Bluewater Miles

www.bluewatermiles.com

LOG BOOK

FOR CRUISING UNDER SAILS

Boat Name ....

Onwer’s Name ....

Onwer’s Phone ....

Port of Registry ....

Flag ....

Type (M/Y, S/Y, other) ....

Year Built: ....

Sea areas in which the boat is authorised to operate ....

Call Sign .... Official Number ....

MMSI ....

Starting Date .... End Date ....

Boat Details

Length Over All .... m

Length Water Line .... m

Draught .... m

Beam .... m

Masthead Height .... m

Gross Tonnage (GT) .... t

Fuel Tank Capacity L

Spare Fuel Capacity L

Engine Type .... HP

Engine Oil ....

Fuel Consumption .... L per Hour at RPM ....

Range on engine .... NM

Water Tank Capacity L

Domestic Battery Capacity .... Ah

Engine Battery Capacity .... Ah

Electricity Consumption (avg) .... Ah

Electricity Generation:
- ☐ Engine .... h run to top up batteries
- ☐ Solar panels .... Ah / day (avg)
- ☐ Wind generator .... Ah / day (avg)
- ☐ .... Ah / day (avg)

Main Anchor .... Kgs .... m
& chain / cable length

Kedge Anchor .... Kgs .... m
& chain / cable length

Sails

No.	Name	Sail Area m^2	Sign	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				

Boat check-in remarks

Crew list

No.	Name	Capacity*	Watch No.	Phone	Date of safety briefing**	Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

*Master (Captain) / Watch Leader (WL) / Crew

**Safety briefing includes: personal safety and safety equipment, emergency procedures (mob, fire, water, abandoning ship), sails and lines handling, night sailing if applicable, crew welfare and teamwork

Instructions

A well-kept ship's logbook should serve as an accurate narrative, permitting anyone to subsequently plot the cruise again from the information supplied.

"The entries in the ship's log can be followed in reverse over the course run, rather in the way that Theseus found his way out of the labyrinth. All the details used in laying the course must be entered: compass course (the one asked for and the one actually followed), the log readings, strength and direction of the wind, and sea conditions. "All changes should also be noted: going about, changes of sail, changes in the weather, fixes taken (and how they were made), along with any ships met. Nothing must be judged insignificant… "The ship's log must be kept scrupulously up to date, even when dead reckonings are not expected to be made. If there is an accident, then the ship's log can be invaluable as evidence of what actually happened. "If the boat is equipped with GPS or other electronic position finders, the log must still be kept up to date and the position noted regularly. This can then serve as the starting point for dead reckoning in case of instrument malfunction or failure." - **The Glenans Manual of Sailing**

At the beginning of each cruise, enter the crew list, departure port and date, and other details.

Each morning, in tidal waters enter the tides and draw the day's tidal curve. Take the first hourly barometer reading. Make your passage plan for the day and write it down, listing the charts required. If a night sail is involved, list the characteristics of any relevant lights.

Every time something happens, or when something changes, or once an hour, enter details of a position fix, weather forecast received and sailing observations (leaving or entering a harbour, changing course, taking a reef, spotting a navy boat, something has broken). Details of that whale on the port side, flying fish, and interesting birdlife can be entered in side notes as well.

At the end of each shift make a navigational and deck watch hand over, log consumables level (water, battery, and fuel).

A well-kept personal log book is useful to keep track of your sea miles / time. When sailing as crew, ask your skipper to sign and date the entries after each cruise. Fill the log using black pen and cross any non-filled fields so that the log cannot be tempered later.

Keep the logbook on ship's time, which may or may not be UTC. For ocean crossings to make celestial navigation easier use UTC.

Make a special logbook entry at the synoptic times of 00, 06, 12 and 18 UTC. These are the times weather maps from global models are created. Make other entries as per your analysis maps at hand.

The Beaufort Scale (B)

No	Description	Wind Speed			At Sea	On Land
		m/sek	km/h	knots		
0	**Calm**	0.0 – 0.2	<1	<1	Sea like a mirror	Smoke rises vertically
1	**Light Air**	0.3 – 1.5	1- 5	1- 3	Ripples like scales form	Wind direction shown by smoke drift, but not by wind vanes
2	**Light breeze**	1.6 – 3.3	6 - 11	4 - 6	Small wavelets	Wind felt on face, leaves rustle, ordinary vane moved by wind
3	**Gentle breeze**	3.4 – 5.4	12 - 19	7 - 10	Large wavelets, crests begin to break	Leaves and small twigs in constant motion, light flags fly
4	**Moderate breeze**	5.5 – 7.9	20 - 28	11 - 15	Small wavelets becoming longer, frequent white horses	Raises dust and loose paper, small branches move
5	**Fresh breeze**	8.0 – 10.7	29 - 38	16 - 21	Moderate waves, many white horses, chance of spray	Small trees in leaf sway, crested wavelets on inland waters
6	**Strong breeze**	10.8 – 13.8	39 - 19	22 - 27	Large waves, extensive white foam crests, probably some spray	Large branches in motion, whistling telephone wires, umbrellas difficult
7	**Near gale**	13.9 – 17.1	50 - 61	28 - 33	Sea heaps up, streaks of white foam	Whole trees in motion, walking against the wind feels inconvenient
8	**Gale**	17.2 – 20.7	62 - 74	34 - 40	Moderately high waves of greater length	Breaks off twigs, generally impedes walking progress
9	**Strong / Severe gale**	20.8 – 24.4	75 - 88	41 - 47	High waves, dense streaks of foam, wave crests topple, spray may reduce visibility	Slight structural damage to buildings
10	**Storm**	24.5 – 28.4	89 - 102	48 - 55	Very high waves, sea surface appears white, visibility affected	Trees uprooted, considerable structural damage, rarely occurs inland
11	**Violent storm**	28.5 – 32.6	103 - 117	56 - 63	Exceptionally high waves, long white foam patches cover sea, poor visibility	Widespread damage
12	**Hurricane**	> 32.6	> 117	> 63	Air filled with foam and spray, sea completely white, bad visibility	Widespread damage

State of the Sea (Douglas scale)

Wave Heights are issued in the warnings section of the Sea Area Forecast, using the mariners' convention whereby heavy swell means significant wave height of 4 metres or higher.

Sea State	Wave height (m)	Description
0	0	Calm (Glassy)
1	0 – 0.10	Calm (rippled)
2	0.10 – 0.50	Smooth
3	0.50 – 1.25	Slight
4	1.25 – 2.50	Moderate
5	2.50 – 4.00	Rough
6	4.00 – 6.00	Very rough
7	6.00 – 9.00	High
8	9.00 – 14.00	Very high
9	Over 14.00	Phenomenal

Cloud Cover

Symbol	Description
0	None or little
1	1/4
2	1/2
3	3/4
X	Completely covered

Additional information can include atmospheric phenomena like rain, hail, drizzle, fog, snow, thunder etc.

Visibility

Symbol	Description	Description
3	Good	more than 5 NM
2	Moderate	2 NM to 5 NM
1	Poor	0.5 NM to 2 NM
0	Very poor (Fog)	less than 0.5 NM

Air pressure changes and their meanings (applicable for *40-60 degrees N, and pressure < 1005 hpa)

Air pressure change / 1 hour	Air pressure change / 3 hours	Expected wind speed (Bft)
> +1,3 hPa	> +4 hPa	6 – 7
+2 bis +3 hPa	+6 bis +9 hPa	8 – 9
> +3,3 hPa	+10 hPa	10 or more
-1 bis -2 hPa	-3 bis -6 hPa	6 – 7
> -2 hPa	> -6 hPa	8 – 12

*The lower the latitude (i.e. the closer you are to the equator), the more wind you will see from small changes due to a weak Coriolis force. Conversely, higher latitudes require more of a barometric change to produce a given amount of wind.

Leeway (example for a modern cruiser)

Point of sails	Leeway*
Close-hauled	10 (light wind and slight waves) - 20° (strong wind and rough seas)
Close-reach	5° - 15°
Beam-reach	4° - 10°
Broad-reach	2° - 6°
Dead-run (running)	0° - 2°

*Depends on boat design (e.g. shallow draft, deep keel, long keel), apparent angle to the wind, sail trim, tack, wind and wave conditions. Adjust leeway less if the wind is light, and more if the wind is strong. Reduce this amount linearly as you bare away from the wind.

Estimating leeway

1. Sail with a recognizable land marker dead ahead.
2. Measure your speed.
3. Drop the sails and begin motoring at the same speed in exactly the same direction.
4. Take note of your GPS course.
5. Set the sails and turn off the engine.
6. Continue to aim for the same point on land.
7. Read out your GPS course.
8. The difference in course angles is your leeway.
9. Repeat for different points of sails, opposite tack, and different wind and wave conditions.

Note that:
(a) In an area of heavy current, you will also need to allow for that.
(b) This method does not account for the leeway due to the hull of your boat presented to the wind and swell.

Variation (Declination) on large-scale charts

Variation can be found by looking at the magenta compass rose on a chart. The bearings on the rose refer to true north and the arrow inside the rose indicates the direction of magnetic north. You should always use the compass rose closest to your position.

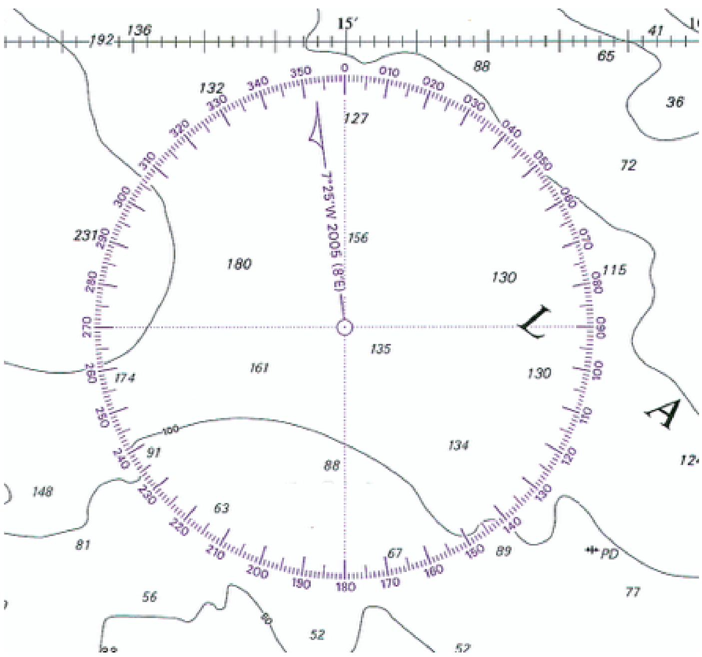


Fig. 1 - Example of compass rose magnetic variation. In 2005 the magnetic north pole was 7°25' West of the true north pole and estimated to be traveling 8' East per year.

What is the variation in 2021?

1. Find the difference in years between 2021 and 2005 = 16 (years).
2. Multiply 16 (years) x 8' (decrease per year) = 128' or 2º 8'.
3. Apply this to the variation shown. In this example, we subtract: 7°25’ W - 2º 8' E = 5º 17' W.
4. Round off the final number to the closest whole degree. Use 5º W variation at this location.

Variation (Declination) on offshore charts

Offshore charts rarely show more than one or two compass roses and only show true direction. Variation is presented using lines (curves) of equal variation, the so-called isogonals. These are magenta-coloured, diagonal lines running across the chart. Use the variation indicated on the isogonic line closest to your position. The isogonal lines show the variation for the year indicated in the chart description. You have to apply the annual difference in the same way as for the rose magnetic variation.

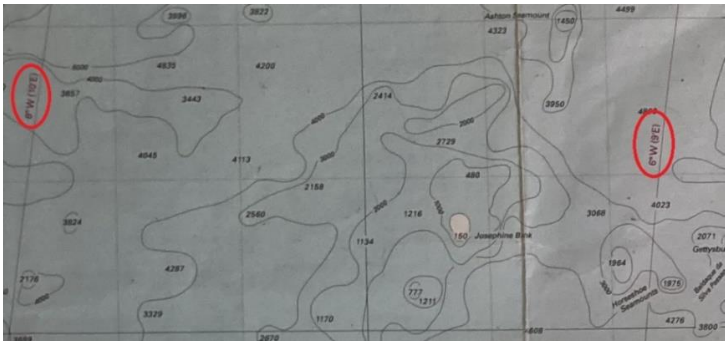


Fig. 2 - Variation on offshore charts.

Alternatively, the variation can also be read from magnetic variation charts or from the world magnetic model:

Calculating compass deviation

See: https://bluewatermiles.com/docs/deviation-card.pdf

Abbreviations and symbols used in the logbook

Abbreviations:

Comp. Course - Compass course in [º]

True Course - True course in [º]

Log - Distance run in [NM]

Speed – Average boat speed in [kn]

Position Fix - lat. & long. or location relative to nav. aids

Sails - sails set (e.g. J – Jib, M_{II} – mainsail second reef)

Motor - revolutions per minute [rpm] if operating engine (e.g. 1600)

Ship’s TZ - Time zone used on board (e.g. UT+1)

Wind Dir & Force – True wind direction and true wind speed in knots or Beaufort scale (e.g. NW 6)

Vis - visibility (e.g. 3, see visibility table)

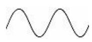
Baro - pressure at sea level measured by barometer in [hpa], rate of change is critical, not the absolute reading

Air / Sea Temp - air and sea temperature in Celsius degree

Symbols:

↑ set sails

↓ drop sails

 berth / moor

→ depart berth / mooring

⚓ anchor

 change course / tack

⊕ position fix obtained from GPS

+ position fix obtained without GPS

 estimated position (EP) / dead reckoning pos (DR)

strbd / port - starboard side / port side

Use other symbols as per „Symbols and Abbreviations used on Admiralty Paper Charts (NP5011)”

Marine Forecast Glossary

Marine forecasts contain a number of terms which are used to convey specific meanings.

Gale warnings

Gale	Winds of at least Beaufort force 8 (34-40 knots) or gusts reaching 43-51 knots
Severe gale	Wind force 9 (41-47 knots) or gusts reaching 52-60 knots
Storm	Wind force 10 (48-55 knots) or gusts reaching 61-68 knots
Violent storm	Wind force 11 (56-63 knots) or gusts of 69 knots or more
Hurricane force	Wind force 12 (64 knots or more)

Timing

Imminent	Expected within 6 hours of the time of issue
Soon	Expected within six to 12 hours of the time of issue
Later	Expected more than 12 hours from the time of issue

Visibility

Good	more than 5 NM
Moderate	2 NM to 5 NM
Poor	0.5 NM to 2 NM
Very poor	less than 0.5 NM

Movement of pressure systems

Slowly	Moving at less than 15 knots
Steadily	Moving at 15 to 25 knots
Rather quickly	Moving at 25 to 35 knots
Rapidly	Moving at 35 to 45 knots
Very rapidly	Moving at more than 45 knots

Pressure tendency in station reports

Rising (or falling) more slowly	Pressure rising (or falling) at a progressively slower rate through the preceding three hours
Rising (or falling) slowly	Pressure change of 0.1 to 1.5 hPa in the preceding three hours
Rising (or falling)	Pressure change of 1.6 to 3.5 hPa in the preceding three hours
Rising (or falling) quickly	Pressure change of 3.6 to 6.0 hPa in the preceding three hours
Rising (or falling) v. rapidly	Pressure change of more than 6.0 hPa in the preceding three hours
Now rising (or falling)	Pressure has been falling (rising) or steady in the preceding three hours, but at the time of observation was definitely rising (falling)

Wind

Wind direction	Indicates the direction from which the wind is blowing
Becoming cyclonic	Indicates that there will be a considerable change in wind direction across the path of a depression within the forecast area
Veering	The changing of the wind direction clockwise, e.g. SW to W. If Tropical Revolving Storm is approaching it will indicate a dangerous semicircle.
Backing	The changing of the wind in the opposite direction to veering (anticlockwise), e.g. SE to NE. If Tropical Revolving Storm is approaching it will indicate a navigable semicircle.

Sea State

Term	Wave height (m)
Smooth	< 0.50
Slight	0.50 – 1.25
Moderate	1.25 – 2.50
Rough	2.50 – 4.00
Very rough	4.00 – 6.00
High	6.00 – 9.00
Very high	9.00 – 14.00
Phenomenal	Over 14.00

Classification of Tropical Cyclones

Term	Wind speed (kn)
Tropical depression	< 34
Tropical storm	34 – 63
Hurricane	> 63

Category of Hurricanes (Tropical Revolving Storms) in the Saffir-Simpson wind scale

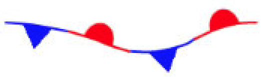
Category	Wind speed (kn)
1	64 – 82
2	83 – 96
3	97 – 113
4	114 – 134
5	> 134

Whilst all hurricanes have their origins in tropical depressions, not all tropical depressions become hurricanes. Of the 70 areas of tropical circulation that occur annually, less than 10% become hurricanes.

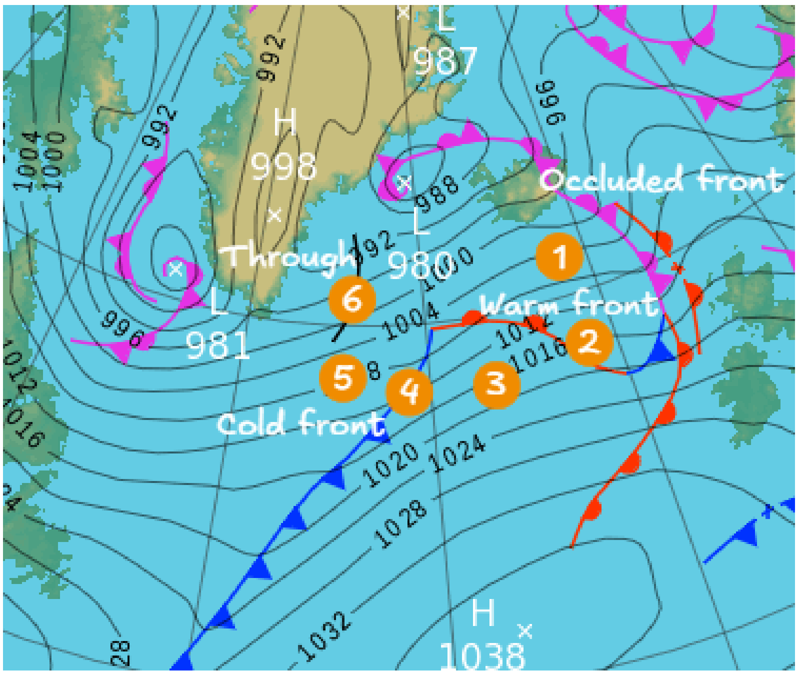
Source of weather information

- Own Ship
- VHF / MF / HF
- Navtex
- Sat-C SafetyNET
- Weather Fax
- Internet (weather services, info sent via email)
- Local forecasts posted in harbours

Symbols on Surface Pressure charts

Cold front		The leading edge of an advancing colder air mass. Its passage is usually marked by cloud and precipitation, followed by a drop in temperature and / or humidity
Warm front		The leading edge of an advancing warmer air mass, the passage of which commonly brings cloud and precipitation followed by increasing temperature and / or humidity
Occluded front		Occlusions from when the cold front of a depression catches up with the warm front, lifting the warm air between the fronts into a narrow wedge above the surface. Occluded fronts bring cloud and precipitation.
Stationary front		A front between warm and cold air masses that is moving very slowly or not at all.
Through		mark areas where the air is particularly unstable. This means that the air is quite turbulent or moving around a lot. Tend to bring showers. They don't mark any sort of boundary in the same way that a front does.

Passage of a Low / Depression



Element	1. Advance of Warm front	2. At the Warm front	3. Rear of warm front / In advance of Cold front	4. At the Cold front	5. Rear of Cold front	6. At the Through
Pressure	Falling steadily	Stop falling	Steady, then slowly falling	Sudden drop, then rising rapidly	Rising steadily	Falls slightly
Wind direction	Steady	Veers (backs in SH)	Steady	Veers (backs in SH), shifting	Steady	Veers (backs in SH)
Wind strength	Increasing, moderate	Steady, light to moderate	Steady, light to moderate, squally near the cold front	Increases, strong and gusty	Strong, decreasing later	Increasing, strong, gusty, squally
Temperature	Steady	Rises	Steady	Sharp decrease	Cool but steady	Steady
Cloud	Increasing, High cirrus clouds, then thickening to Cirrostratus and Altostratus and finally Nimbostratus	Low, thick clouds, Nimbostra tus	Scattered Stratus or Stratocumulus depending on stability of air, then Cumulus	Towering Cumulus and Cumulunimbus, Altostratus	Clearing skies, Cumulus, Altocumulus, Stratocumulus, Cirrocumulus	Cumulus, sometimes Cumulunimb us
Precipitation	Light rain increasing to moderate	Rais stops or changes to drizzle	Fair, drizzle or intermittent slight rain, heavy rain near cold front	Heavy rain or showers, possibly hail and thunderstorms	Clear conditions, isolated showers	Isolated showers
Visibility	Deteriorating	Poor, mist or fog	Moderate or poor, mist or fog	Poor	Good except in showers	Good except in showers

"Traditional" Navigation Primer

Convert True course (T) to Compass course (C)

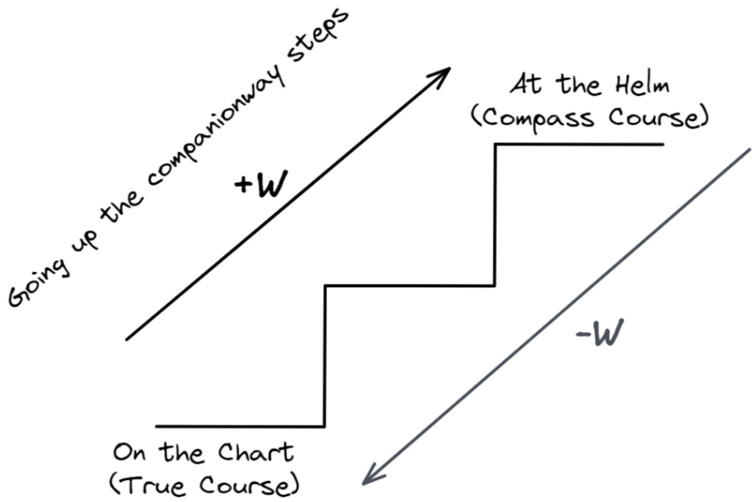
True course (T) ± Variation (V) = Magnetic (M) ± Deviation (D) = Compass course (C)

Apply a simple mnemonic to remember the formula:
True Virgins Make Dull Company + Whiskey (add westerly)

Deviation (D): effect of deflecting a compass by electrical equipment or metal. Read this off from the boat's deviation card. Since hand-bearing compasses are not used on a fixed position, no deviation table can be used to correct deviation errors. As a consequence, bearings should preferably be taken from deviation-free locations on the boat well away from electronic and metallic gear. Make sure to remove watch and metal frame glasses too. Remember that deviation is determined by the course you are sailing (heading), not the bearing. If you bear 015° but sail on 220°, read deviation for 220°.

Variation (V) - aka Magnetic Declination: the difference between the direction of true and magnetic north. Read this off from a chart's compass rose or isogonic lines (magenta-coloured, diagonal dashed lines on offshore charts).

You can apply a simple mnemonic to know which sign (+ or -) to use for deviation and variation when converting from True course to Compass course and vice versa:



If you are going from True Course (shown on the chart down below deck) to Compass Course (shown by the compass at the helm) then Westerly degrees are added, and Easterly subtracted. When going backwards the opposite logic applies.

Fig. 3 - Sign rule when converting courses from True to Compass and vice versa.

Example:

Input	**Solution**
True course (T): 40°	40° (T) + 3°W (V) - 2°E (D) = 41° Compass course (C)
Variation (V): 3°W Deviation (D): 2°E (read based on T+V = 43°)	

Convert Compass course (C) to True course (T)

Compass course (C) ± Deviation (D) = Magnetic (M) ± Variation (V) = True course (T)
(opposite logic to conversion from True to Compass)

Example:

Input	**Solution**
Compass course (C): 72°	72° (C) + 2°E (D) - 3°W (V) = 71° True course (T)
Deviation (D): 2°E (read based on C) Variation (V): 3°W	

Dead reckoning and Estimated position

Dead reckoning (DR) is a position derived just from the course steered and the distance the boat has travelled through the water. A more accurate variant of this is where the effect of leeway has also been taken into consideration.

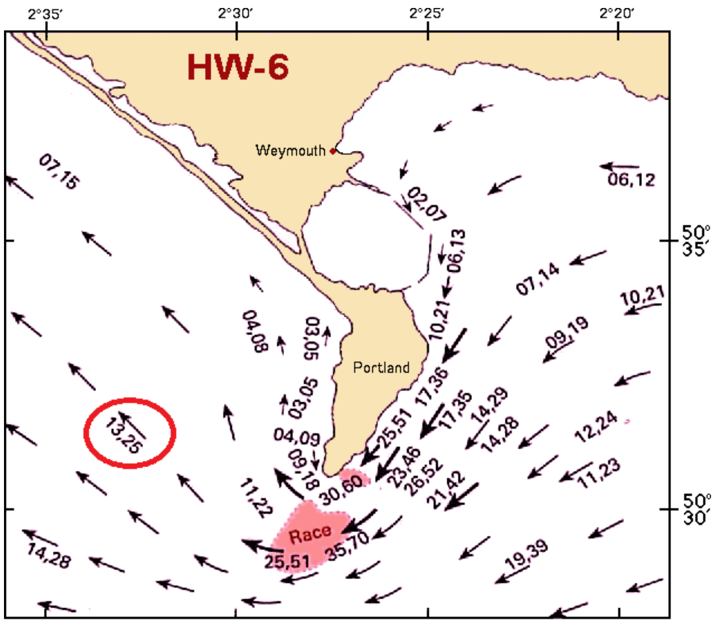
Estimated Position (EP) is DR with the tidal stream added on.

Leeway: angle between the direction of the boat's heading and the direction in which she is actually moving through the water as a result of being blown sideways (off course) by the wind. It does not change the heading of the boat therefore should always be applied at the end.

Tidal stream: in tidal waters read set (direction) and rate (speed) off from tidal diamonds on top of a chart or from a tidal atlas (see below). On the open ocean, the surface current is usually negligible, therefore we can skip the tidal stream.

Referred to high water (Eastbourne)									
	A 50° 42·3'N 0° 26·5'E			B 50° 53·0'N 1° 00·0'E			C 51° 01·0'N 1° 10·5'E		
Hours	Dir	Sp	Np	Dir	Sp	Np	Dir	Sp	Np
Before HW 6	248	0,8	0,4	213	1,6	0,9	224	0,9	0,5
5	067	0,5	0,3	214	2,1	1,2	239	1,0	0,6
4	068	1,9	1,0	215	1,8	1,1	235	1,1	0,6
3	071	2,6	1,5	213	0,9	0,5	242	0,6	0,4
2	069	2,3	1,3	S	l a	c k	S	l a	c k
1	068	1,2	0,6	033	0,8	0,5	052	0,6	0,3
HW	067	0,1	0,1	032	1,5	0,8	049	1,2	0,7
After HW 1	248	0,9	0,5	031	1,9	1,1	049	1,3	0,7
2	247	1,4	0,8	030	1,7	1,0	056	1,0	0,5
3	251	1,8	1,0	031	1,2	0,6	054	0,5	0,3
4	253	1,7	1,0	032	0,4	0,2	S	l a	c k
5	250	1,6	0,9	211	0,4	0,2	219	0,4	0,2
6	249	1,2	0,7	212	1,3	0,7	217	0,8	0,4

Fig. 4 - Example of a tidal stream on a nautical chart: 3h after HW Eastbourne, rate: 1.2kt at spring, 0.6kt at neap, set: 031°. Tidal diamonds are shown on nautical charts at locations where tidal stream information has been measured.



-6 Hours before HW Portland (01:45 after HW Dover)

Fig. 5 - Example of a tidal stream from tidal atlas: 6h before HW Portland, rate: 1.3kt at neap, 2.5kt at spring, set: 330°.

Tide tables: specify the times of each HW and LW for each day of the year for standard ports (larger ports or reference ports). You need to know the HW or LW before you enter the tidal stream table or atlas. Time is based on the standard time of the country concerned (noted on the tide table). When a daylight-saving scheme is in operation, an hour has to be added to the time shown in the tide table.

Times and heights of high and low waters — Standard port

January

	Time	m		Time	m
1 TU	05:10	0,9	3 TH	00:43	5,5
	11:26	5,8		06:45	1,0
	17:42	0,7		13:01	5,7
	23:54	5,6		19:20	0,8
2 W	05:56	0,9	4 F	01:35	5,3
	12:12	5,8		07:33	1,2
	18:30	0,7		13:53	5,6
				20:15	0,9

Fig. 6 - Example of a tidal table that gives the time and heights *of high and low waters for the standard port.*

It is not practical for publishers of tide tables to issue tides for every harbour for the entire year. Therefore the tide tables include calculations for "standard ports" only and the other ports' (secondary ports) tide times and heights can be calculated using adjustments from these standard ports. We can then use this newly calculated information to fill out the standard port's tidal curve. We then have our curve for the day set up for the secondary port.

Dead Reckoning (DR) procedure

Gives answer: Where we are based on the course steered and distance run. DR traditionally does not include leeway, but in practical navigation, we often account for it.

1. Calculate Water Track (T).

   Course Steered (Compass course C) ± Deviation (D) ± Variation (V) ± Leeway (L) = Water Track (T)

2. Plot the Water Track (T) on the chart from the last position and apply the distance travelled by the boat. The position drawn is the DR.

   Because there is no tidal stream: Water Track (T) == Ground Track (T) (aka COG)

Leeway rule for DR/EP:

- Wind coming from Port – Add (Plus), the boat was blown off the course in a clockwise direction
- Wind coming from Starboard – Subtract (Minus), boat blown off the course in an anticlockwise direction

Example:

Input	**Solution**
Compass course (C): 64° Speed: 4.2kt; Time: 0800 – 0900 (1h)	Distance run (log): 4.2NM (1kt == 1NM per hour)
Deviation (D): 1°W (based on C) Variation (V): 2°E Leeway (L): 5° port tack	Water Track (T) = 64° (C) - 1°W (D) + 2°E (V) + 5° (L) = 70°

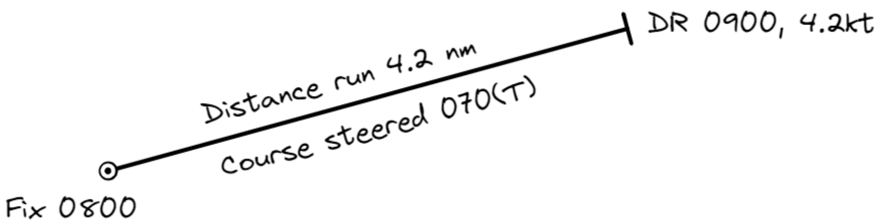


Fig. 7 – Dead reckoning (DR).

Estimated Position (EP) procedure (tidal waters)

Gives the answer to where we are based on the course steered, distance run and the tidal stream at that time.

Follow the DR procedure and add the following when a tidal stream is present:

3. From the end of the Water Track (T) (DR 0900) plot the Tidal Stream (read Set and Rate from tidal atlas or chart).
4. A line drawn between the Last Position (0800) and the end of the Tidal Stream is the Ground Track/COG/Course made good (T). The crossing point between the Tidal Stream and the Ground Track is the EP.

Example:

Input	Solution
Compass course (C): 64° Speed: 4.2kt Time: 0800 – 0900 (1h)	Distance run (log): 4.2NM (1kt == 1NM per hour)
Tidal stream: Set 160°, Rate 2kt Deviation (D): 1°W (based on C) Variation (V): 2°E Leeway (L): 5° port tack	Water Track (T) = 64° (C) - 1°W (D) + 2°E (V) + 5° (L) = 70° Ground Track (T) = 90° (measured on the Ground Track vector)

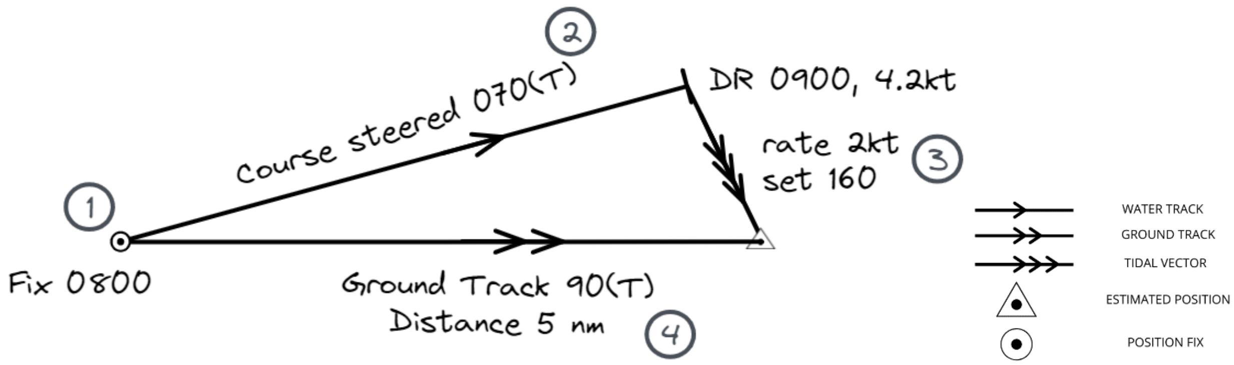


Fig. 8 - Estimated position.

Course to Steer (when there is no tidal stream)

Gives answer: What course the helmsman should steer to arrive at the intended waypoint.

1. Plot the required Ground Track (T) (aka Intended Track or COG) on the chart from the last position.
2. Calculate Course to Steer (Compass).

Water Track (T) ± Variation (V) ± Deviation (D) ± Leeway (L) = Course to Steer (C)
(opposite logic to DR)

If there is no tidal stream: Ground Track (T) == Water Track (T)

Leeway rule for Course to Steer (counteract the leeway):

- Wind coming from Starboard – Add (Plus), counteract boat blown off the course in clockwise direction
- Wind coming from Port – Subtract (Minus), counteract boat blown off the course in anticlockwise direction

Example:

Input	Solution
COG (T): 320°, no tidal stream Speed: 4.2kt Time: 0800 – 0900 (1h)	Distance to run (log): 4.2NM (1kt == 1NM per hour)
Leeway (L): 10° port tack Variation (V): 2°E Deviation (D): 7°W (based on T-V = 318°)	Course to Steer (C) = 320° (T) - 2°E (V) + 7°W (D) - 10° (L) = 315°

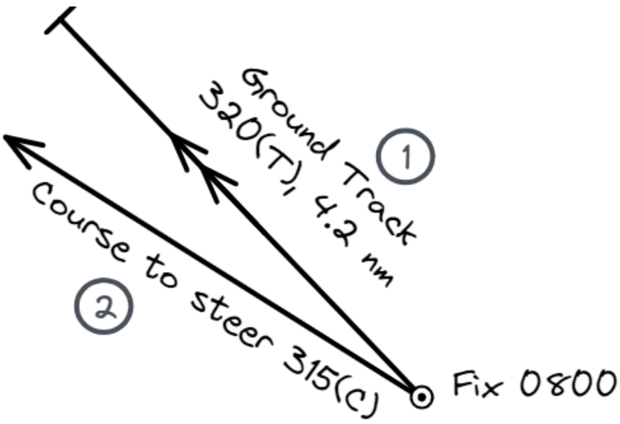


Fig. 9 - Course to steer in non-tidal waters.

Course to Steer (when there is a tidal stream)

Gives answer: What course the helmsman should steer to arrive at the intended waypoint.

1. Plot the required Ground Track (T) (aka Intended Track or COG) on the chart from the last position.
2. Plot the Tidal Stream from the starting point. Read Set and Rate from a tidal atlas or chart.
3. With dividers centered at the end of the Tidal Stream and a radius set equal to the anticipated speed, swing an arc to cut the Ground Track (Intended Track).
4. The line between the end of the Tidal Stream and the Intended Track is the Water Track (T).
5. Calculate Course to Steer (Compass) – use the above formula.

<u>Example:</u>

Input	Solution
COG (T): 320° Speed: 4.2kt Time: 0800 – 0900 (1h)	Distance to run (log): 4.2NM (1kt == 1NM per hour)
Tidal stream: Set 186°, Rate 1.8kt Leeway (L): 10° port tack Variation (V): 2°E Deviation (D): 7°W (based on T±V)	Water Track (T) = 310° (from plotting, points 1-4) Course to Steer (C) = 310° (T) - 2°E (V) + 7°W (D) - 10° (L) = 305°

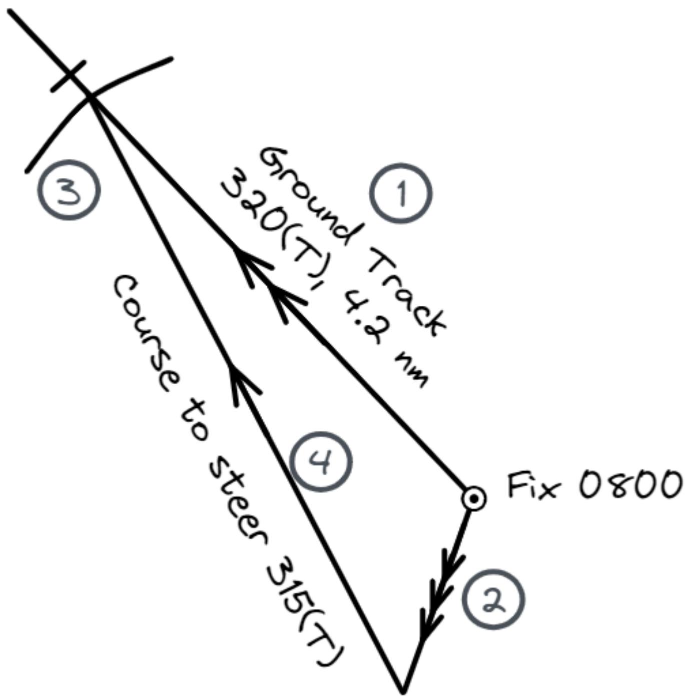


Fig. 10 - Course to steer in tidal waters

Fixing Positions without GPS (Coastal)

3 point fix: compass bearings to three separate marks gives a fix. It is unlikely that the three position lines will meet at one point, instead forming a triangle known as a cocked hat. Assume the closest point to danger and take another set of bearings if the triangle is large. If this does not help, consider the position poor and use a secondary method like range and bearing from radar.

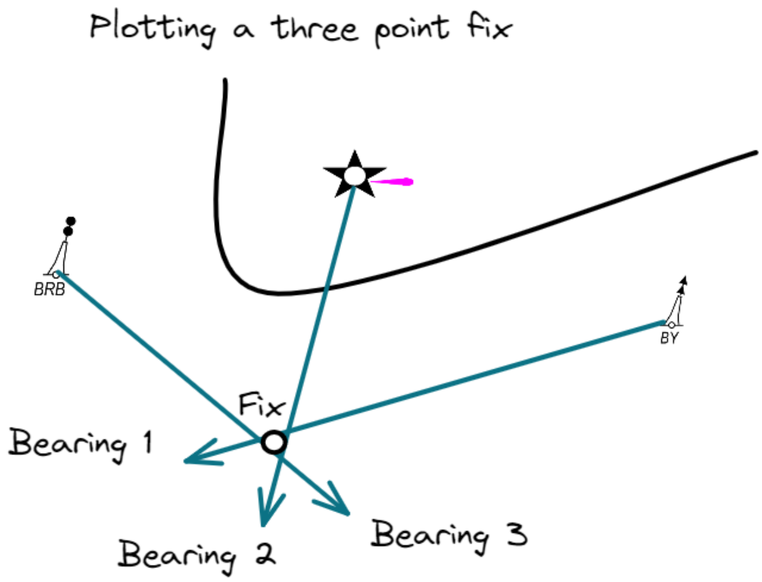


Fig. 11 - three-point fix.

Even two bearings can do but the more position lines the better.

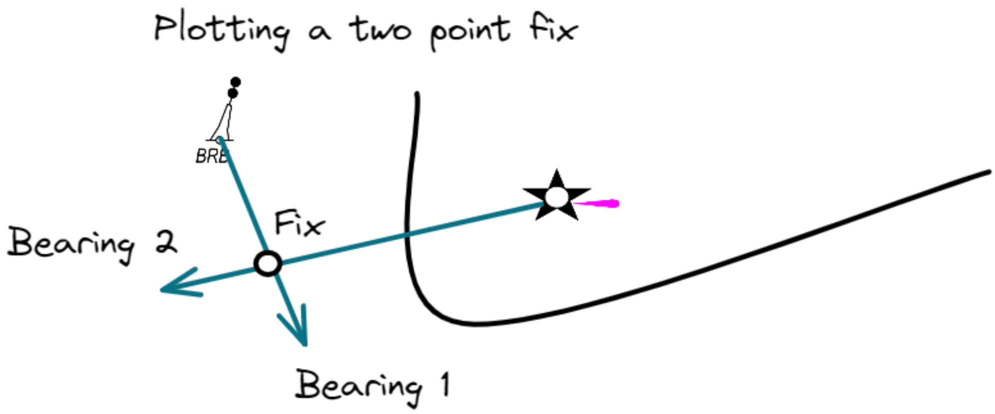


Fig. 12 - two-point fix.

Running fix (aka Transferred position line): estimating position based on one mark only.

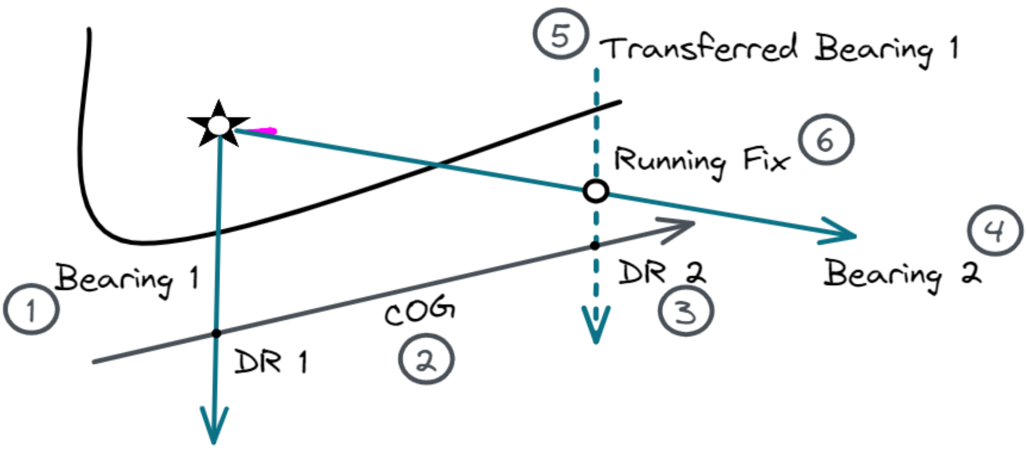


Fig. 13 - Running fix on a lighthouse.

Transit: two charted objects in line with one another, gives a transit. Two transits give a fix.

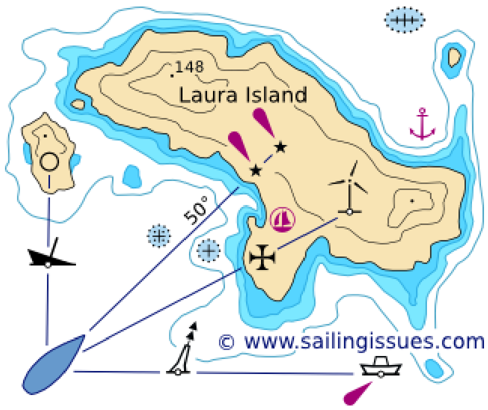


Fig. 14 - Charted transit lines: leading lights.
Uncharted *transit lines: church and wind turbine, north cardinal buoy and light vessel.*

Bearing and depth contour: compass bearing to a landmark with depth contour, gives a fix.

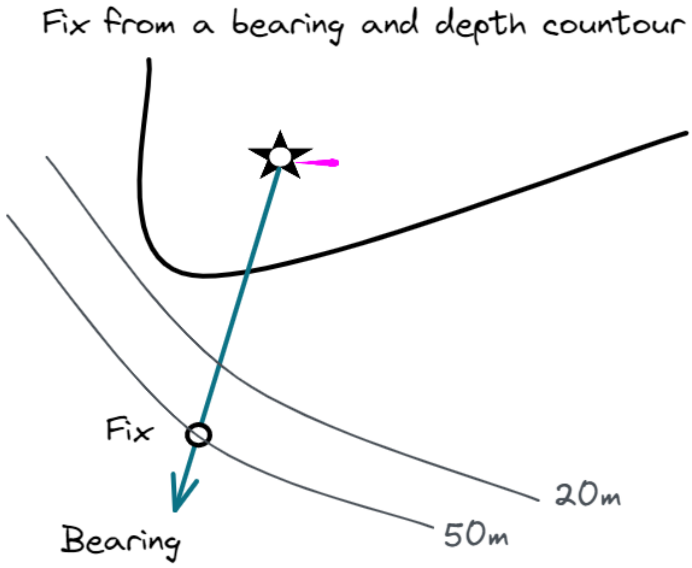


Fig. 15 - Lighthouse provides a position line from a bearing and the 50 metres depth contour help to fix the position (the tidal level needs to be taken into account!).

Clearing marks: this involves taking a bearing on an object which if exceeded or reduced will place you in danger.

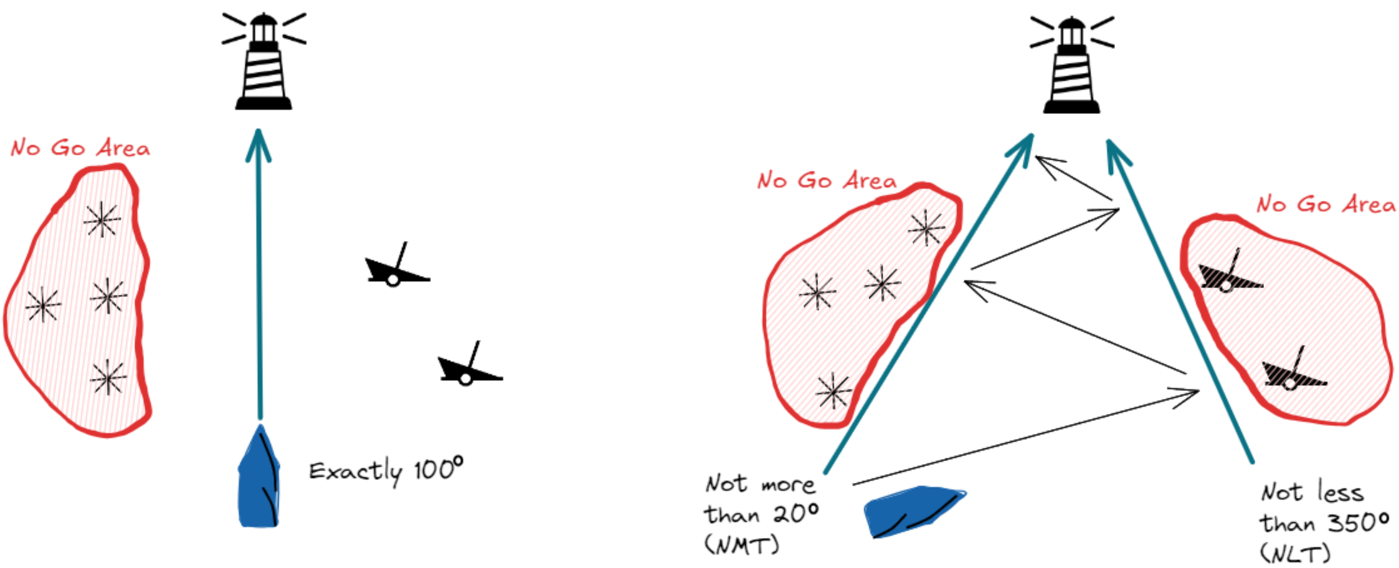


Fig. 16 – Clearing bearing (left), and Clearing marks (right)

Forward and back bearings: bearing to a fixed object can be made either astern or ahead. By keeping the object on this bearing we stay on a fixed safe line on the chart.

Fig. 17 - Forward and back bearings.

Vertical sextant angle (VSA) and bearing: range (distance) and compass bearing to a landmark, gives a fix. By measuring the vertical sextant angle between the top of a landmark of known height (e.g. lighthouse, peak of a mountain) and water, the distance can be read from a table (Norie's Nautical Table or Range by Vertical Sextant Angle table in Reeds Almanac) or calculated as below:

$$Distance\ off\ [NM] = \frac{1.852\ x\ height\ of\ object\ (in\ metres)}{\text{sextant angle (in minutes) corrected to height of eye}}$$

which comes from Trigonometric formula: *D = h x Cotag of sextant angle*

The elevation of charted objects can be found on nautical charts but these provide the elevation of a light (focal point of the light). Since we can only take sextant angle during the day we need to know the total height of the structure. This can be found in Admiralty List of Lights and Fog Signals.

The correction for the height of eye can be found in Norie's Nautical Table, Nautical Almanac or Reeds Almanac.

<u>Example</u>:

Input	Solution
Light characteristics: FL 6s 104m 27NM Vertical sextant angle: 2°30'	Take bearing to the lighthouse and measure the vertical sextant angle to get the distance off. $Distance\ off\ [NM] = \frac{1.852\ x\ 104m}{150\text{min}} = \sim 1.3NM$

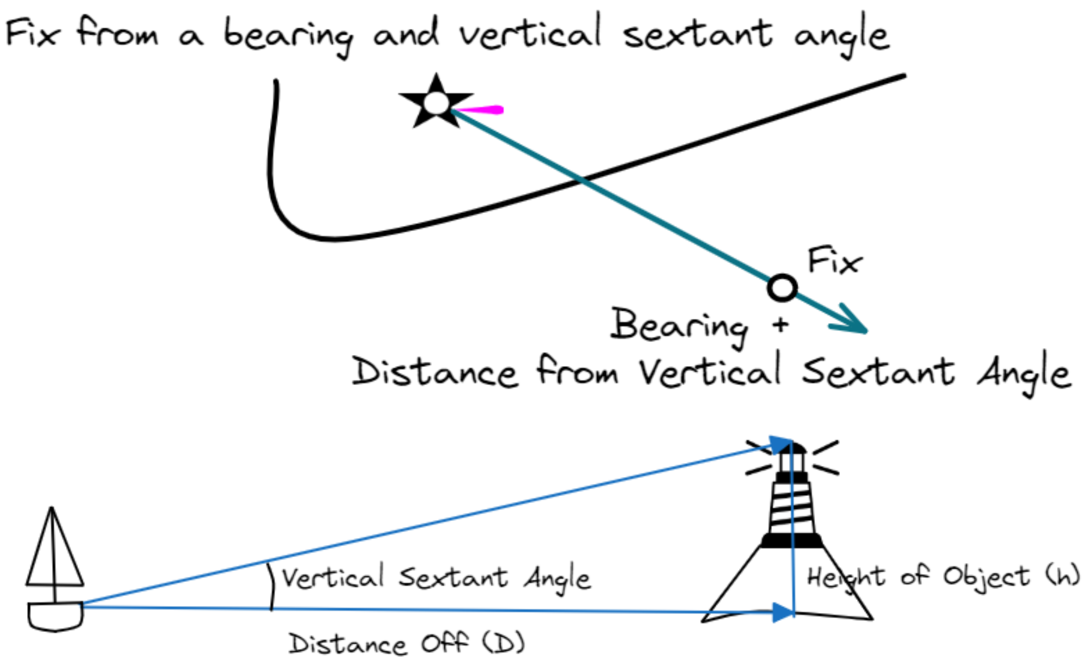
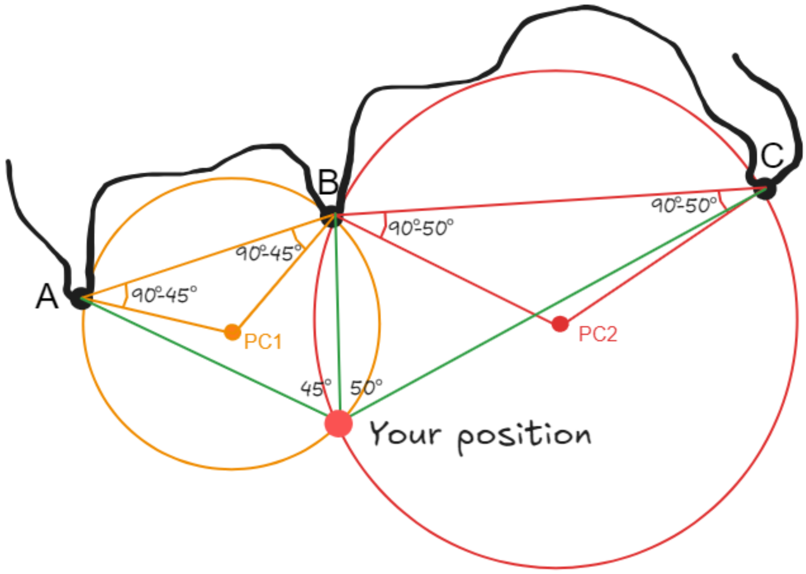


Fig. 18 - Bearing and distance from vertical sextant angle.

Horizontal sextant angle (HSA): this method requires two horizontal sextant measurements and three landmarks. It is highly accurate, but for precise results, the vessel should remain stationary or moving very slowly in the water. To determine your position, use a sextant to measure the angles between landmarks A and B, and B and C. The position can then be found using a station pointer or by resolving it geometrically on a nautical chart, as described below.

<u>Example</u>:

Input	**Solution**
HSA(A-B) = 45° HSA(B-C) = 50°	diff(A-B) = 90° – HSA(A-B) = 90° – 45° = 45° diff(B-C) = 90° – HSA(B-C) = 90° – 50° = 40° 1. Draw a straight line between points A and B. 2. Use a protractor to measure and mark the angle diff(A-B) on both sides of the A-B line. 3. The intersection of these two lines is the center of the first position circle (PC1). 4. Using a compass, draw a circle centered at PC1 so that it passes through points A and B. 5. Repeat the same process for points B and C to determine the center of the second position circle (PC2). 6. Your position is at the intersection of the two position circles (PC1 and PC2). 

Bearing and distance from rising or dipping (Horizon Ranges / Dipping Distance): compass bearings to a landmark with range (distance) to it, gives a fix. This is especially useful for landfalls. If a landmark is observed to be just rising above (when coming towards it) or just dipping below (when sailing away from it) the visible horizon, its distance (Geographical range) can be calculated:

$$\text{Geographical Range } [NM] = 2.08 \cdot \sqrt{\text{Eye } height\ (in\ metres)} + 2.08 \cdot \sqrt{\text{Object height (in meters)}}$$

$$\text{Distance of Horizon} = 2.08 \cdot \sqrt{height\ of\ object\ or\ observer\ (in\ metres)}$$

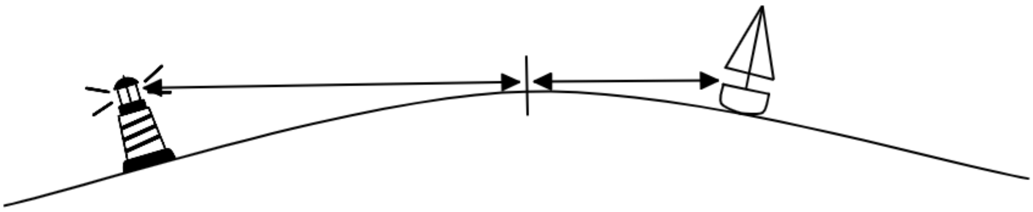


Fig. 19 - Bearing and distance from rising or dipping.

The "Geographical Range" is just a function of the curvature of the earth and is determined solely from the heights above sea level of the light itself and of the observer's eye. The geographical range can also be read directly from the Geographical Range table, so long as it is a nice clear day. Alternatively, use the Distance of Horizon table that you can find in Norie's Nautical Tables or Reeds Almanac and simply sum the distance to the horizon for the observer and the object.

Example:

Input	Solution
Height of eye: 2m Visibility: good Landmark height: 40m	2.9 NM distance of horizon for the height of eye 2m +13.2 NM distance of horizon for landmark height 40m Geographical range = 16.1 NM

At night you can use the same calculations to raise or dip a light. However, the light's intensity (its luminous range) might be greater or smaller than its geographical range. The "Visible Range", the distance that you will likely see the light is ALWAYS equal to the lesser of the Luminous Range or Geographic Range:

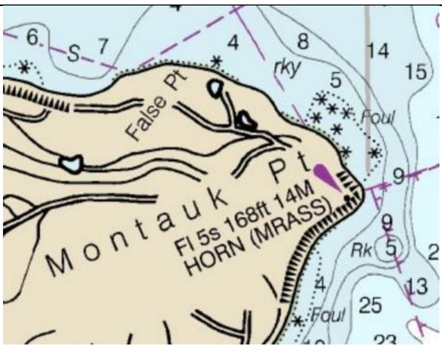
If Luminous range >= Geographical range, then use Geographical range
(on the approach, the light loom in the sky above the horizon would first be observed. At the moment that the light itself shines clear over the horizon, the dipping/raising distance is reached)

If Luminous range < Geographical range, then use Luminous range

A light's "Luminous Range" is an approximation of the maximum range at which an observer can see a light under existing meteorological conditions. This luminous range ignores all other considerations that may affect the visibility of the light such as but not limited to: background lighting, the elevation of the light, and the observer's height of eye. It can be read from the Luminous Range table (see below) based on the landmark's Nominal Range and the existing meteorological visibility.

The "Nominal Range" is the maximum distance at which a given light may be seen in "clear weather." (Clear weather is defined as meteorological visibility of 10 nautical miles). It is equal to the Luminous Range (explained below) when in a homogenous atmosphere a meteorological visibility of 10 NM exists. The Nominal Range of any given light is shown on and can be read directly from nautical charts and is also given in the "List of Lights" publications. On a clear nigh it may shine further and on a hazy night less far. Lights with a range of less than 10 NM will often merge into other lights on the shore.
For sector lights, the general practice is for coloured sectors to indicate danger and white sectors safe passages. Generally, if a light shows a white safe sector with red and green sectors on each side, the green sector is to starboard and the red to port. However, this rule is not universal and should be checked for each light. Some lights are directional, that is, they show brightly over a very narrow sector and sometimes faintly outside the sector.
Example:

Input	Solution
Height of eye: 2m Visibility: 20NM (approximate, hard to estimate) Light: Fl 5s 168ft 14M (height 51m) *(flashing white light with a period of 5 seconds 168ft / 51m high – focal point of light, and 14 miles nominal range, in meteorological visibility of 10 nautical miles)*	2.9 NM distance of horizon for height of eye 2m +14.8 NM distance of horizon for height 51m Geographical range = 17.7NM Luminous range = 22 NM *(from the luminous range diagram: light with a nominal range of 14 NM - the top of the table, 20 miles visibility - on the curved line, read* luminous *range on the left)* Luminous range >= Geographical range therefore the light should raise or dip from ~18NM. The loom of the light should be visible from 22NM. 

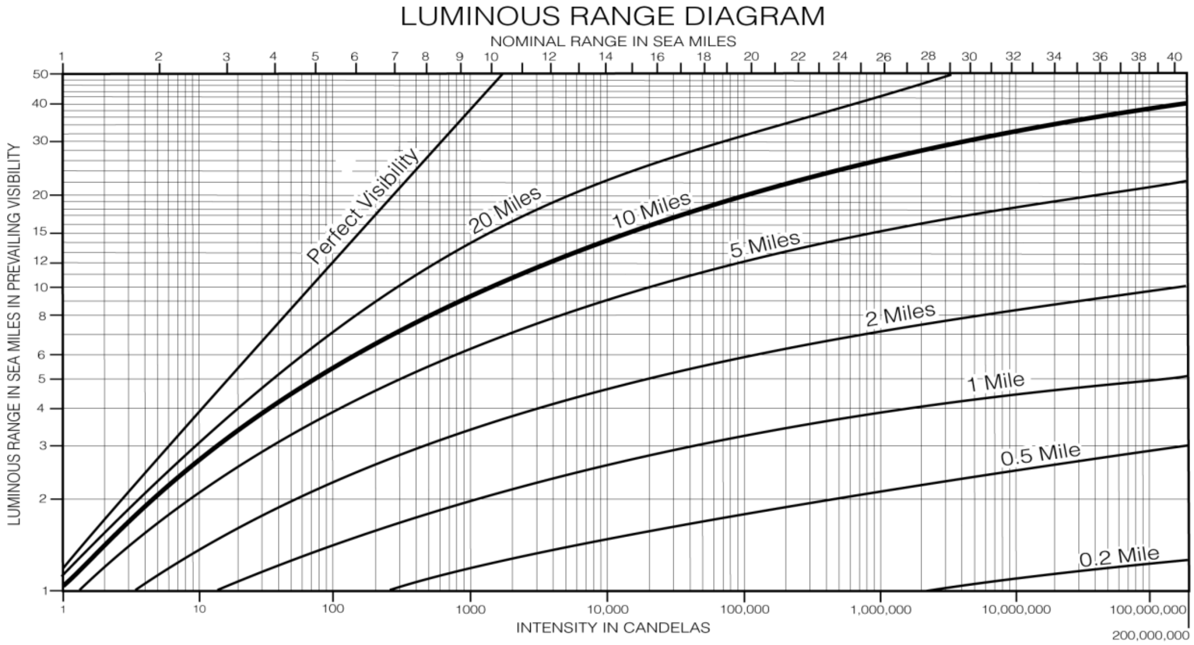


Fig. 20 - Luminous range diagram.

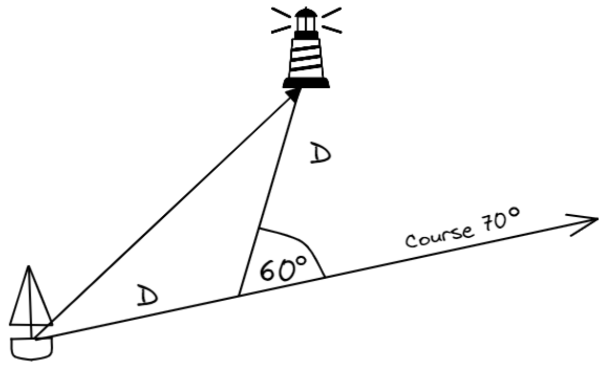
Distance-off by doubling the relative bow bearing: it is a simple method of finding a distance-off a mark by measuring the distance travelled while the relative bearing (right or left) of a fixed object doubles. The distance from the object at the time of a second bearing is equal to the distance run between the bearings. The fix requires the first bearing to be less than 45º from the bow.

You can use this technique when the mark is already passed by taking the second bearing at half of the first relative bearing instead of double. This will give the distance-off at the time of the first bearing.

You can also use a similar method to predict the distance-off when the mark will be abeam before you reach it. Instead of using the double bearing, certain combinations of relative bearings can be used: 20º/30º, 22º/34º, 25º/41º, 26.5º/45º, 27º/46º, 29º/51º, 32º/59º, 35º/67º, 37º/72º, 40º/79º, 43º/86º, 44º/88º, 45º/90º. In each of these bearing combinations, the distance-off when the mark will be abeam is equal to the distance run between them.

Example:

Input	**Solution**
Steering course (S): 70º Speed: 5kt First bearing to a lighthouse (A): 60º (absolute). Relative bearing from bow to the lighthouse: 70º (S) - 40º (A) = 30º Next, the boat is run until the relative bearing to the lighthouse doubles: 70º (S) - 20º (A) = 60º (it has to bear 20º absolute) Time difference between bearings: 30min	$Distance\ of\ lighthouse\ at\ the\ second\ bearing:$ $\mathrm{D} = \frac{\mathrm{Speed\ [kt]} \cdot Time\ [min]}{60} = \frac{5 \cdot 30}{60} = 2.5\ [\mathrm{NM}]$



7/10 and 7/8 rule: can be used to predict distance-off when the sighted object is abeam.
In the 7/10 rule, if the first relative bearing is 22.5° and the second is 45°, the distance-off when the object is abeam is 0.7 the distance run between the first two bearings. In the 7/8 rule, the two bearings are 30° and 60°. When the object is abeam, the distance-off is 0.875 the distance run.

Estimating distance-off shore: if you can count individual trees, you are about 1 NM offshore. If you can count windows on waterfront houses, the distance off is about 2 NM. And if you can see the junction line between land and water, you are about 3 NM away.

The Rule of 60: can be used to estimate a safe course around a hazard that lies at a distance dead ahead. The method is accurate to within 5° and works only when short distances are involved. However, even if off by a couple of degrees, it provides an extremely quick solution.

$$\text{Course alteration} = \frac{60 \cdot desired\ distance\ off\ [NM]}{\text{distance ahead [NM]}}$$

For example, sailing on a course of 185°, the boat is headed right at a reef 6 miles ahead. The safest passage around the reef is 2 miles to the side from its centre. The safe course around the reef is 20° to either side of the present course (either 165° or 205°):

$$\text{Course alteration} = \frac{60 \cdot 2}{6} = 20^o$$

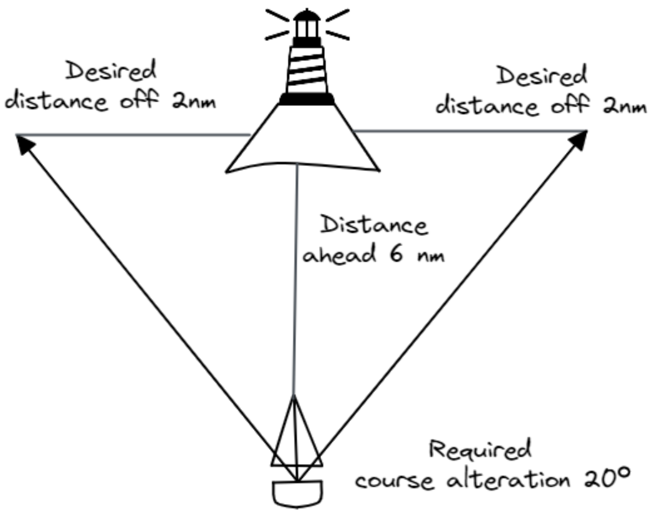


Fig. 21 – Graphical representation of the Rule of 60.

Radar ranges and bearing: you can make a fix to known charter objects (preferably lighthouses, other buildings, or headlands) using radar range rings (VRM - Variable Range Marker) to at least two such charter objects. While radar ranges are generally more accurate than radar bearings (ELB - Electronic Bearing Line), accurate only to within 3 to 5 degrees, bearing fixes can be made using the bearing much the same way that they are made with a compass. Range and bearing fixes can be made with just one charter object by determining both your range and your bearing to a charted object at the same time.

Pilotage in restricted visibility: by knowing the current height of tide we can pick a depth contour that keeps us safely off dangers and leads out towards our destination (aka "blind navigation").

If the visibility is poor or there is no conspicuous object to keep a bearing on, take a course to intercept a safe depth contour. Once the depth has been reached turn onto the general heading which the contour follows. This should bring you within sight of the harbour entrance.

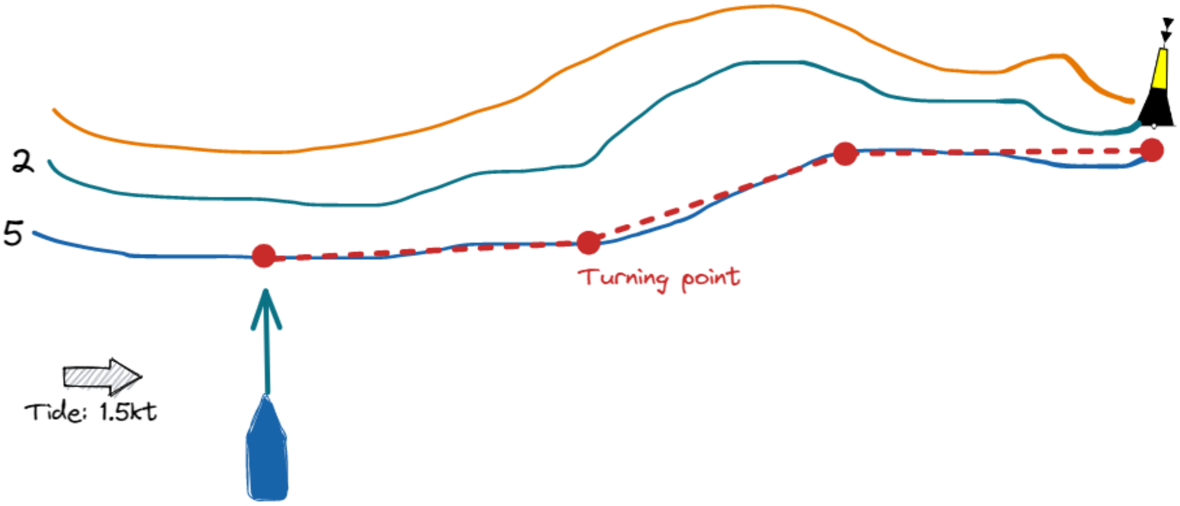


Fig. 22 - Navigating in restricted visibility using "Blind" navgiation.

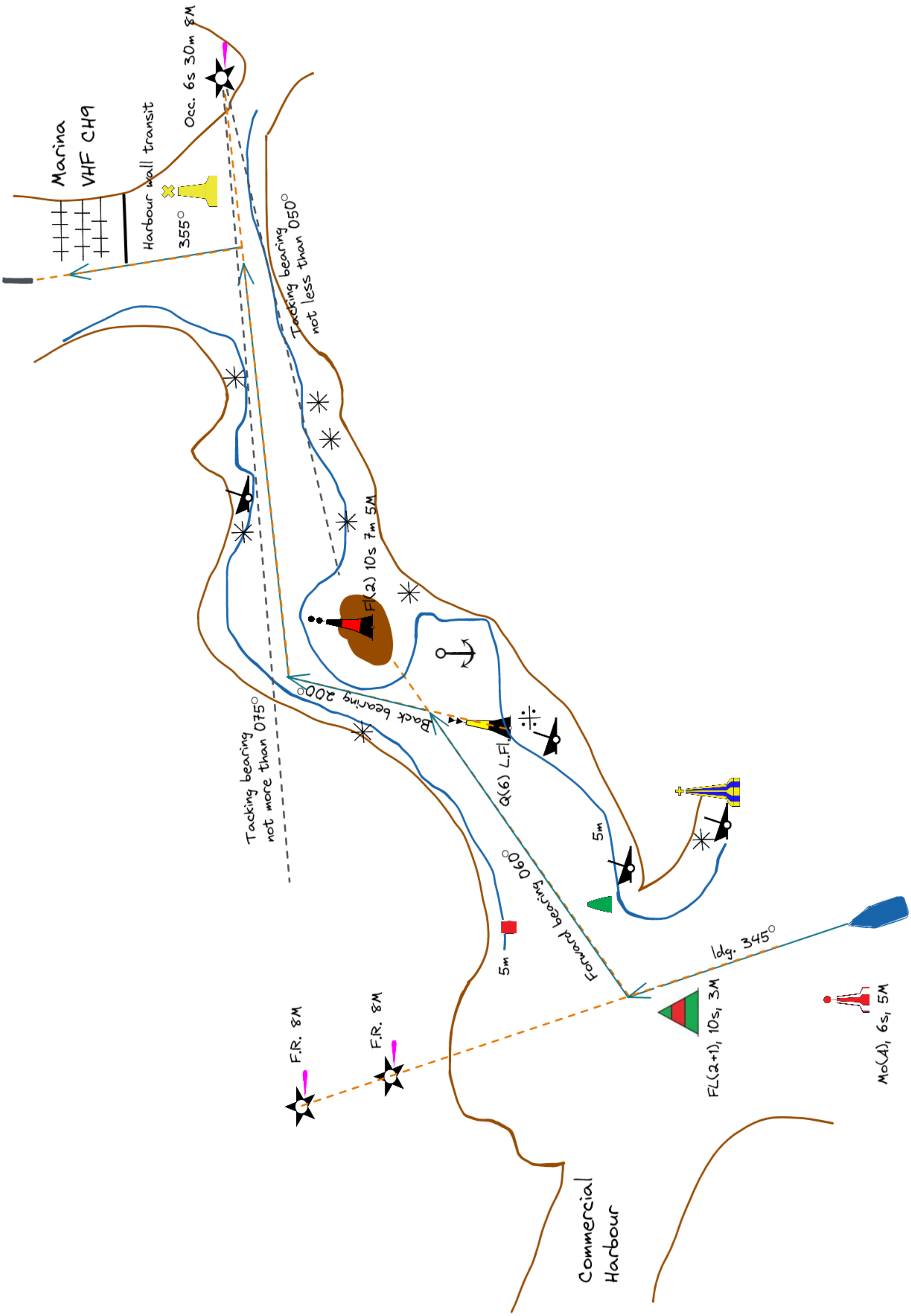
Keeping a navigational log and plotting the yacht's position on the chart is vital.
Apply the **6 minutes rule**. For example, if the yacht is travelling along at 6kt, in 6 minutes the yacht would have done a tenth of the current boat speed which is 0.6nm.

<u>Example:</u>

Tidal stream: set 090°, rage 1.5kt
Height of tide: 3m
Draught: 2.5m
Depth sounder callibrated for the end of the keel
Deviation (D): 1°W (0° to 90°)
Variation (V): 4°W
Destination: south cardinal buoy (see picture above)

Time [min.]	Trip [NM]	Course [o]	Depth [m]	SOG [kt]	Notes
0	0.0	030° T = 035° C (skipped tidal stream)	15.1	4.5	050°47'.1 N 001°10'.2 W Keep until 5.5m depth is read: 5m depth + 3m height of tide - 2.5m draught
6	0.6 (4.5kt SOG + 1.5kt tide = 6NM in 60min = 0.6NM in 6 min = 0.3NM in 3 min etc.)	085° T = 090° C	5.5	4.5	5m contour reached, turning to starboard
3	0.3	075° T = 080° C	5.6	4.5	Turning 10° to port
3	0.3	095° T = 100° C	5.4	4.5	Turning 20° to starboard
3			5.5		South cardinal sighted to port

Example of Pilotage Plan



Fixing Positions without GPS (Offshore)

Celestial navigation (aka astronavigation) is a method of position fixing out of sight of land. It uses "sights", or angular measurements taken by sextant between a celestial body (e.g. the Sun, the Moon, a planet, or a star) and the visible horizon. The sights can be taken when both the celestial object and the horizon are visible (during daylight or twilight).

A handy guide to measuring angles in the sky:

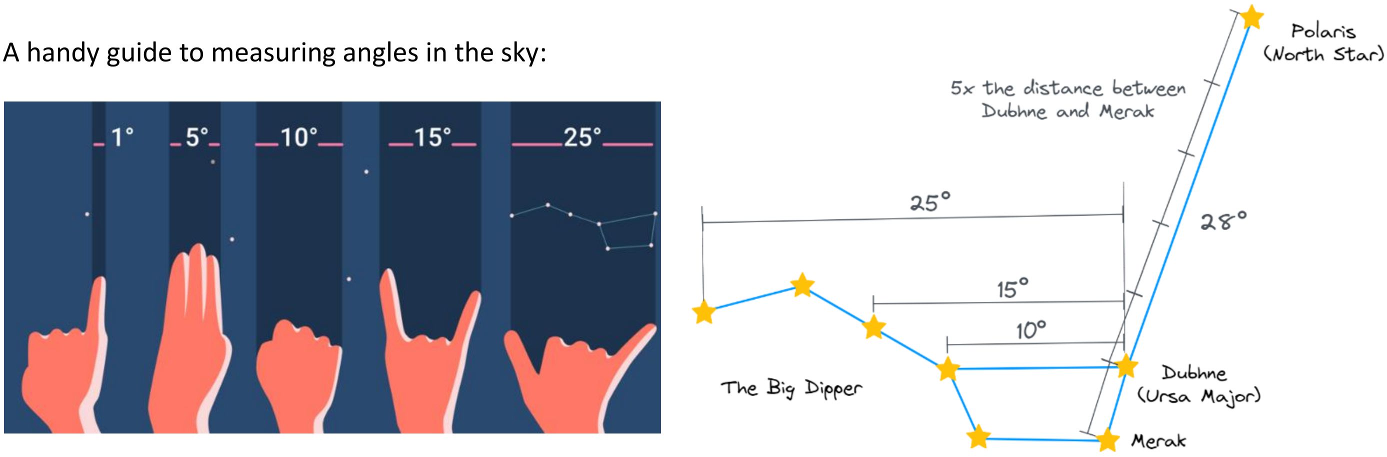


Fig. 23 - Simple methods to measure angles in the sky.

Performance

VMG (Velocity Made Good) indicates the speed of a boat towards (or from) the direction of the wind. It can be used to find the optimal angle to the wind to reach the destination. At optimal speed and wind direction, VMG is maximized (the higher the VMG the better). VMG is available in most marine navigation apps given GPS and wind instruments are connected. VMG can be calculated using the below formula:

$$\mathrm{VMG} = \mathrm{SOG} \cdot \cos(\theta)$$

$$\textit{gives boat speed in knots towards/from the direction of the wind,}$$
$$\textit{where } \theta \textit{ is the angle between the true wind direction and the boat's heading}$$

Example:

$\boldsymbol{\theta}$	**SOG**	**VMG [kt]**
55°	4.0	2.3
60°	5.0	2.5
65°	5.2	2.2

To reach the destination in the fastest time sail on course 60°.

Date: 16.09.2021 **Day of Week:** Thursday **Ship's TZ:** UT **From:** Cowes **Towards:** Falmouth

		Navigation					The Boat		Weather					
Watch No.	Time	Comp. Course	True Course	Speed	Log	EP / Position Fix	Sails	Motor	Wind Dir & Force	Sea State	Cloud Cover	Vis	Baro	Air / Sea Temp
1	0100													
1	0200													
1	0300													
1	0400													
2	0500													
2	0600													
2	0700													
2	0800	/	/	4.0	/	→ 0832 Cowes, depart for Falmouth	-	1600	/	2	1	3	2013	12°/16°
3	0900	250	245	5.1	2	Pilotage out of Cowes	J,M	/	NE 12	2	1	3	2013	13°/16°
3	1000	250	245	5.3	7,1	1050 Yarmouth abeam port	J,M	/	NE 15	2	1	3	2012	13°/16°
3	1100	250	245	6.6	12,4	1120 Hurst Pt. strbd	J,M_I	/	NE 18	3	1	3	2012	14°/16°
3	1200	250	245	6.6	19,0	⊕ 50°44.2N 001°08.2W	J,M_I	/	NE 19	3	1	3	2012	13°/15°
1	1300	240	234	6.6	25,6	/	J,M_I	/	NE 18	3	1	3	2012	14°/15°
1	1400	240	234	5.2	32,2	⊕ 50°44.2N 001°08.2W	J,M_I	/	NE 16	4	1	3	2011	16°/15°
2	1500	240	234	5.0	37,4	/	J,M_I	/	NE 14	4	1	3	2011	16°/14°
2	1600	240	234	5.0	42,4	⊕ 50°44.2N 001°08.2W	J,M	/	NE 14	4	1	3	2011	16°/14°
3	1700	240	234	5.0	47,4	(3 p. fix) 50°30.2N 002°09.6W	J,M	/	E 15	4	2	3	2011	15°/13°
3	1800	265	270	5.0	52,4	△ 50°25.7N 002°26.1W Portland Lt. to strbd	J,M	/	E 15	4	2	3	2012	15°/13°
3	1900	265	270	5.0	57,4	/	J,M	/	E 15	3	2	3	2012	15°/12°
3	2000	265	270	5.0	62,4	△ 50°22.1N 002°38.2W	J,M	/	E 16	3	2	3	2012	14°/11°
1	2100	265	270	5.0	67,4	+ 2005 50°21.7N 002°41.4W	J,M	/	E 16	3	2	3	2012	13°/11°
1	2200	265	270	5.0	72,4	△ 50°16.6N 002°52.8W	J,M	/	E 14	3	2	3	2012	12°/11°
1	2300	265	270	5.0	77,4	/	J,M	/	E 14	3	2	3	2012	11°/11°
1	2400	265	270	4.5	81,9	(3 p. fix) 50°08.2N 003°02.3W	J,M	/	E 12	3	2	3	2012	11°/11°

Sailed	Sail hours	Engine hours	Night hours	Distance [NM]
Today	17	1	0	81.9
Transferred	22	4	5	92.1
Total	39	5	5	174

Deviation from deviation card. Leeway estimated.
Variation: 2°W
Notes:
1500 VHF Weather Forecast:
Wight NE4, moderate, Portland E4, moderate, showers

1820 Bildges check, deck walk – OK
1950 Nav. lights ON

Additional notes

0700 Safety Briefing

0845 ↑ J,M

0910 Practice MOB

Course to steer: 245° (T) + 2°W (V) - 1°E (D) + 5° (L, strdb tack) = 251° (C) ~ 250° (C)

1055 Consumables: Water 100% (tank 1), 100% (tank 2), 32/34 (bottles); Fuel: 100%; Battery: 12.6 Ah

1100 Put reef I on Main

1300 corrected course to 240° (C)

True course: 240° (C) + 1°E (D) - 2°W (V) - 5° (L, strdb tack) = 234° (T)

15:40 Shaked out reef I on Main

1610 Dophin spotted on port side

1710 ⁄\↘ Gybed, 265° (C)

True course: 265° (C) + 2°E (D) - 2°W (V) + 5° (L, port tack) = 270° (T)

1600 Noted GPS position and switched to traditional navigation for training purposes

Dinner at sunset

2005 + (star sights) 50°21.7N 002°41.4W

2330 Consumables: Water 90% (tank 1), 100% (tank 2), 28/34 (bottles); Fuel: 100%; Battery: 12.5 Ah

Date: .... **Day of Week:** .... **Ship's TZ:** .... **From:** .... **Towards:** ....

		Navigation					The Boat		Weather					
Watch No.	Time	Comp. Course	True Course	Speed	Log	EP / Position Fix	Sails	Motor	Wind Dir & Force	Sea State	Cloud Cover	Vis	Baro	Air / Sea Temp
	0100													
	0200													
	0300													
	0400													
	0500													
	0600													
	0700													
	0800													
	0900													
	1000													
	1100													
	1200													
	1300													
	1400													
	1500													
	1600													
	1700													
	1800													
	1900													
	2000													
	2100													
	2200													
	2300													
	2400													

Sailed	Sail hours	Engine hours	Night hours	Distance [NM]	Deviation from deviation card. Leeway estimated. Variation: .... Notes:
Today					
Transferred					
Total					

Additional notes