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With thanks to Martin Paget, NZ Police.

CREATIVE COMMONS

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Welcome

The marine environment poses particular challenges for the search and rescue sector, requiring personnel with specialist skills. New Zealand has an extensive and varied coastline, and our search and rescue region covers over 30 million square kilometres of the Pacific and Southern Oceans. Nearly half our search and rescue operations each year are water and marine related.

This course is one component of the training available to ensure New Zealand has effective SAR services for people in distress in the marine environment.

Marine SAR Technical is a foundation course, developed to provide you with the technical competencies for chart work, plotting and associated calculations.

This is a stand-alone course, but is also designed as a pre-requisite for further training in marine incident management.

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Introduction

1. On the NZSAR website (<http://nzsar.org.nz/Knowledge-Training/Start>) there is related video information that you need to have viewed, and a downloadable self marking knowledge check-test that is to be completed before attending the training day.
2. It is strongly recommended that, as the tutor explains each topic, you supplement the following notes with your own written information. You will then have a handy reference for the future.

YOUR LEARNING OUTCOMES

Overall, by the end of the training you will be able to:

1. Read and interpret New Zealand marine charts for SAR planning purposes.
2. Accurately plot positions on the chart using navigation charting instruments.
3. Calculate Time/Speed/Distance.
4. Plot courses, directions and distances on charts.
5. Locate relevant information relating to tidal movements using tide predictions from Land Information NZ and tidal diamonds.
6. Use Leeway tables to calculate the leeway effect on any identified target.
7. Identify the relationship between Sweep Width and Track Spacing to calculate Coverage Factor.
8. Plot a Search Area Determination and understand the calculations relating to Total Drift Vector length.
9. Plot a Search Area Determination for the different plotting scenarios of LKP(target adrift) –Track line Overdue –Position Uncertainty –Time uncertainty.
10. Identify Probability of Detection using Coverage Factor, understand the relationship between single searches and multiple searches and the effect of different asset types or heights of eye.
11. Understand and explain the relationship between Search Area, Time, Velocity and Track Spacing.

TRAINING TIMETABLE

During the training day you will take part in practical exercises that will allow you to progressively practice your skills and knowledge with the assistance of your tutor and the support of the others in the course.

At the end of the day you will be given an exercise to complete on your own. This will form the assessment for the course.

Please note there is a pre-course requisite. You need to view the two Marine SAR videos (SAD, SAC) and completed the related online tests before attending the training day.

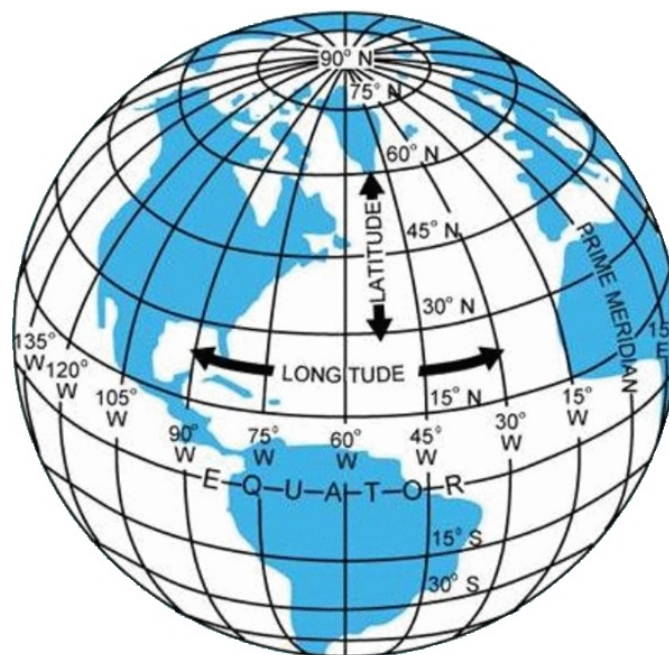
SER	TIME	ACTIVITY
1	0800-0815	Welcome and introductions.
2	0815-1030	Review of pre-course work, Charts, Plotting Positions, Calculations, Plotting Courses.
		Morning Tea
4	1100-1230	Tides, Leeway, Coverage Factor
		Lunch
8	1330-1430	SAD, SAC, POD, ATVS
9	1430-1515	Assessment
		Afternoon Tea
10	1530-1600	Wrap up
11	1600-1645	Re-assessment if needed.

Reading and Interpreting Marine Charts

Because latitude lines are parallel the only measurement to be sure of is between those lines.

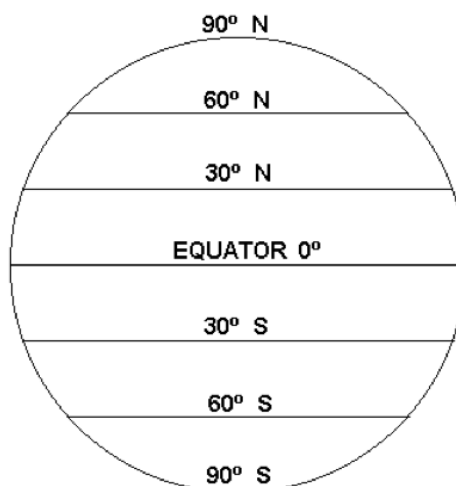
Lines of latitude stretch for 360° horizontally around the Earth.

Longitude lines narrow as they get closer to the North and South Poles.



There is:

- 90° of latitude between the Equator and the North or South Pole.
- 180° of latitude between the North Pole to the South Pole.



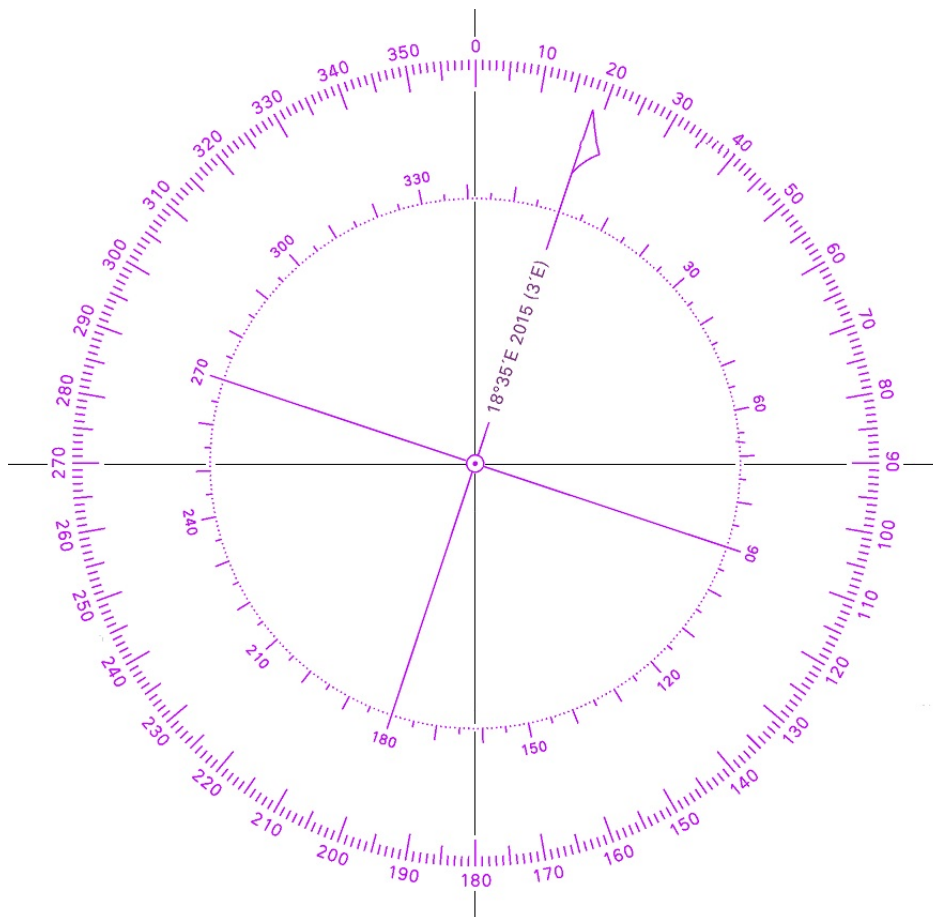
1° of latitude is equal to 60 nautical miles.

There are 60 minutes in each degree.

1 minute of latitude is equal to 1 nautical mile.

Note: A coordinate is read out as: degrees and minutes then seconds.

A compass rose is a figure that is printed onto a chart. It shows North, East, South, and West and the intermediate points.



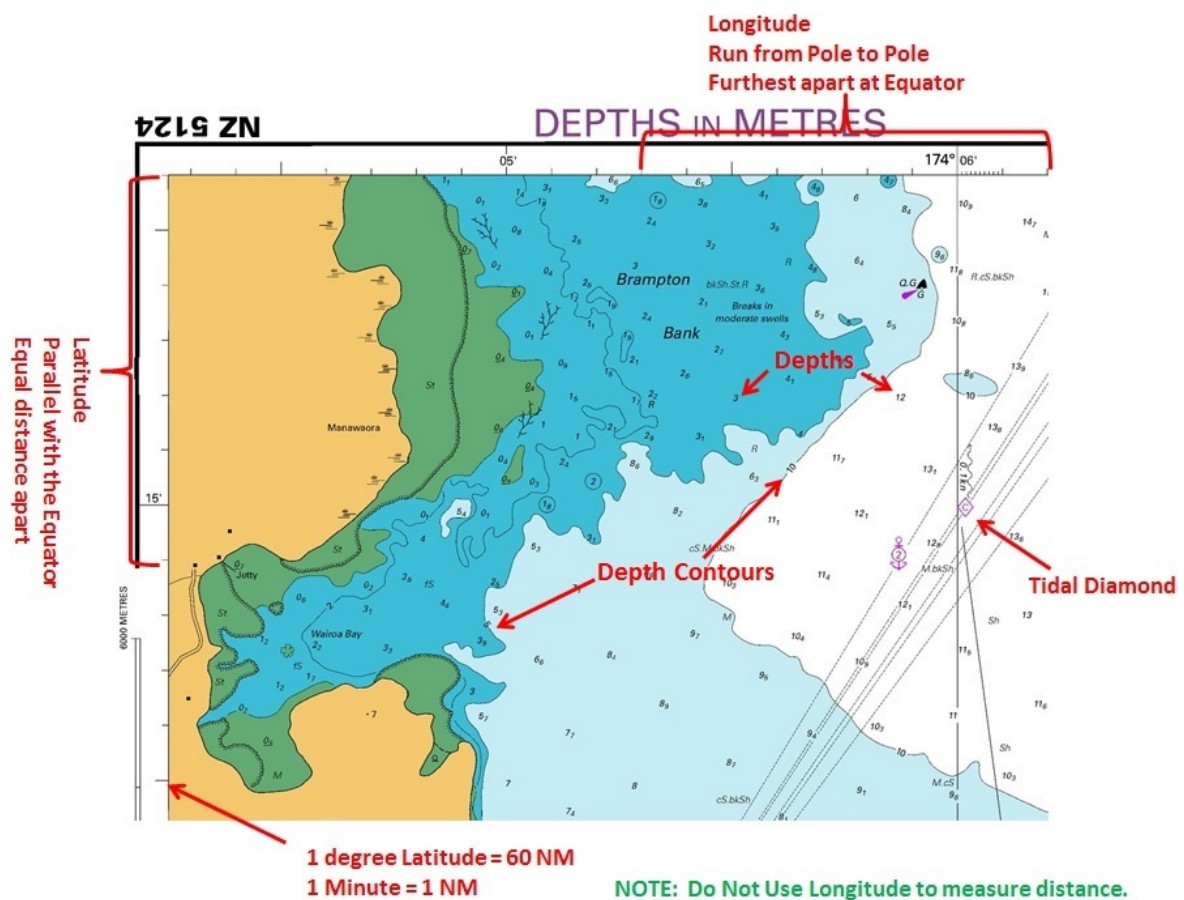
On a compass rose the outer circle shows True Bearings – the '0' at the top always points to True North.

Ignore the inner circle that shows Magnetic Bearings – only ever use True Bearings.

A line drawn through '0' and '180' on the compass rose will always point to the North and South Poles. A line drawn through '270' and '90' will always point East and West, and be parallel to the lines of latitude on the chart.

Use the scale on the left or right of a chart to identify degrees, minutes or decimal minutes.

Depth contours are drawn on a chart; they represent the depth at that point at its lowest astronomical tide.

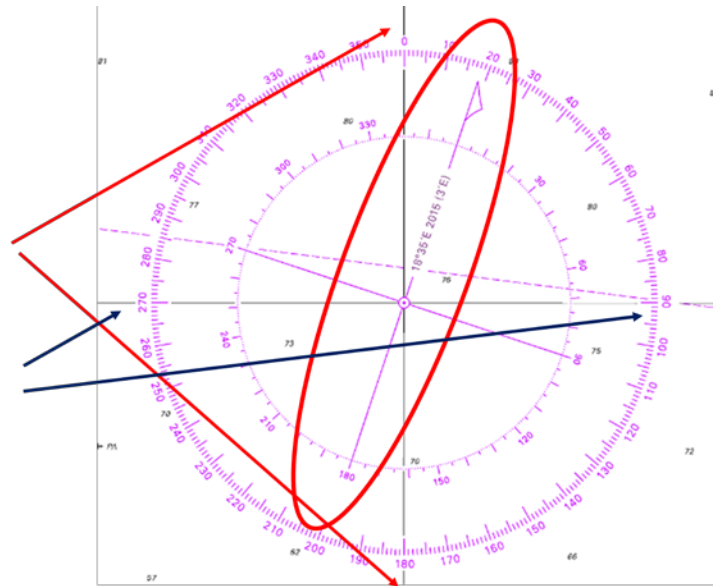


Compass Rose
Also on Plotting Tool

Place Centre over position
Ensure 0-180 line is perfectly aligned
With True North & South
Or

90-270 line is perfectly aligned with
Latitude line

Tide/Currents move towards:
Wind comes from



NOTES

Plotting Positions On A Chart

1. Begin with a latitude position on the left or right of the chart.
2. Make a mark in pencil on the scale of the latitude you want to use.
3. Using the top or bottom of the chart, locate the longitude you want to use. Mark with a pencil.
4. Plot the conjunction of the two points.

Use the centre of the compass rose to read the bearing going to or away from the conjunction points.

CALCULATING TIME/SPEED/DISTANCE

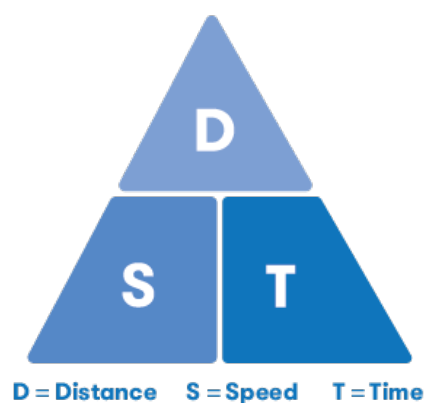
You can find the distance, speed or time data for a search object by using a three part equation. If you know the number for any two of the parts of the equation, you can then work out the missing number.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Distance} = \text{Speed} \times \text{Time}$$

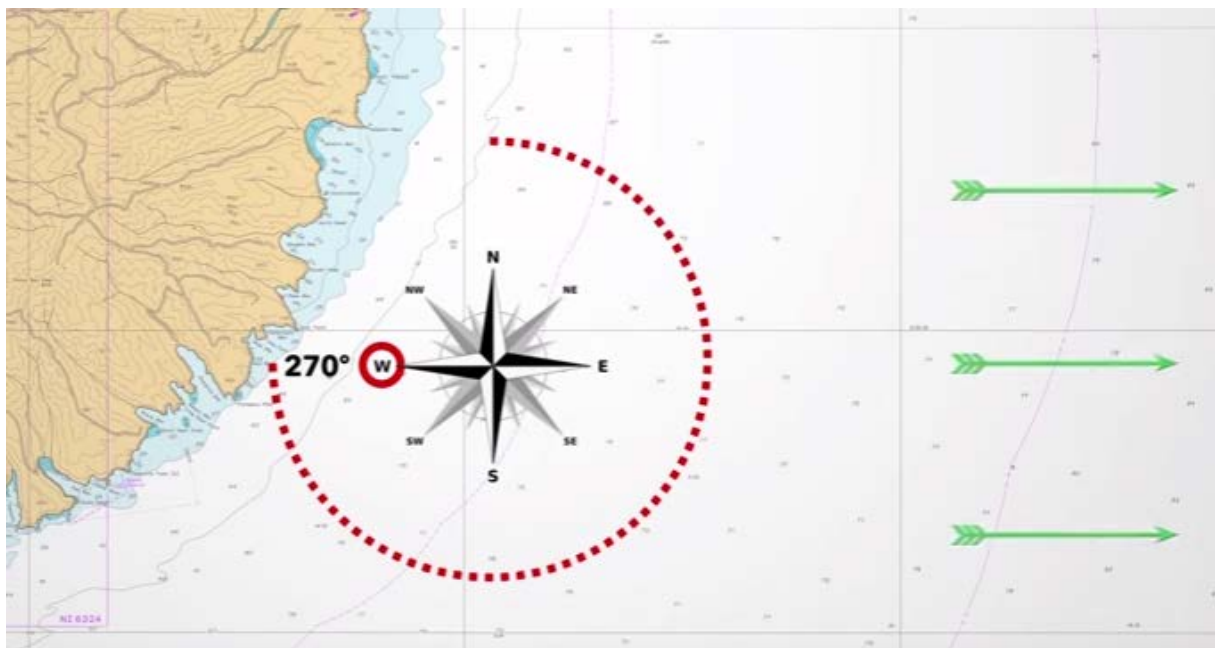
An easy way to remember the Distance, Speed and Time equations is to put the letters into a triangle.



PLOTTING A COURSE ON A CHART

Wind directions mean the compass point from which the wind is coming; an easterly wind is coming from the East and includes a bearing, for example “Coming from 270° True”.

Current is described as the compass point direction the current is heading to; a southerly current is moving to the South. This also includes a bearing as per the wind direction, for example “South setting current is heading to 180° True.



NOTES

Using Tide Predictions

The direction and speed that a search target is estimated to be moving is a combination of two main influences

1. Tide / current.
2. Wind and waves (Leeway).

Land Information New Zealand (LINZ) have online information for Tides:
<http://www.linz.govt.nz/sea/tides/tide-predictions>

Primary Port: A port from which the main tide measurements are taken.

Secondary Port: Calculated tide information based resulting in a tide time occurring before or after the Primary Port.

Land Information
New Zealand
Toitū te whenua

Sourced from <http://www.linz.govt.nz/>

E-mail address customersupport@linz.govt.nz

NEW ZEALAND HYDROGRAPHIC AUTHORITY TIDE PREDICTIONS

WELLINGTON

Lat. 41° 17' S Long. 174° 47' E

JANUARY 2016

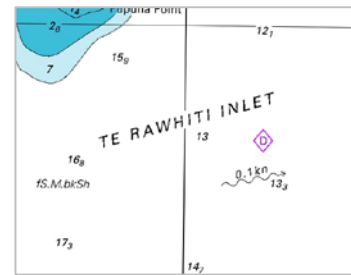
N.Z. LOCAL TIMES AND HEIGHTS OF HIGH AND LOW WATERS

Time	m	Time	m	Time	m	Time	m
1	0504 0.6	9	0448 1.6	17	0534 0.5	25	0021 0.6
	1110 1.6		1108 0.7		1147 1.7		0631 1.7
Fr	1734 0.6	Sa	1717 1.5	Su	1808 0.5	Mo	1300 0.6
	2338 1.6		2316 0.7				1906 1.6
2	0550 0.7	10	0537 1.6	18	0012 1.8	26	0114 0.6
	1155 1.6		1203 0.7		0629 0.5		0723 1.7
Sa	1814 0.6	Su	1809 1.5	Mo	1241 1.7	Tu	1354 0.7
					1858 0.5		1957 1.6
3	0023 1.6	11	0009 0.7	19	0106 1.8	27	0206 0.6
	0634 0.7		0628 1.6		0723 0.5		0814 1.6
Su	1238 1.6	Mo	1258 0.6	Tu	1336 1.7	We	1445 0.7
	1853 0.7		1901 1.6		1949 0.5		2046 1.6

Tidal diamond tables

Tidal diamond symbols on a chart represent locations where the set and drift (stream) of the tide has been measured or calculated. Each has a unique letter to identify it on the chart.

Find that tidal diamond reference letter and refer to the Tidal Diamond Table on the chart.



The Tidal Diamond Table will then give you the tidal stream at that reference point for different tides namely the:

- geographic reference point for that diamond
- direction of movement
- rate or speed of movement.

Tidal Streams referred to HW at AUCKLAND

Hours	Geographical Position	Direction of Streams (degrees)	Rates at Spring tides (knots)	Rates at Neap tides (knots)
Before High Water	35°10'.90S 174°09'.50E	071	0.1 0.0	278
4	35°12'.70S 174°04'.40E	011	0.1 0.1	275
3	35°15'.00S 174°06'.00E	223	0.1 0.1	223
2		031	0.4 0.3	172
1		315	0.5 0.3	169
High Water		321	0.2 0.1	163
After High Water		262	0.1 0.1	152
1		132	0.3 0.2	126
2		116	0.2 0.1	018
3		114	0.2 0.1	000
4		112	0.2 0.2	353
5		134	0.4 0.3	344
6		173	0.1 0.1	321
		223	0.1 0.1	313
	35°14'.30S 174°12'.20E	287	0.1 0.0	173
	35°13'.20S 174°14'.90E	288	0.1 0.1	159
	35°10'.10S 174°20'.15E	257	0.1 0.1	158
	35°09'.60S 174°20'.60E	282	0.1 0.1	164
		272	0.1 0.0	166
		218	0.1 0.0	159
		250	0.1 0.1	016
		133	0.0 0.0	333
		081	0.1 0.1	341
		066	0.1 0.1	337
		079	0.1 0.1	342
		092	0.1 0.0	315
		154	0.0 0.0	115
				102
				101
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Leeway Tables

Leeway is the off-course lateral drift movement of an object caused by wind.

The authoritative source in NZ for past and current weather records is MetConnect.

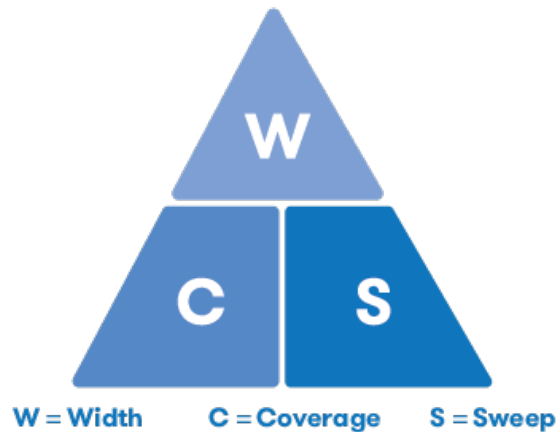
The Leeway Modifier is a figure that allows for parameters outside the Table.

The Divergence Angle allows for the shape and characteristics of the particular drifting object.

NOTES

Coverage Factor

The Coverage Factor is a measurement of 'quality' or effectiveness of the coverage in a search area. The Factor is determined by sweep width and track spacing, and is normally written as a percentage.



Any variation in sweep width or track spacing leads to a variation in the Coverage Factor.

Weather Correction allows for weather conditions to be factored in due to their effect on the searchers detection range.

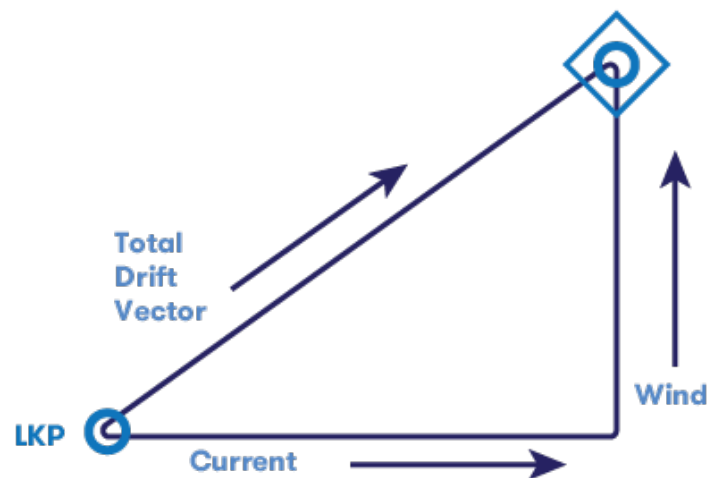
Fatigue Factor is a correction to allow for tired searchers.

NOTES

Plotting a Search Area Determination

Using the known information about tide movement and time we know that the tide is going to move a certain search object in a certain direction at a certain rate.

It is possible to identify the probable location of the target (so as to set a start point for a search). This location is shown as a chart datum point (control mark). That datum takes into account the target characteristics, the forces affecting it and the elapsed time.



NOTES

Mathematical rationale is based on the assumption that the target is not anchored or being propelled but simply drifting, and it will move at the same rate as the tide or current - the object will move at same rate and in same direction as water regardless of size or displacement.

Note: This is not a precise science!

The leeway figure is applied. Leeway is based on empirical evidence that resulted in a set of Tables, which provide Leeway Rates (speed of movement) for a variety of objects (vessels, rafts etc).

Position error allows for drift characteristics of the particular target and a lack of accuracy around the Last Known Position (LKP). The reason a 6 NM or greater radius is used around the Datum is to allow for position errors

Probability Distribution Density maps the highest probability of where the target will be in the calculated search area using a mathematical theory.

A Trackline Overdue is a technique for determining a search area based on the assumption that the target may have lost propulsion and begun to drift at a number of points along the proposed or intended track (course).

Position Uncertainty is the same process as described above, but assumptions are made based on estimated positions.

NOTES

Probability of Detection (POD)

POD describes the estimated effectiveness of a search. POD can be calculated. It is based on the relationship between Track Spacing and Search Width.

A POD of 79% equals a Coverage Factor of 1 (based on the mathematical model for a single search).

Search assets of the same characteristics, for example two vessels, can use capability cumulatively and be treated as one search.

Different types of assets, for example a vessel and a helicopter, are regarded as different searches and treated accordingly on the POD graph.

To determine the sweep width for a particular type of asset, refer to the Sweep Width table for that particular asset.

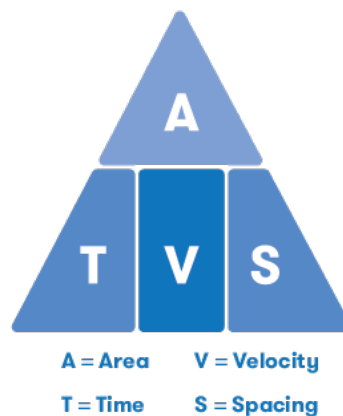
- Heights of eye means higher search assets can see further.

NOTES

$$A = TVS$$

It is possible to find Area, Time, Velocity or Spacing by using the equation

$$\text{Area} = \text{Time} \times \text{Velocity} \times \text{Spacing}$$



You need to know the figures for any three parts of the equation to find the missing fourth part.

Velocity can be the cumulative asset search speed providing it is the same asset type.

Multiple searches increase the POD, if multiple resources conduct multiple searches at the same time, it may be possible to increase sweep widths without unnecessarily reducing the POD.

NOTES

Worked Exercise Examples

Worked Exercise Examples