
# MANAGING A MARINE SAR RESPONSE TECHNICAL

# COURSE NOTES

# 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. Pre-course work. Before you attend the training day there is on the NZSAR website (http://nzsar.org.nz/Knowledge-Training/Start) related video information that you need to have viewed, plus a downloadable self-marking knowledge check-test that is to be completed.

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:

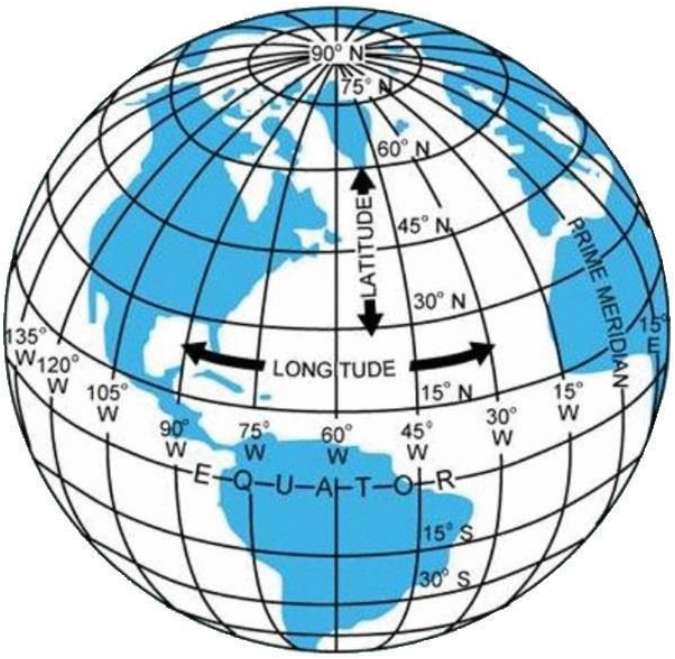
1. Read and interpret New Zealand marine charts for SAR planning purposes.
2. Accurately plot positions on the chart using navigation charting instruments.
3. Calculate Time/Speed/Distance.
4. Plot courses, directions and distances on charts.
5. Locate relevant information relating to tidal movements 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.

# Reading and Interpreting Marine Charts

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

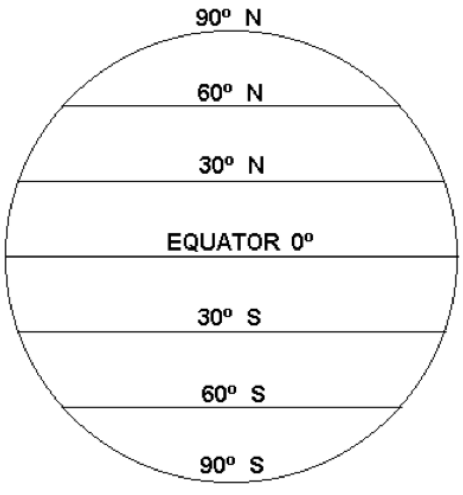
Lines of latitude stretch for $360^0$ horizontally around the Earth.

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




There is:

- $90^0$ of latitude between the Equator and the North or South Pole.
- $180^0$ of latitude between the North Pole to the South Pole.



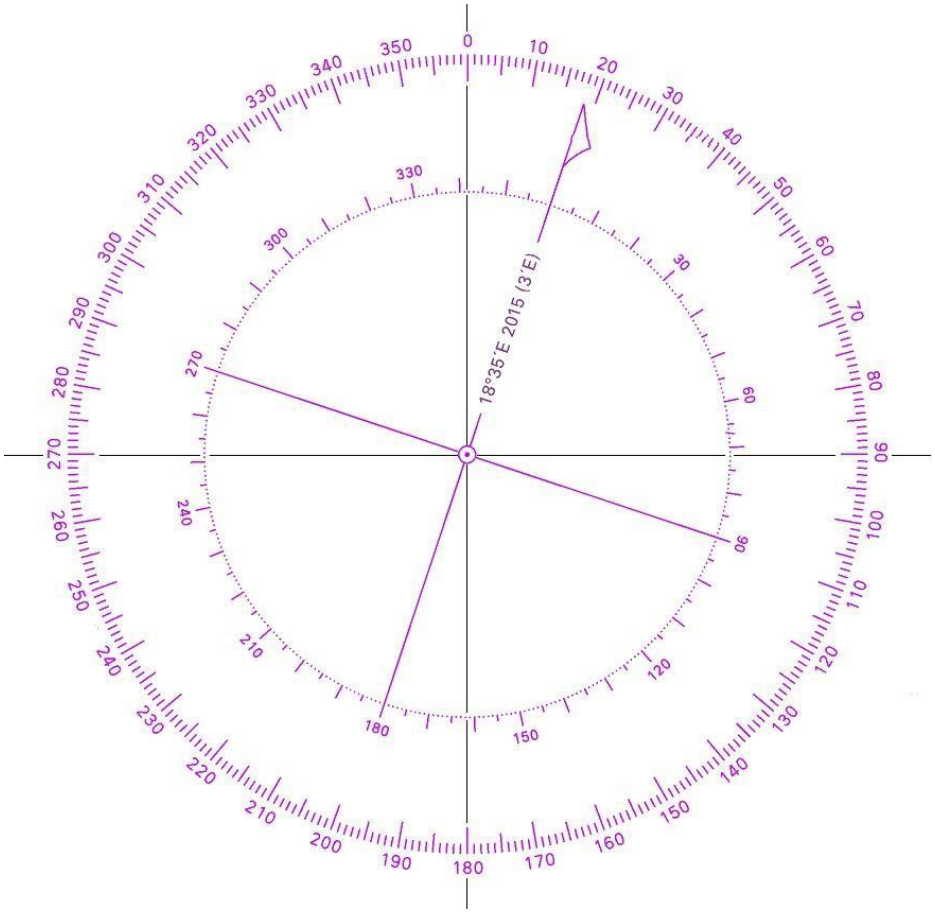
1° of latitude is equal to 60 nautical miles.

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.



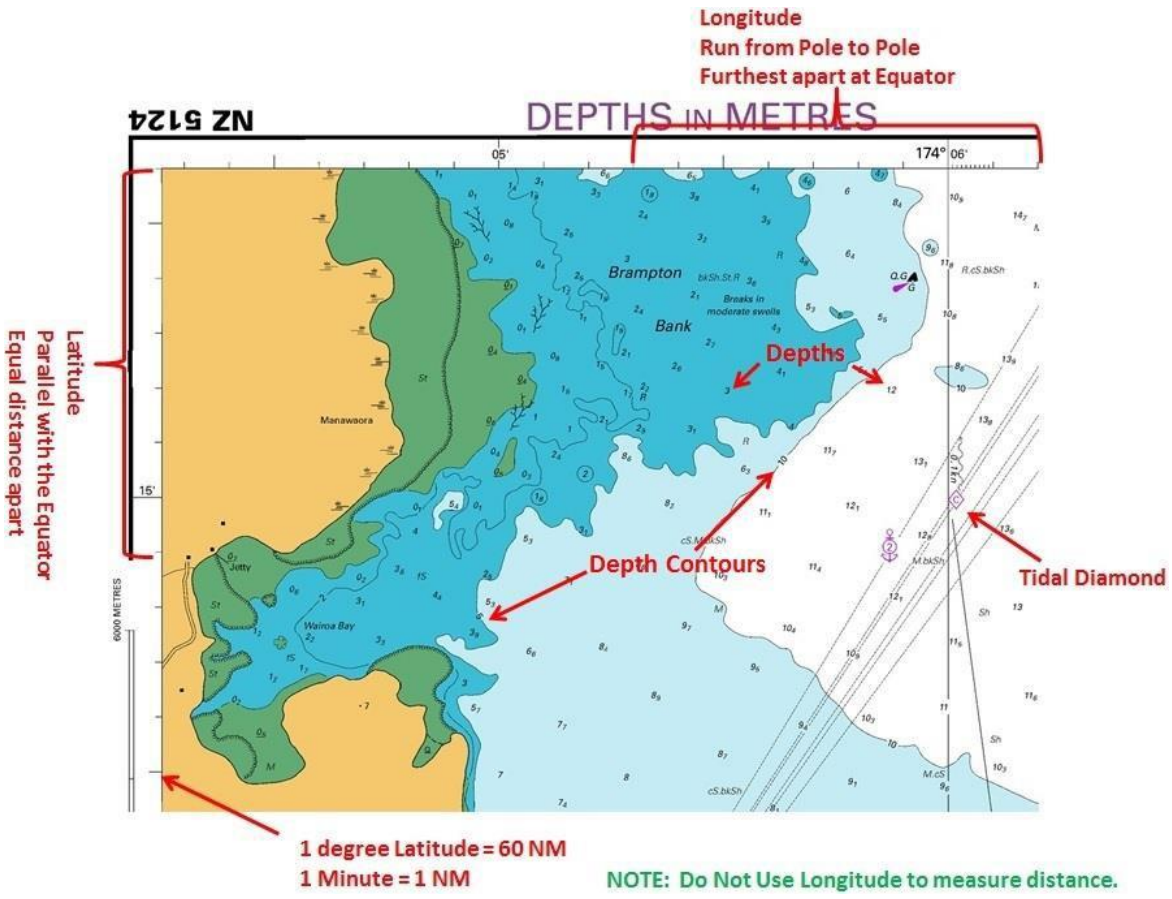

On a compass rose the outer circle shows True Bearings – the '0' at the top always points to True North.

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.

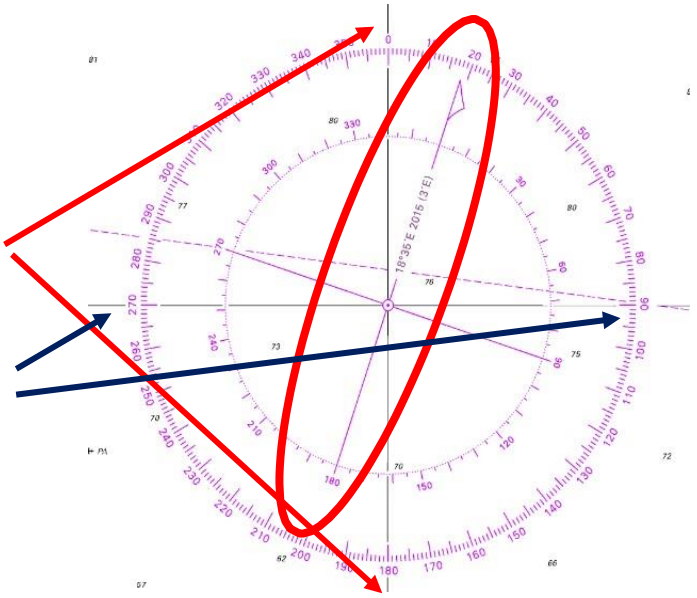


Compass Rose (also on Plotting Tool)

1. Place Centre over position.
2. Ensure 0-180 line is perfectly aligned with True North & South

Or

3. The 90-270 line is perfectly aligned with the Latitudeline



**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

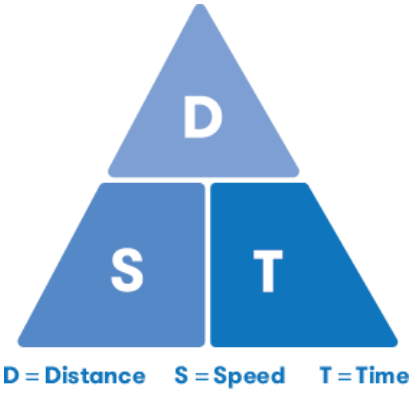
You can find the distance, speed or time data for a search object by using a three part equation. If you know the number for any two of the parts of the equation, you can then work out the missing number.

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

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

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

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



REMEMBER:

To change hours and minutes to hours and the decimal of an hour:

Divide the minutes by 60

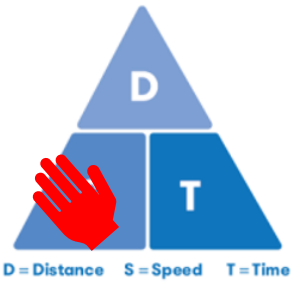
34 minutes = 34/60 = .566 of an hours

To change decimal of hours to minutes

Multiply the decimal by 60

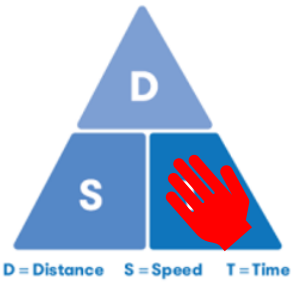
.52 of an hour = .52 x 60 = 31.2 minutes

## Triangle use example: (*Always use hours and decimals)*



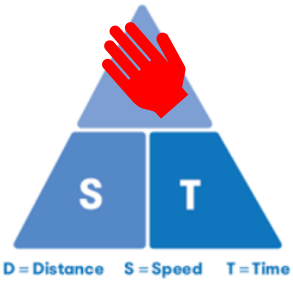

**Speed** = ?????

10 Nm *(Nautical Miles)* = 3.89 Knots *(Knots = Nautical Miles per hour)*
2.566 hours




**Time** = ????

10Nm = 0.83 hours or 0.83 x 60 = 49.9 minutes
12 knots

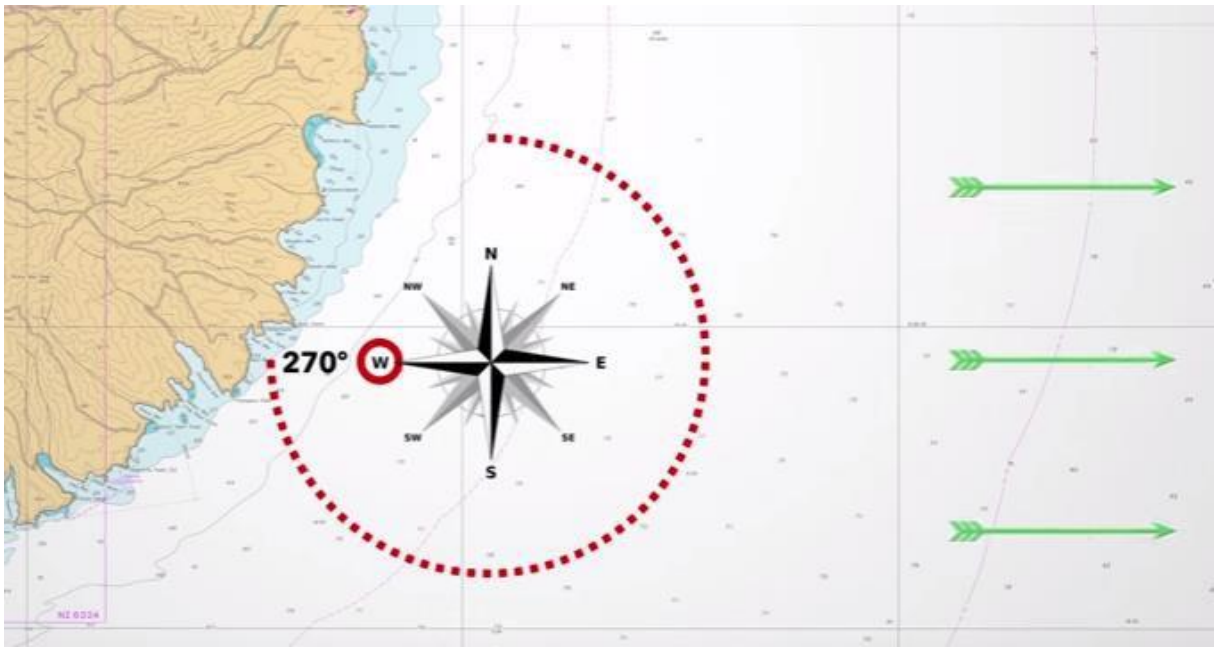



**Distance** = ????  15 Knots x 2.2 = 33  Nm
*2 hours 12 min = (2.2 hrs.)*

## 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$^0$ 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$^0$ 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

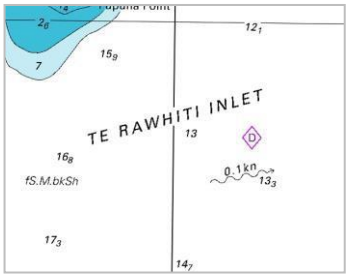
Lat. 41° 17' S Long. 174° 47' E

**JANUARY 2016**

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

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

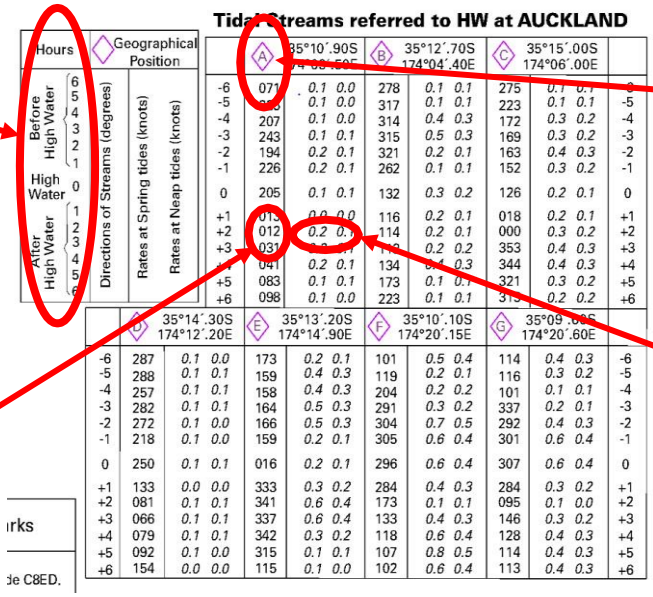
Find that tidal diamond reference letter and refer to the Tidal Diamond Table on the chart.

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.

Hours before or after High Water

Direction water is moving TOWARDS




Tide Diamond refers to location on chart

Rate (speed) water is moving (Nm per hour) in Knots

## NOTES

# Leeway Tables

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

> The authorative 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

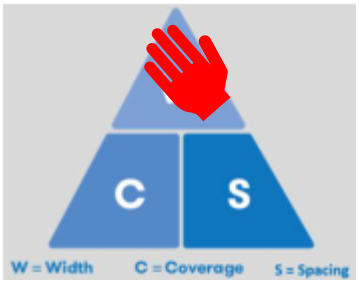
The Coverage Factor is a measurement of 'quality' or effectiveness of the coverage in a search area. The Factor is determined by sweep width and track spacing, and is normally written as a percentage.

- Any variation in sweep width or track spacing leads to a variation in the CoverageFactor.
- Weather Correction allows for weather conditions to be factored in due to their effecton the searchers detection range.
- Fatigue Factor is a correction to allow for tired searchers.

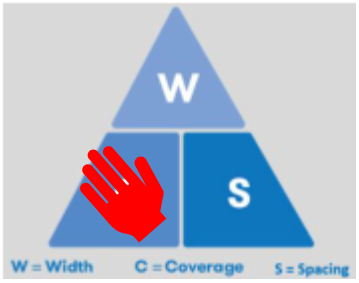
**W -** Width is found in the Sweep Width" Tables, but in some circumstances you may use a width that is different from the Table. Only increase width in very exceptional circumstances (and where you fully understand the risks).

**S -** Spacing is whatever you decide should be the distance between the vessel actual tracks.

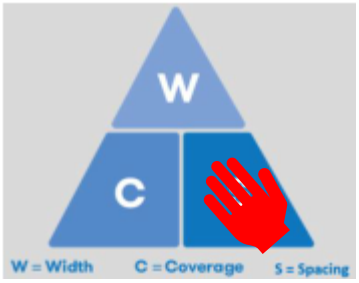
**C -** Coverage factor is the ratio between W and S.




**Width** = Coverage factor x Spacing (Vessel or aircraft Track spacing)




**Coverage** = Sweep Width / Spacing

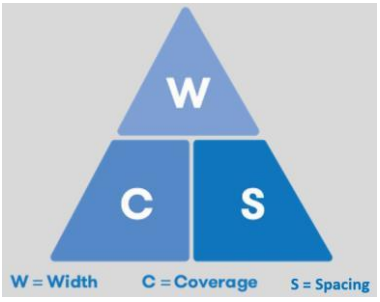



**Spacing** = Sweep width / Coverage Factor

POD (probability of Detection can be increased by increasing the Coverage factor (Coverage Factor in other words can be expressed as a ratio or %... 1 = 100% Coverage)

If you reduce the Spacing (track distance between each vessel or each pass when only one vessel or aircraft is being used) and your Coverage Factor will increase above 1 (100%).

Refer to the POD Graph to see effect of increasing the Coverage Factor (C).




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.

Mathematical rationale assumes 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.

**Search Area Determination (SAD)**

Each SAD is unique and has a specific start location, specific start time/date and is for a specific period. To calculate each SAD you may at times, by scenario analysis, identify an IPP (Initial Planning Point).

NOTE: When calculating more than one SAD identify each IPP with a number unique to that SAD. For example: $IPP^1$, $IPP^2$ etc.

**Position Uncertainty**

Position uncertainty is where you need to determine an Initial Planning Point (IPP) for a Search Area Determination, and you identify one or more IPP's for a series of SAD's through the analysis of your intelligence gathering. For example, you may be able to identify a likely departure point and destination and thereby using local knowledge and expertise identify possible locations you can use for one or more IPP's

**Time Uncertainty**

For Time Uncertainty, you may know the actual track the target intended to use but you may not know the time of departure (ETD) or intended arrival (ETA)
In conjunction with the process identified under "Position Uncertainty" your intelligence and subsequent analysis will help you make some educated assessments about what time your SAD's should be calculated from.

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.

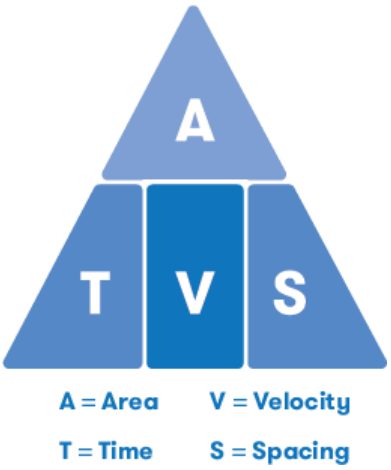
- Heights of eye means higher search assets can see further.

NOTES

# A = TVS

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

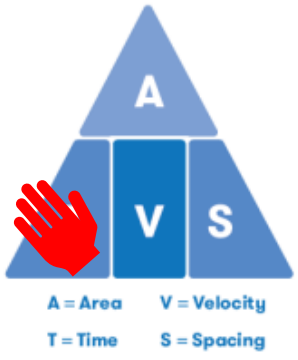
**Area = Time x Velocity x Spacing**




You need to know the figures for <u>any three parts</u> 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.

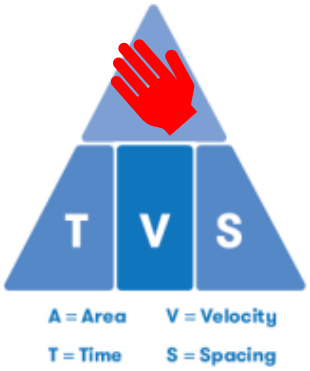



Time = A *(area)* / (V *(Velocity)* x S *(Track Spacing)*

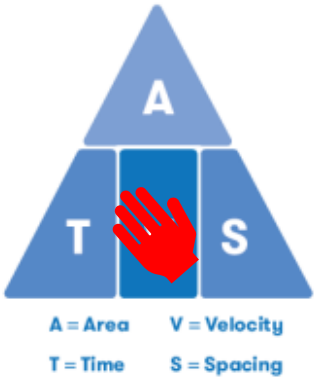
Always complete the in-brackets calculation first, then divide the answer into the A.

The time will be in hours and decimal of hours.

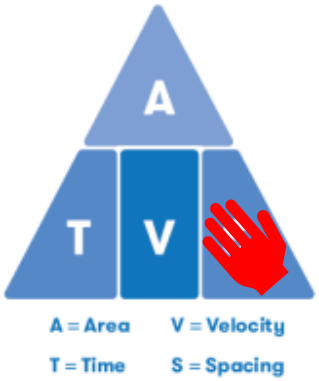
NOTE: Velocity is the sum of all craft used in the same search. For example; 4 boats @ 10 knots means the velocity is 4 x 10 = 40 knots Velocity.




A *(area)* = T *(Time)* x (V *(Velocity)* x S *(Track Spacing)*




V *(Velocity)* = A *(area)* / (T *(Time)* x S *(Track Spacing)*




S *(Track Spacing* = A *(area)* / (V *(Velocity)* x (T *(Time) )*
S (Track Spacing) should be = or less than the Sweep Width to keep your POD to an acceptable percentage. Usually the minimum would be 78% (though higher is more desirable).

NOTES

# Worked Exercise Examples

# Worked Exercise Examples