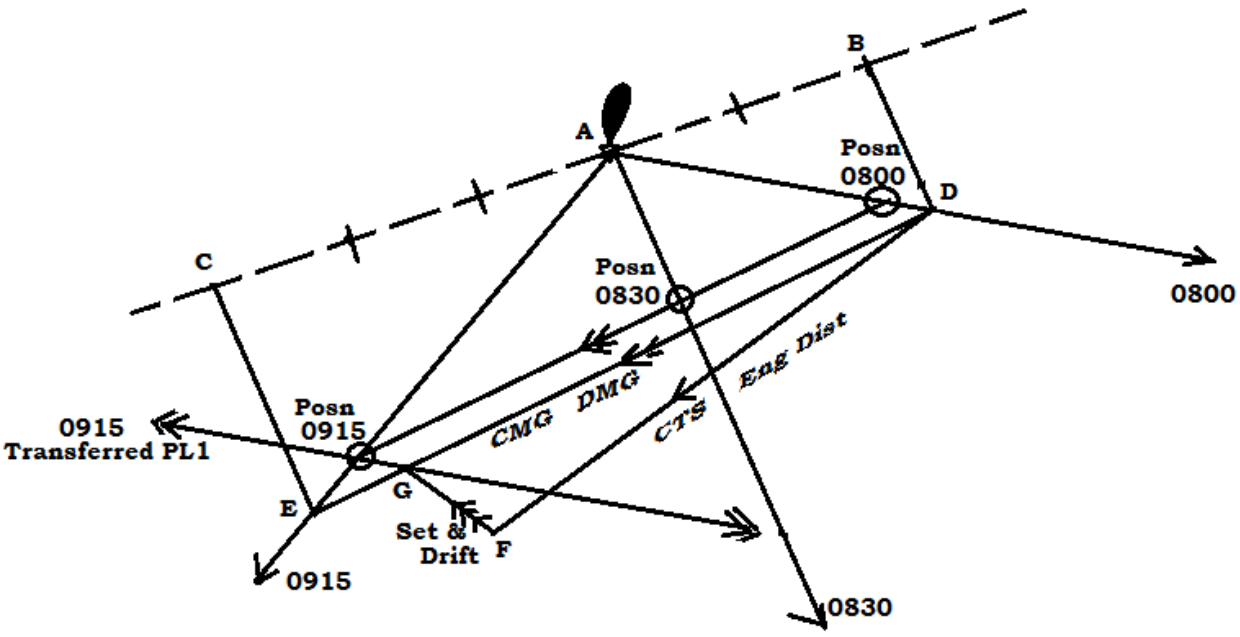
e) **When 3 brgs at different times are given from a single Lt Ho./Point/object and 1 brg from a different Lt Ho./Point/object intersect to give a posn.**



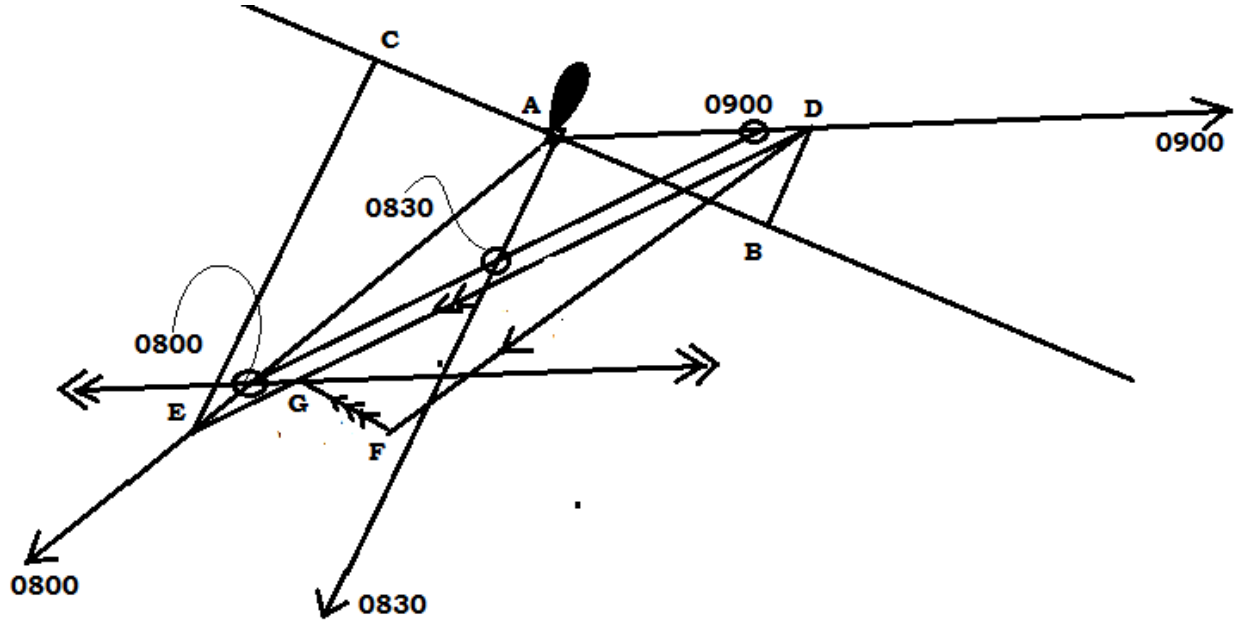
f)

i) 3 point brgs, CTS, Eng Spdv& Set are given. **Find DRIFT of current & all 3 posns** **OR**
3 point brgs, CTS, Eng Spd & Rate are given. **Find SET of current & all 3 posns**

- Draw all 3 brgs from the Lt ho
- Draw a line perpendicular to 2nd brg through the Lt Ho.
- Find the ratio of time interval between 1st& 2nd brg and betwn 2nd& 3rd brg.
- Cut the ratio from the Lt Ho. - first at 'B', then at 'C'
- Draw a line parallel to 2nd brg, from 'B' to intersect at 'D'
- Draw a line parallel to 2nd brg, from 'C' to intersect at 'E'
- Join 'D' & 'E', this is the CMG.
- From 'D' draw the CTS & cut the Eng dist at 'F'
- **1. If Set is given,** From 'F' draw the Set. 'FG' is the Drift
- **2. If Rate is given,** find Drift & from 'F' cut Drift at 'G'**.** Direction 'FG' is the SET
- Through G transfer the PL1
- Where the **Transferred PL1 intersects PL3 is the Last Posn**
- Draw a reverse CMG from last Posn & find other 2 Posns.

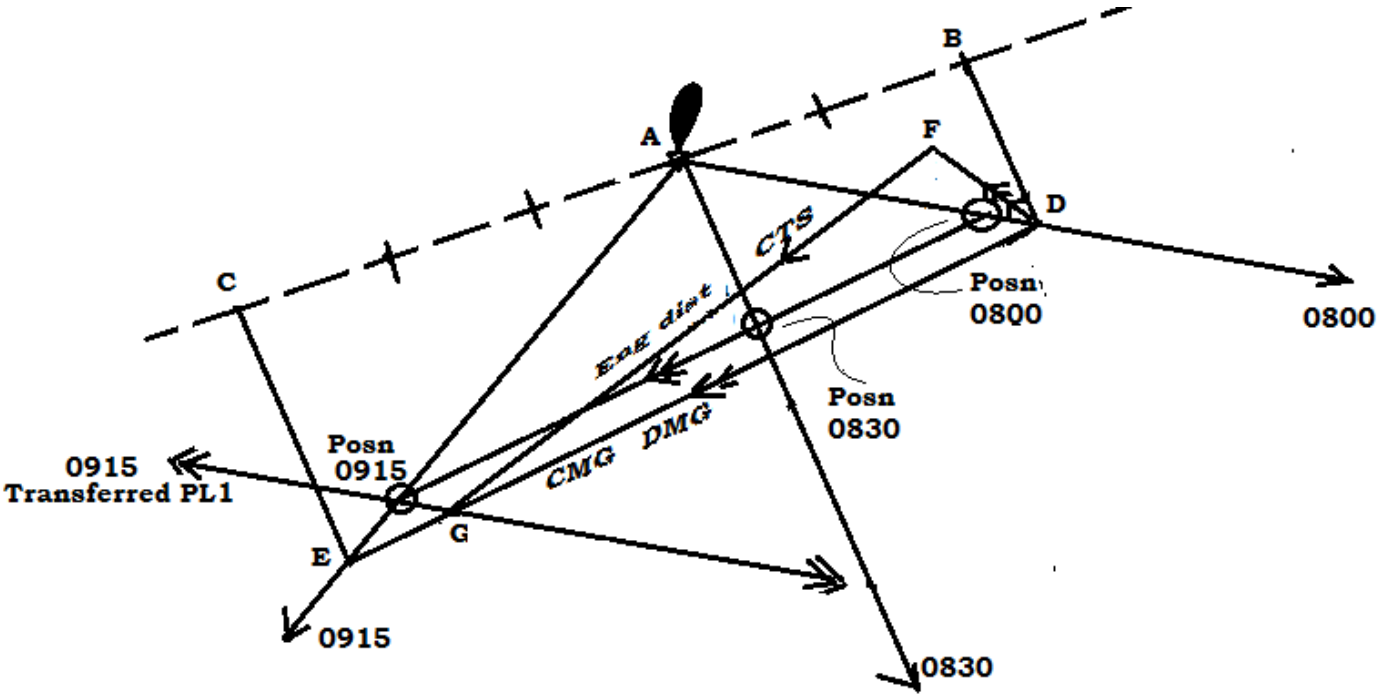


e.g.



ii) <u>3 point brgs, Eng Spd, Set Rate are given</u>**. <u>Find CTS & all 3 posns</u>** **OR**
<u>3 point brgs, CTS, Set& Rate are given</u>**. <u>Find Eng Spd & all 3 posns</u>**

- Find the CMG (DE) as explained above.
- From 'D' draw the Set & cut the Drift at 'F'
- **From 'F' cut the Eng dist on the CMG at 'G'.Direction of 'FG' is the CTS**
- **If CTS is given from 'F' draw the CTS to intersect the CMG at 'G'. 'FG' is the-Eng dist**
- Through G transfer the PL1
- Where the **Transferred PL1 intersects PL3 is the Last Posn**
- Draw a reverse CMG from last Posn& find other 2 Posns.



iii) 2 point brgs, CTS, Eng Spd are given. **Find SET & RATE of current & other 2 posns** **OR**
2 point brgs, SET, RATE are given. **Find CTS & Eng Spd & other 2 posns** **OR**
2 point brgs, CTS, Set are given. **Find Eng dist & RATE of current & other 2 posns** **OR**
2 point brgs, CTS, RATE are given. **Find Eng dist & SET of current & other 2 posns** **OR**
2 point brgs, Eng speed, Set are given. **Find CTS & RATE of current & other 2 posns OR**
2 point brgs, eng speed, Rate are given. **Find CTS & SET of current & other 2 posns**

- Draw the 2 brgs from the Lt ho.
- Join the posn to the Lt ho& make it 3 point brgs
- Draw a line perpendicular to 2nd brg through the Lt Ho.
- Find **the ratio of time interval** betwn1st & 2nd brg and betwn 2nd & 3rd brg.
- Cut the ratio from the Lt Ho. - first at 'B', then at 'C'
- Draw a line parallel to 2nd brg, from 'B' to intersect at 'D'
- Draw a line parallel to 2nd brg, from 'C' to intersect at 'E'
- Join 'D' & 'E', this is the CMG.
- Transfer the CMD through Posn at 'F'.
- The CMG will intersect PL1 at 'J' (Posn at 0830) & PL2 at 'I' (Posn at 0900).

1. **If CTS & Eng Spd are given**. From 'F' draw the CTS & cut Eng Spd at H (DR). Join 'H' to 'I'. **'HI' = Set & Rate of current.**

OR

2. **If SET & RATE are given,** From 'I' draw reverse Set and cut Rate on Set at 'H' (DR).
   Join F to H**.'FH' = Eng spd & CTS**

OR

3. **If CTS & Set are given,** From 'F' draw the CTS & from 'I' draw Reverse Set to intersect CTS at 'H' (DR).
   Measure **'HI' = (Rate) &** Measure **'FH' = (Eng Spd).**

OR

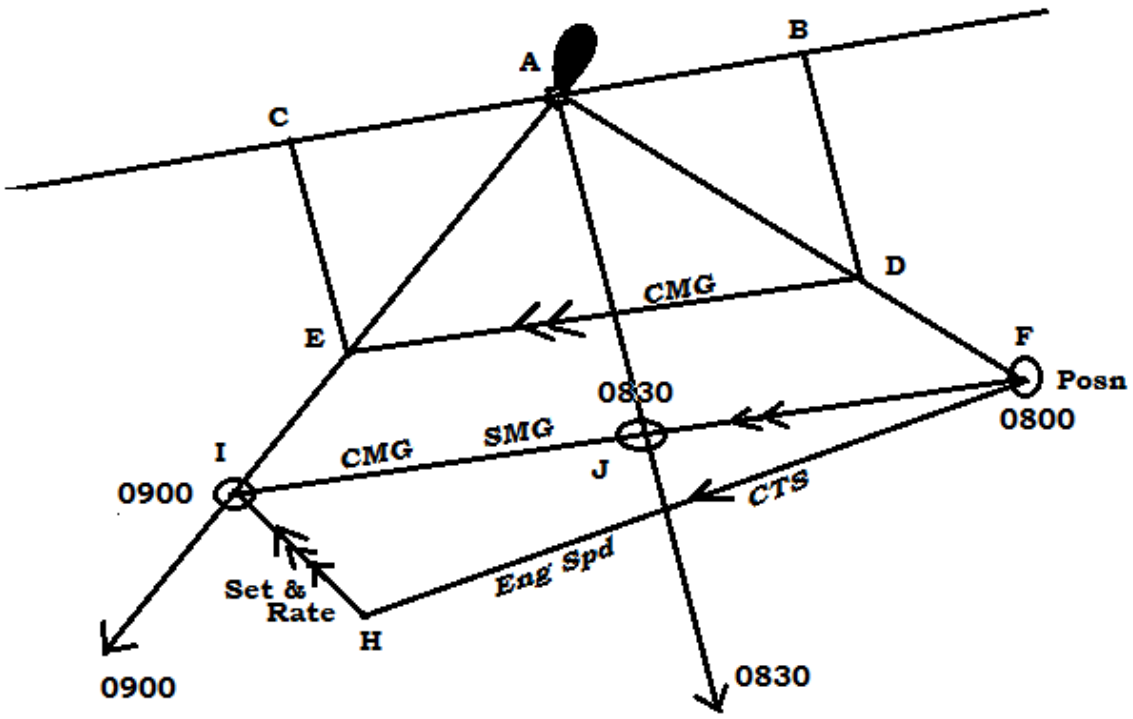
4. **If CTS & RATE are given,** From 'F' draw the CTS & from I draw RATE arc to intersect CTS at 'H' (DR).
   'HI' = SET & Measure **'FH' = (Eng Spd).**

OR

5. **If Eng spd & SET are given,** From 'F' draw the Eng spd arc &from 'I' draw reverse SET to intersect Eng spd arc at 'H' (DR).
   Measure**'HI' = RATE & 'FH' = CTS**

OR

6. **If Eng spd & RATE are given,** From 'F' draw the Eng spd arc &from I draw RATE arc to intersect Eng spd arc at 'H' (DR).
   'HI' = SET& 'FH' = CTS



(Chart 5072, Spd 12 kts, HE 12m, Dev card No.2, Var 1°W)

Q.1. A vessel at anchor observes the following compass bearings

a) Christiano (S) Lt. (55° 19'N 015° 11'E) 065°(C)
b) Svanke Lt. (55° 08'N 015° 09'E) 161°(C)
c) Hammerodde Lt. (55° 18'N 014° 47'E) 284°(C)

Find the vessel's position and the deviation on the ship's head.

Solution:

Christiano (S) Lt. 065°(C)
Svanke Lt. 161°(C)
HSA(θ) = 96°
As HSA(θ) > 90°,
Angle = θ - 90° = 96° - 90° **= 6°**

Svanke Lt. 161°(C)
Hammerodde Lt. 284°(C)
HSA(θ) = 123°
As HSA(θ) > 90°,
Angle = θ - 90° = 123° - 90° = **33°**

Position: 55° 16.3'N 015° 02.7'E

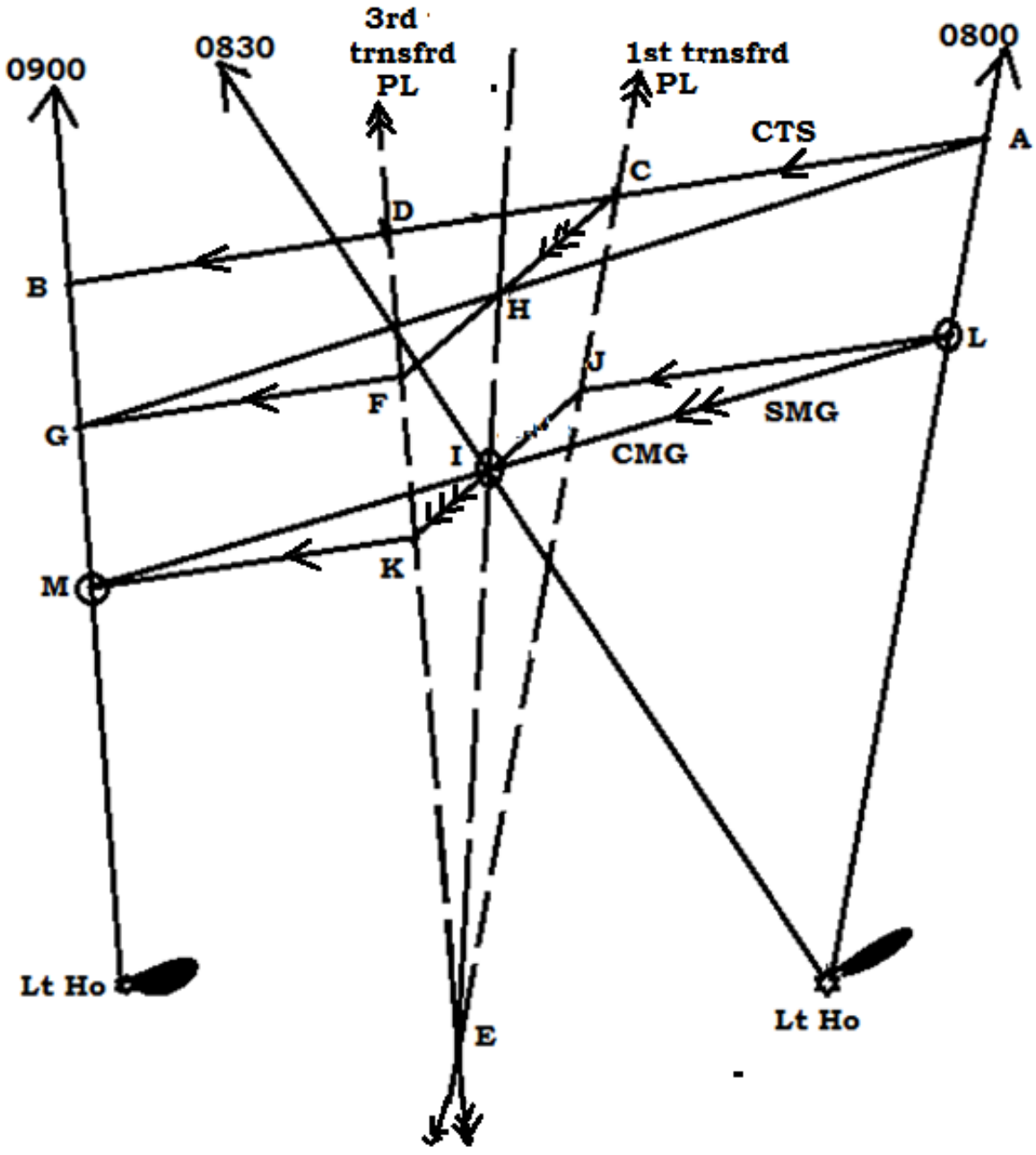
	Christiano (S) Lt.	Svanke Lt.	Hammerodde Lt.
Compass brgs	065°(C),	161°(C)	284°(C).
If from plot T. brgs of	°(T),	°(T)	°(T)
Compass Error of	°	°	°

Average Compass Error = $\frac{(° + ° + °)}{3}$ = °

FISH TRIANGLE (with following current)

1. 2 brgs from one Lt Ho. and 1 brg from another Lt Ho.
2. CTS, Eng spd & Set is given. **Rate & Positions** unknown.

- First draw the PLs from the Lt Hos.
- Then draw the CTS from 1st first PL (A) to the 3rd PL (B)
- From (A) cut the eng dist on CTS (C) for the time interval between 1st PL & 2nd PL & transfer the 1st PL to (C).
- From (B) cut the eng dist on CTS (D) for the time interval between 2nd PL & 3rd PL & transfer the 3rd PL to (D).
- The transferred 1st PL & 3rd PL will intersect at (E).
- From (C) draw the set which will intersect transferred 3rd PL at (F).
- From (F) draw the CTS to 3rd PL at (G).
- Join (A)&(G), this will intersect the set at (H).
- Draw a line through (E) & (H) which will intersect 2nd PL at (I). This is Position on 2nd PL.
- Through (I) draw the SET which will intersect 1st PL at (J) & 3rd PL at (K).
- Measure **(JK) = Rate**.
- From (J) draw the CTS to 1st PL (L). This is the Posn on 1st PL.
- From (K) draw the CTS to 3rd PL (M). This is the Posn on 3rd PL.
- Join (L) & (M), (LM) is the CMG & SMG



FISH TRIANGLE (with against current)

1. 2 brgs from one Lt Ho. and 1 brg from another Lt Ho.
2. CTS, Eng spd & Set is given. **Rate & Positions** unknown.

- First draw the PLs from the Lt Hos.
- Then draw the CTS from 1st first PL (A) to the 3rd PL (B)
- From (A) cut the eng dist on CTS (C) for the time interval between 1st PL & 2nd PL & transfer the 1st PL to (C).
- From (B) cut the eng dist on CTS (D) for the time interval between 2nd PL & 3rd PL & transfer the 3rd PL to (D).
- The transferred 1st PL & 3rd PL will intersect at (E).
- From (C) draw the set which will intersect transferred 3rd PL at (F).
- From (F) draw the CTS to 3rd PL at (G).
- Join (A)&(G), this will intersect the set at (H).
- Draw a line through (E) & (H) which will intersect 2nd PL at (I). This is Position on 2nd PL.
- Through (I) draw the SET which will intersect 1st PL at (J) & 3rd PL at (K).
- Measure **(JK) = Rate**.
- From (J) draw the CTS to 1st PL (L). This is the Posn on 1st PL.
- From (K) draw the CTS to 3rd PL (M). This is the Posn on 3rd PL.
- Join (L) & (M), (LM) is the CMG & SMG