9 SEARCH TECHNIQUES

Overview

This module covers search terminology, search patterns and some basic information about search planning.

In marine SAR the responsibility for search planning generally lies with the Marine SAR Controller (as part of the Incident Management Team), the On Scene Command, and / or RCCNZ. (See Module NZ SAR System)

As an integral member of a SAR team it is vital that all Coastguard Crew are able to understand tasking instructions, and the requirements for setting up and carrying out a search.

Developing the Search Plan

When planning a search, the Marine SAR controller will have to take into consideration numerous variables. These will need to be constantly revised and updated during the search.

Search Planning Sequence

The planning sequence encompasses six specific steps;

1 Define the Target

This is the major factor in the planning and implementation of a search. An accurate description of the target can make all the difference. Size, colour, type of vessel, markings, equipment carried, and number of persons on board (POB) are all vital details.

2 Define the Datum

The SAR Controller will calculate the most probable location of the target allowing for;

- The accuracy and reliability of available information.
- Time elapsed since the incident.
- Wind direction and strength, and its probable affect on the target.
- Tide / current direction and strength, and its probable affect on the target.

3 Define the Search Area

The size of the search area will influence the choice of search pattern and resources required.

4 Select the Appropriate Search Pattern

The selection of the appropriate pattern is often made after consultation with the On Scene Command / CRV Skipper.

5 Determine the Desired Area Coverage

The required coverage of the search area is dependant on the size of the search area, resources available, and time available.

6 Develop a Practical Search Plan

A practical search plan is a combination of the points above, and the conditions on scene.

The form shown below is an example showing the type of information that may be relevant to the search operation. *A record of the key information in any SAROP must be kept on the CRV and updated when required.*

SAR BRIEFING & TASKING FORM

DATE _____

Search Object	
Type	
Name & Call Sign	
Description	
POB	
Emergency equip	
Nature of Distress	
Search Area	
Lat & Long	1
	2
	3
	4
Datum/Start Point	
Type of Pattern	
Direction of Creep	
Track Spacing	
Other Resources	
Aircraft	
Land Parties	
Vessels	
VHF channel for	
SAR Controller	
Search Object	
Search Aircraft	
Search Vessels	
Land Parties	

Search Terminology

Initial Position / Splash Point (IP / SP)

The position where the distress incident first occurred.

Last Known Position (LKP)

The last known position may not be the same as the initial position

Area of Probability (AOP)

The area to be searched which is normally communicated to the CRV by reference to charted objects / land features, or positions in Latitude & Longitude.

Datum (D)

The probable location of the target (and hence start point of any search). This is not the same as the Initial Position, as the target may have been subject to drift (due to tide / current & wind) in the intervening time.

The Datum for a search may be;

- An individual position (Datum Point) in Lat & Long or distance and bearing from charted object.
- It may be a line (Datum Line) representing the track of a missing vessel.
- Or it may be a given area (Datum Area) in which to commence the search.

In the diagram opposite the target gave a position when it made the initial Distress call. (IP)

A subsequent position was given a little later, but there has been no update since then. (LKP)
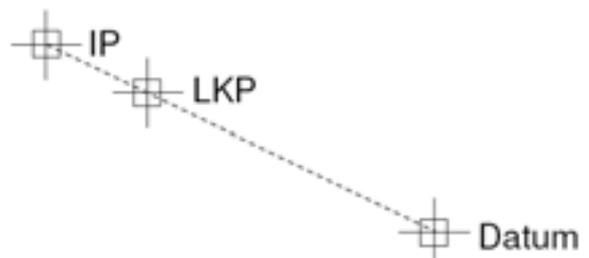
The Datum is the most likely position for the target given its estimated rate and direction of travel (target drift) since the IP and LKP.

Target Drift

The direction and speed that a search target is estimated to be moving is known as Target Drift. This is the combination of two main influences of the target;

- The wind and waves (leeway).
- The tide / current.

Any body of water can be subject to movement through tide or current. This can include inland lakes where currents may be caused by a predominant wind, the circulation of water due to differences in temperature, or rivers running into the lake.

There are tables available to the SAR Controller which give estimated leeway speeds for different types of target, in different wind conditions. Combined with information on tidal streams and current, this will produce an estimate on the targets drift.

The direction of a search should be orientated in the direction of the targets drift.

Depending on the rate of the targets leeway estimated by the SAR Controller, this can result in a search pattern being orientated a varying angles to or even in the opposite direction to the tide / current.

In the diagram opposite;

- Tide is setting East at 0.6kts (black feathered arrow).
- Wind is from a NNW direction at 25kts (blue arrow).
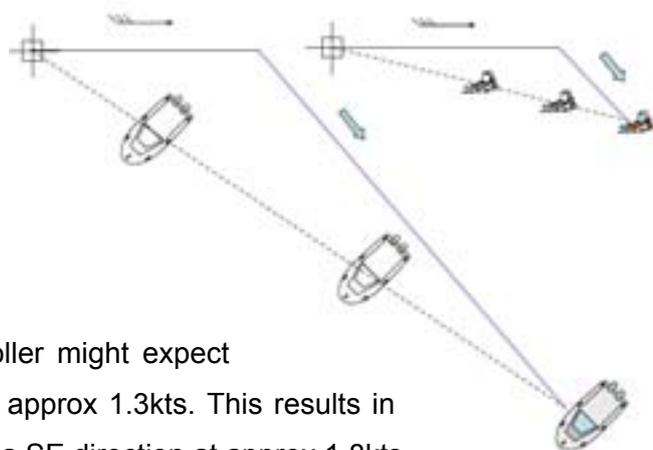
From the leeway tables the SAR Controller might expect that the speed of a small vessel adrift is approx 1.3kts. This results in an estimated target drift (dotted line) of in a SE direction at approx 1.8kts

The same tide and wind will produce a very different target drift on a PIW (diagram right), whose leeway might be around 0.3kts, resulting in a target drift in an ESE direction of approx 0.8kts.

Any subsequent change in tide / current or wind direction & speed will have a corresponding influence on the target drift.

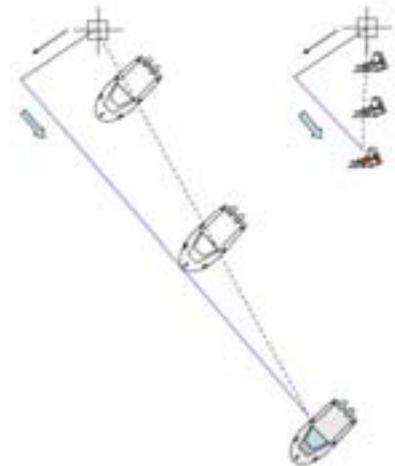In the diagrams opposite the wind speed, direction and leeway remain the same as the previous diagrams, but the tide has changed direction and weakened. This results in a very different rate and direction of target drift.

This is why it is vital that the IMT – and more specifically the SAR Controller, be kept in formed of any changes in wind speed / direction and tide / current.

Leeway Angle / Divergence

The job of the SAR Controller is further complicated by the fact that targets do not drift directly downwind, but invariably move at an angle to the wind direction. This is known as Leeway Angle or Divergence, and it has a profound effect on search planning.

Using one of the previous examples, the PIW could be expected to move at an angle of up to 30° either side of the downwind direction. The estimated leeway angles for different types of targets are also contained within the leeway tables used by the SAR Controller.
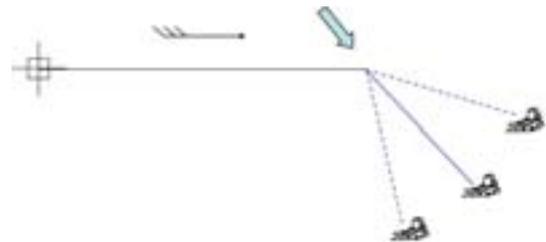
Maximum Detection Range

The maximum distance each side of the vessel at which the target *might* be located.

Maximum Detection Distance

The sum of the maximum detection ranges each side of the vessel.

Beam Sighting Distance (BSD)

The BSD is distance that can be *effectively* searched on either side of the vessel.
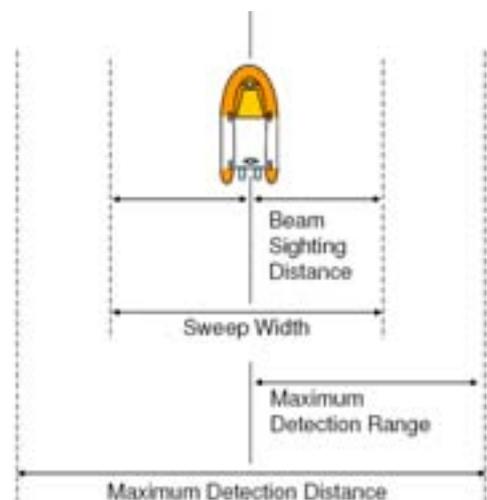
The beam sighting distance should represent the maximum distance in which the target will be, not could be detected.

Sweep Width (W)

The sum of the distance effectively searched each side of the vessel (beam sighting distance x 2). Sweep width can apply to multiple vessels - known as Total Sweep Width.
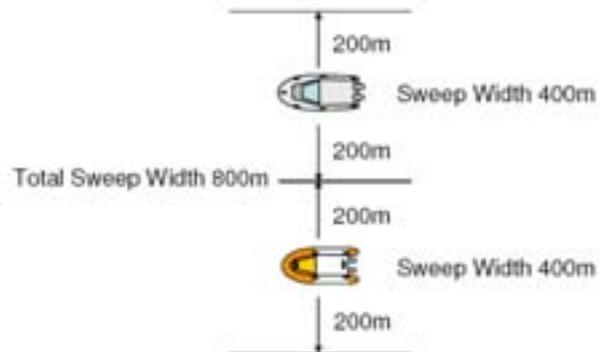
Establishing the Sweep Width is crucial as usually it forms the basis for setting up a search pattern.

Track Spacing (S)

The distance between successive search legs in a search pattern. Track spacing can also apply to multiple vessels known as Total Track Spacing.
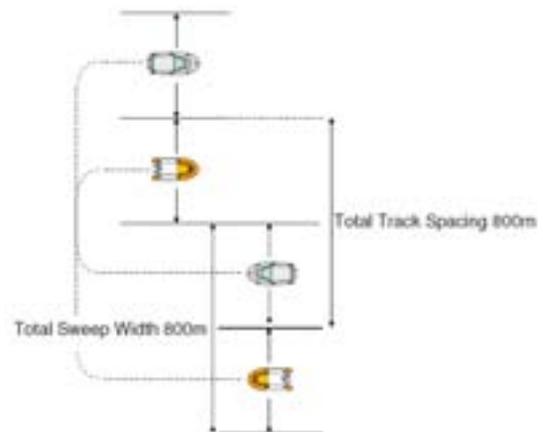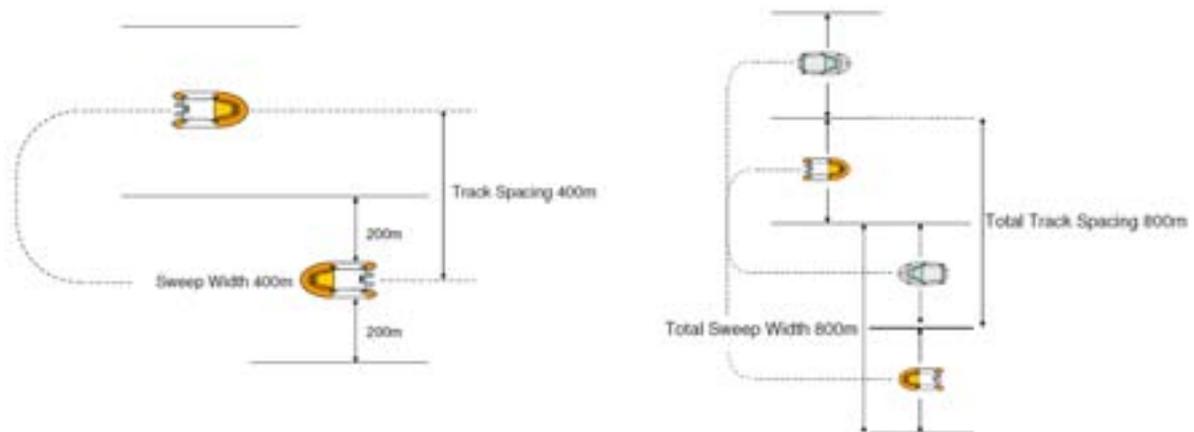
Search Leg

Search legs are generally the longest tracks in a given search pattern.

Cross Leg

Cross legs are the shorter tracks which connect the search legs

Coverage (C)

The Coverage Factor is a measurement of 'quality' or effectiveness of the coverage in a search area. The coverage is determined by sweep width (W) and track spacing (T).

$$\text{Coverage Factor (C)} = \frac{\text{Sweep Width (W)}}{\text{Track Spacing (S)}}$$

For example;

- If the sweep width is 1 NM but it is only possible to achieve a track spacing of 2 NM then the coverage factor will be 0.5. (50%)

- If the sweep width is 1 NM and the track spacing is 0.5 NM then the coverage factor will be 2. (200%)

In the first example the coverage is far from ideal, but time and resources available are always factors in the SAR Controllers planning. It may be that coverage of 0.5 is the best that can be achieved, at least on the initial search.

An example of this situation would be a search initiated only a short time before sunset. With the resources available at the time it will not be possible to search the whole area with 100% coverage before its dark. The SAR Controller may make the tactical decision to search the AOP with a lower coverage, knowing that more resources will soon be available to search the area again with a much higher coverage.

In such cases the track spacing may not be of equal distance to the sweep width.
(Diagram right)

In the second example with coverage of 200% the probability of detecting the target is far higher, but consequently the time taken to search the AOP is far greater.

In search operations;
Survivability decreases with the passage of time.
Search areas increase with the passage of time.
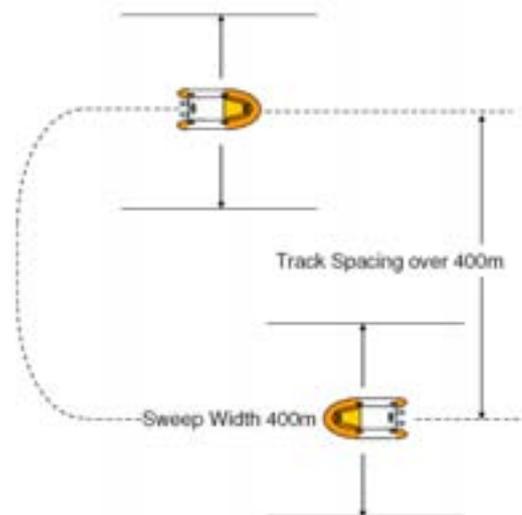
Probability of Detection (POD)

In conversation it is normally referred to as POD (pee oh dee), and it is based on the coverage of the search area achieved by single or multiple searches with different coverage factors. SAR Controllers can calculate the POD of a search from tables and graphs available to them. While not something that Coastguard crew are expected to calculate, it is a phrase that is commonly used to describe the estimated effectiveness of a search.

Search Patterns

Shore Line Search

A Shore Line search entails following the natural contours of the land with due caution regarding any hazards.
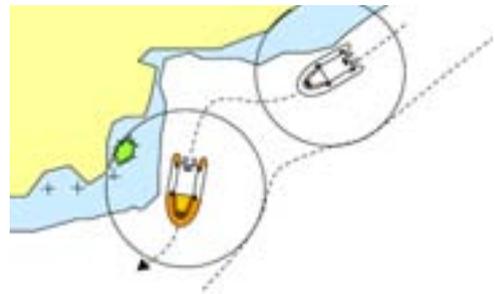
The distance off the land can often be maintained using the Radars VRM (Variable Range Marker). The search can be conducted with observers looking to shore or on either side of the vessel.

Track Line Search

A Track Line search follows the presumed track of a missing vessel. Conducted by one or multiple vessels directly down the track, or offset by half the individual sweep width (beam sighting distance)

The vessel(s) then returns along the other side of the track using same offset. If the supposed track of the missing vessel is entered as a route in the CRV's chart plotter, the correct off set can be maintained by XTE (Cross Track Error) as well as visually on the chart plotter.
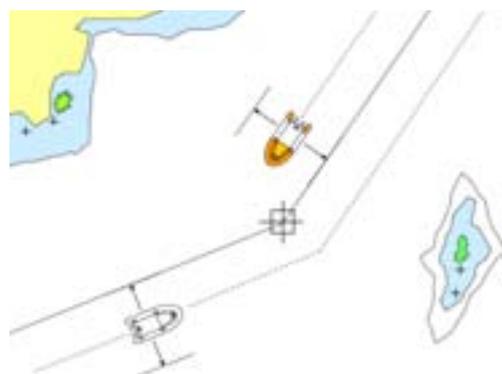
Barrier Search

A barrier search is essentially a patrol between fixed points on the land, conducted by one or multiple vessels. Principally used in rivers / estuaries or channels with significant tidal / current flow. This would normally be conducted in conjunction with another vessel(s) searching up tide / current of the Barrier Search.
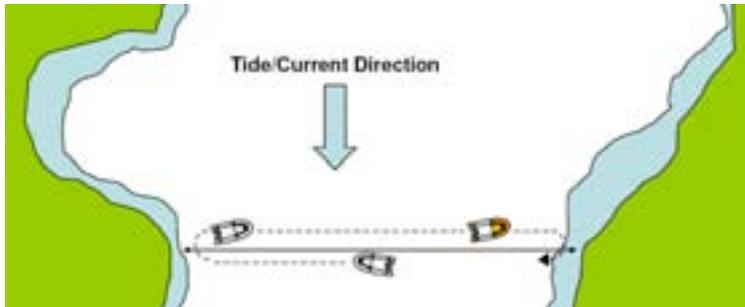
Sector Search

Used when the datum is well established and AOP is small. This pattern gives a very high POD, and with pre calculated courses is easily executed.

The Sector Search is however limited in the area it covers – once the length of the search legs exceed 3x the sweep width, 'gaps' start to appear in the pattern. Its coverage and hence POD is correspondingly reduced.

The first leg is usually orientated in the probable direction of the target drift, and the datum point itself is marked with a floating datum.
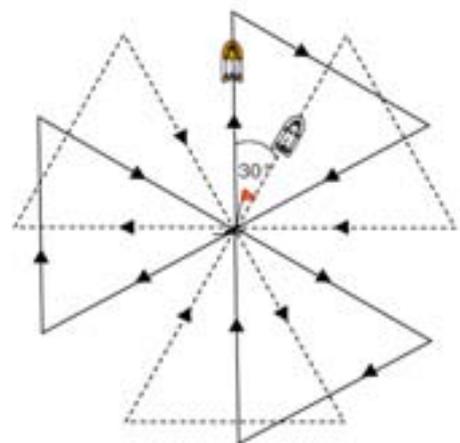
The Sector Search can be carried out by two vessels; one vessel carries out the first sweep while the second conducts the second sweep orientated 30° to starboard.

There must be a delay or separation between the vessels to avoid collision at or near the datum point.

Box or Square Search

Used when the datum is reasonably well established and AOP is relatively small. The Box Search does not give as high a POD as a Sector Search, and is more complicated to carry out due to the constant changes in distance and times for the search legs.
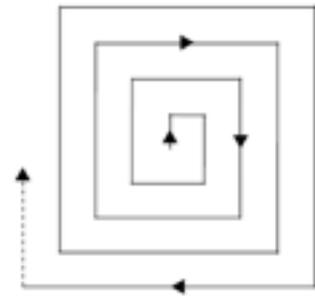
Unlike the Sector Search it is not limited in the area it can cover. The datum point itself can be marked with a floating datum. The first leg is usually orientated in the probable direction of the targets drift.

The Box Search can be carried out by two vessels (resulting in a very high POD). The second vessel commences the same pattern orientated 45° to Starboard. If the same speed is used for both vessels, the first vessel must be allowed to complete at least 3 search legs before the second commences to avoid risk of collision.
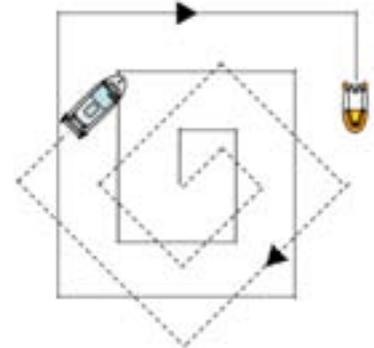
Parallel Track & Creeping Line

Parallel Track

Used when the AOP is large and location of target not well established. The search legs are parallel to the major axis of the search area. The pattern can be carried out by single or multiple vessels.
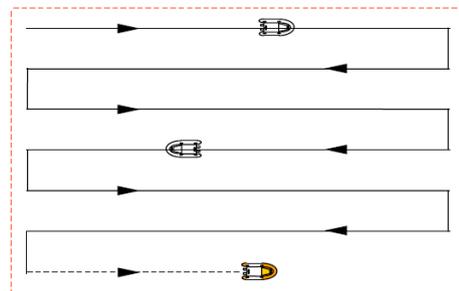
Creeping Line

Used when the AOP is large and location of target is more probable at one end of the search area. The pattern can be carried out by single or multiple vessels. Essentially the same as the Parallel Track but with the search legs at right angles to the major axis of the search area.
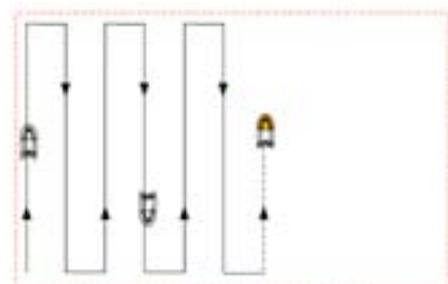
The Parallel Track and Creeping Line patterns are very versatile and can be adapted to suit search areas of various size and shape. They are probably the most commonly used of all the search patterns.
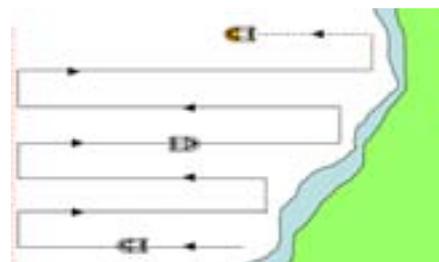
The search legs usually terminate because of the proximity of hazards, or because the CRV has reached the edge of the search area. They can often be combined with a shore line search (opposite).
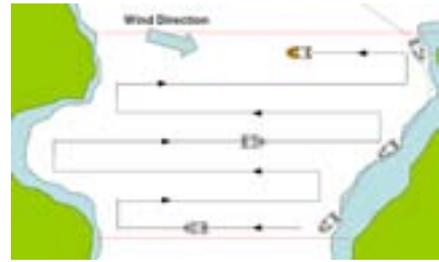
Templates for Sector, Box, and Parallel Track / Creeping Line searches are shown at the end of this Module.

Combined Aircraft Vessel Search

The aircraft flies a Creeping Line / Parallel Track pattern, while the vessel maintains a course along the centre of the search area. Ideally the aircraft and vessels speeds are coordinated so that the aircraft passes overhead of the vessel at the mid point of each of its search legs.
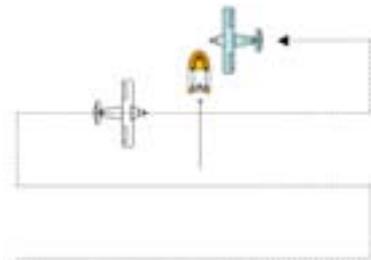
In this pattern the aircraft is the primary search resource, while the vessels course and speed is to ensure that there is the least possible delay in reaching the target once spotted by the aircraft. The SAR Controller will use a simple formula in order to determine what speed the CRV should be driven, using the searching speed of the aircraft.

$$\text{CRV speed} \quad = \quad \frac{\text{track spacing (miles) x aircraft speed (knots)}}{\text{search leg (miles) + track spacing (miles)}}$$

With a track spacing of one mile, aircraft speed of 100 knots, and the search leg of three miles, the CRV speed would need to be:

$$\frac{1 \times 100}{3 + 1} \quad = \quad \frac{100}{4} \quad = \quad 25 \text{ knots}$$

Use of GPS

Important - When searching an area for a target on the water (not anchored or aground) such as in a Box, Sector, or Creeping line pattern, searches are run using;

- The compass for direction.
- Time at a set speed, to determine the length of search legs or cross legs as required.

This is to maintain the search patterns sweep width, and track spacing on the **surface** of the water, regardless of tide / current. While the search area may be defined by fixed geographical points such as charted objects on land, or a position in Lat & Long, the CRV must carry out a search of the **water surface** within that area.

The influence of tide or current can have a marked effect on a search pattern when it is viewed on a chart plotter. The GPS chart plotter shows positions, and hence course and speed over the ground (sea / lake bed).

A search pattern accurately steered through the water can appear distorted on a chart plotter. The diagram below left shows the track of a vessel through the water (black), and what it would look like on a chart plotter (red) with the tide / current running in a South Easterly direction.

With the tide / current running in the opposite direction (below right), the track shown on the chart plotter now looks quite different.
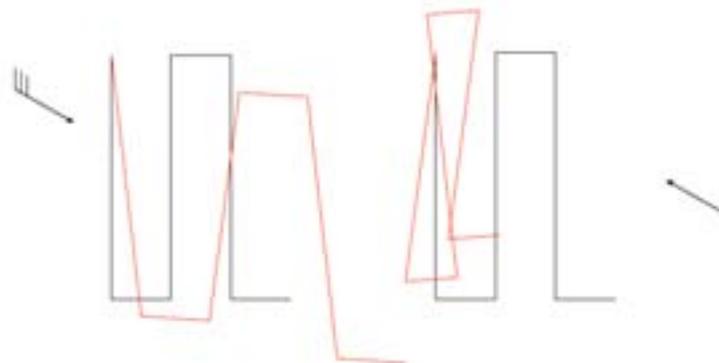
The diagrams above are drawn in correct proportions for a tide / current speed of approx 1/8 of the vessels speed through the water. I.e. Vessels speed through the water 8kts, tide / current speed 1.0kts

If a search pattern is run using the GPS for direction (by COG course over the ground information) the coverage of the search area will be affected.

In the diagram below left the search pattern and relative speed of the tide / current are the same as the previous example. This time however the search is run using the chart plotter to set the pattern.

To keep to the pattern (red) and the course over the ground, the vessel must steer to counteract the tide / current. This will produce a track through the water (black) that is very different from the intended search pattern.

Viewed on a chart plotter the pattern looks fine. The actual pattern through the water however is not. In this case the search legs are actually beginning to cross each other, and the track spacing varies enormously.

In the diagram below right the tide / current is running the other way. The pattern through the water is stretched to a point where the track spacing is more than twice the required distance. Coverage and hence POD have been dramatically reduced.
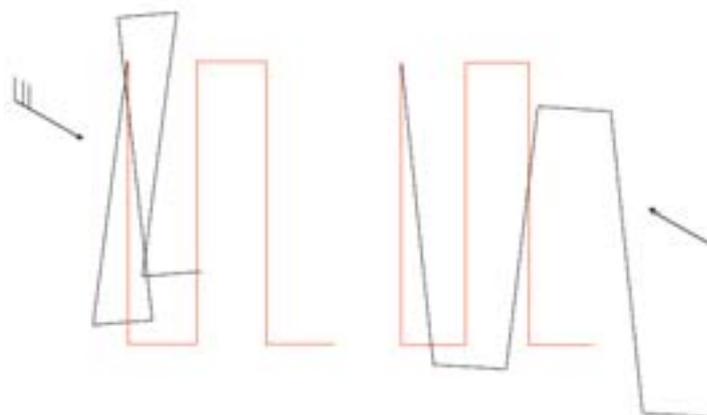
Remember – because search patterns are primarily orientated with the target drift, which is a combination of the influence of wind and tide / current, they may (depending on the target and its estimated leeway) be run with the tide at any angle to the search direction.

Outlining the AOP

While GPS is not generally used to run area search patterns, it can be used to outline the AOP. This can be especially useful in a Parallel Track / Creeping Line Search. In a Sector or Box Search every leg needs to be timed, but if the AOP is outlined in a Parallel Track / Creeping Line Search then only the cross legs need be timed.

- Some chart plotters will allow the operator to draw lines / bearings on the screen – which can be used to draw the outline of the search area.
- Alternatively with the corners of the search area entered as waypoints they can be joined as a 'route'.
- A Chart plotter can be used to display the edge of the AOP regardless of 'zoom'.

The vessel should ideally turn to initiate a cross leg when it is half the track spacing from the edge of the search area. To identify the turning point;

- Most chart plotters will give distance and bearing to the cursor, so if the cursor is placed on the edge of the search area, this can be used to indicate the turning point.
- With the option of Radar overlay a VRM can be set to show the distance to the edge of the search area.

Use of Floating Datum

A floating datum is a marker that is deployed in the water. It should be;

- Highly visible (brightly coloured / reflective tape / flag attached).

- Have a light / strobe attached for use at night.

- Be able to be deployed quickly.

- Be affected as little as possible by the wind - to ensure it drifts at the same rate and direction as the surrounding body of water.

Marking the Search Datum

A floating datum can be deployed at the start of such patterns as the Sector or Box search.

- The time at the start of the search is recorded.

- A waypoint is entered on the GPS.

- If the target is not found in the initial search, the floating datum is recovered.

- The distance to the waypoint and the time between deploying and recovering the floating datum will give a fairly accurate rate and direction for tide / current in the area.

With a Sector search the floating datum also provides a reference point so that small corrections to the CRV's course can be made to maintain the pattern.

Pausing or Leaving a Search Pattern

If a search is temporarily suspended for any reason (taking a break to rotate / rest crew or leaving the pattern to investigate a possible sighting);

- The time is recorded.

- A waypoint is entered on the GPS.

- The IMT is informed.

- A floating datum is deployed.

A GPS position/waypoint can be used to return to the general area, but the floating datum will help the CRV return to the actual point in the water to recommence the search.

The smaller the sweep width / track spacing, and the stronger the tide / current then the more important the use of a floating datum becomes.

Floating Datum in Use - Examples

In the examples below a CRV is searching for two PIWs. The first target is spotted and the CRV leaves the search pattern to recover the person. A waypoint is activated to mark the geographical position where the search was suspended.

In the intervening time the whole body of water containing the CRV and the remaining target is moving NE. If the CRV returns to the waypoint to resume the search it will be searching water already searched previously.
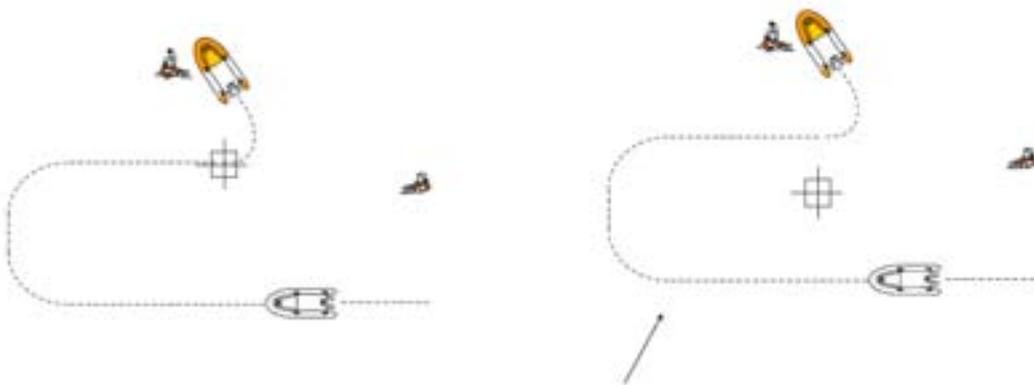
The same situation with the body of water moving in the opposite direction (to the SW) This time if the CRV returns to the waypoint to recommence the search, a gap will have developed in the pattern and the CRV may miss entirely the second target.

If a floating datum is deployed (below right), the CRV will return to the actual point in the water where the search was suspended. This reduces the chance of any gaps in the pattern.
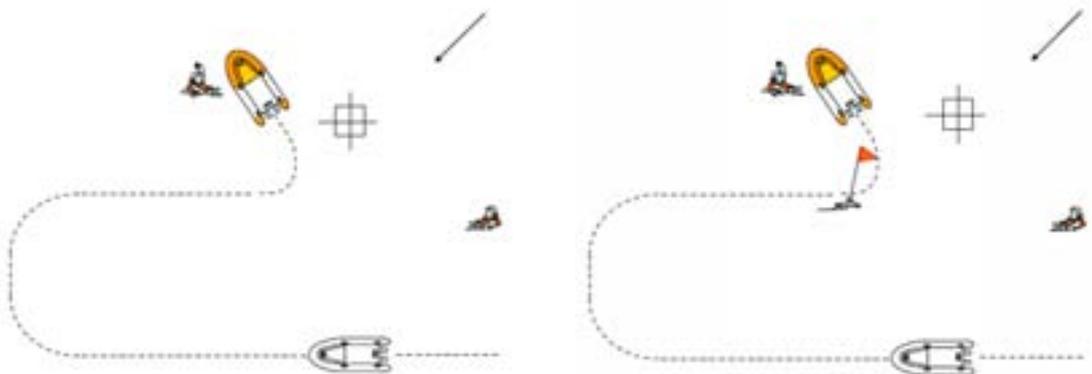
With a tide / current of as little as 0.5kts the body of water will move approx 200m in ten minutes.

Local tide / current eddies can sometimes be running in a very different direction to the general area tide / current.

Establishing Sweep Width

The ability to establish a viable sweep width is crucial. Every opportunity should be taken to practice establishing realistic sighting distances (by both visual & Radar observation) for a variety of objects, and in different conditions.

The SAR Controller may have a theoretical sweep width in mind for a search pattern, but it is only the CRV crew that can provide an actual sweep width for the prevailing conditions.

- Using Radar to verify an objects distance is a useful practice (which also gets crew familiar with some of the basic Radar functions).
- Alternatively an estimate on the objects distance can be made, a waypoint activated and the CRV driven to the object (such as a mooring buoy). The GPS will give a reasonably accurate distance travelled by the range to the waypoint (also gets crew familiar with basic GPS / chart plotter functions).
- Another practice is for the CRV to drive away from the object (typically a small object such as a mooring buoy or something similar deployed from the CRV). The time is recorded for the object to be still visible for approx 50% of the time, which will be the effective sweep width. The comparison of time / speed will give the distance from the object (also gets crew familiar with time / speed / distance tables).

On the next page is an example table of Visual Sweep Width Guidelines. The main body of the table is of uncorrected sweep widths (calm sea, no wind or swell). Below the main body are correction factors that can be applied depending on the wind strength and sea state. For example;

- Visibility approx 5NM (Fair)
- Target 6m power boat.
- Uncorrected Sweep Width of 2.2NM.
- With wind and sea state correction of x 0.5 applied.
- Corrected Sweep Width is 1.1NM.

The tables do not factor in swell, which can have a huge effect on sweep width.
These are just guidelines – an aid that will help in establishing 'ball park' figures. Only practice and experience will enable you to improve these figures.

UNCORRECTED VISUAL SWEEP WIDTH

GUIDELINE ONLY

SEARCH OBJECT	Length Feet	Length Meters	Height of eye 6'-8'/1.8-2.4m Visibility in (NM) 1	3	5	10	15	20	Height of eye 12'-14'/3.6-4.2m Visibility in (NM) 1	3	5	10	15	20
Person in Water (PIW)			0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5
Raft 1 Person			0.7	1.3	1.7	2.3	2.6	2.7	0.9	1.8	2.3	3.1	3.4	3.7
Raft 4 Person			0.7	1.7	2.2	3.1	3.5	3.9	1	2.2	3	4	4.6	5
Raft 6 Person			0.8	1.9	2.6	3.6	4.3	4.7	1.1	2.5	3.4	4.7	5.5	6
Raft 8 Person			0.8	2	2.7	3.8	4.4	4.9	1.1	2.5	3.5	4.8	5.7	6.2
Raft 10 Person			0.8	2	2.8	4	4.8	5.3	1.1	2.6	3.6	5.1	6.1	6.7
Raft 15 Person			0.9	2.2	3	4.3	5.1	5.7	1.1	2.8	3.8	5.5	6.5	7.2
Raft 20 Person			0.9	2.3	3.3	4.9	5.8	6.5	1.2	3	4.1	6.1	7.3	8.1
Raft 25 Person			0.9	2.4	3.5	5.2	6.3	7	1.2	3.1	4.3	6.4	7.8	8.7
Power Boat	< 15	< 4.5	0.4	0.8	1.1	1.5	1.6	1.8	0.5	1.1	1.4	1.9	2.1	2.3
Power Boat	15 - 25	4.5 - 7.5	0.8	1.5	2.2	3.3	4	4.5	1	2	2.9	4.3	5.2	5.8
Power Boat	25 - 40	7.5 - 12	0.8	1.9	2.6	4.7	5.9	6.8	1.1	2.5	3.8	6.1	7.7	8.8
Power Boat	40 - 65	12 - 20	0.9	2.4	3.9	7	9.3	11.1	1.2	3.1	5.1	9.1	12.1	14.4
Power Boat	65 - 90	20 - 27	0.9	2.5	4.3	8.3	11.4	14	1.2	3.2	5.6	10.7	14.7	18.1
Sail Boat	15	4.5	0.8	1.5	2.1	3	3.6	4	1	1.9	2.7	3.9	4.7	5.2
Sail Boat	20	6	0.8	1.7	2.5	3.7	4.6	5.1	1	2.2	3.2	4.8	5.9	6.6
Sail Boat	25	7.5	0.9	1.9	2.8	4.4	5.4	6.3	1.1	2.4	3.6	5.7	7	8.1
Sail Boat	30	9	0.9	2.1	3.2	5.3	6.6	7.7	1.1	2.7	4.1	6.8	8.6	10
Sail Boat	40	12	0.9	2.3	3.8	6.6	8.6	10.3	1.2	3	4.9	8.5	11.2	13.3
Sail Boat	50	15	0.9	2.4	4	7.3	9.7	11.6	1.2	3.1	5.2	9.4	12.5	15
Sail Boat	65 - 75	20 - 23	0.9	2.5	4.2	7.9	10.7	13.1	1.2	3.2	5.5	10.2	13.9	16.9
Sail Boat	75 - 90	23 - 27	0.9	2.5	4.4	8.3	11.6	14.2	1.2	3.3	5.7	10.8	15	18.4

Corrections

Target Type	Wind ~ 15 kts Sea 2 - 3ft / 0.5 - 1.0m	Wind ~ 25 kts Sea > 4ft / 1.5m
PIW, Vessel < 30' / 9m — Any Liferaft	x 0.5	x 0.25
Other targets inc Any vessel over 30' / 9m	x 0.9	x 0.9

Further corrections may be applied for other factors such as
- Serchers fatigue
- Search equip available(night vision. Radar etc)
- PIW lifejacket (reflective tape?)
- Colour of target
- Known target equip (strobe,flares etc)

Time / Speed / Distance

Speed & Distance Tables

Once a viable sweep width has been established, the next decision is usually what speed? It should be the *fastest* speed at which observation is still effective. If the CRV's motion means crew have to constantly struggle to hold on, they are unlikely to be very effective observers. Alternatively the search could be conducted at a very slow comfortable speed, but in search operations;

Survivability decreases with the passage of time.

Search areas increase with the passage of time.

Using the tables the time for the distance and speed can be established.

As mentioned previously Creeping Line / Parallel Track patterns usually need only the cross legs to be timed.

With Sector or Box searches *every* leg needs to be timed. The legs can be timed singly; with the stopwatch stopped, reset and started again each time. This can lead to problems with the delay, and with the increased chance of mistakes.

Alternatively the legs can be timed consecutively, with the cumulative time used to mark the end of each leg. This method also has its drawbacks, as calculating / setting up can be time consuming and prone to error. Having an 'easy' time to work with can make all the difference.

To help with this certain time values have been highlighted in the tables i.e. values above 10 seconds with 5, 10, 15, 20 & 30 seconds as part of the value. Any times + /- 2 seconds of these values have also been highlighted, to indicate times that could easily be rounded up or down to obtain a better time to work with.

Using the extract from the tables below;

A distance of 100m at 10 kts gives a time of 19 seconds. This could be rounded up to 20 seconds without any significant change to the effectiveness of the search pattern, but it will be a whole lot easier to use.

With 20 sec as the chosen time a Sector search could be conducted with all legs timed at 1 min. A Box search would have the first 2 legs at 20sec, the next two at 40sec, and the next two at 1 min and so on.

To get a feel for how much an adjustment to speed or time actually means, it is useful to remember that to convert kts to meters / second you multiply by 0.5 (half the value)

I.e. at 10kts the CRV covers approx 5m / sec.

So if you round up a given time by a second you will be increasing the distance travelled in meters by approx half the speed of the vessel. Round a time up by 2 secs and you will have increased the distance in meters by the speed of the vessel.

For example;
At 10kts in 19 secs you will cover approx 100m
At 10kts in 20 secs you will cover approx 105m (+ 5m – half the boat speed)
At 10kts in 21 secs you will cover approx 110m (+10m – the boat speed)

Distance 20 to 1000m   Speed 4 - 12 kts

METERS	N.Miles	4	5	6	7	8	9	10	11
20	0.011	00:10	00:08	00:07	00:06	00:05	00:04	00:04	00:04
30	0.016	00:14	00:12	00:10	00:08	00:07	00:06	00:06	00:05
40	0.022	00:20	00:16	00:13	00:11	00:10	00:09	00:08	00:07
50	0.027	00:24	00:19	00:16	00:14	00:12	00:11	00:10	00:09
60	0.032	00:29	00:23	00:19	00:16	00:14	00:13	00:12	00:10
70	0.038	00:34	00:27	00:23	00:20	00:17	00:15	00:14	00:12
80	0.043	00:39	00:31	00:26	00:22	00:19	00:17	00:15	00:14
90	0.049	00:44	00:35	00:29	00:25	00:22	00:20	00:18	00:16
100	0.054	00:49	00:39	00:32	00:28	00:24	00:22	00:19	00:18
120	0.065	00:59	00:47	00:39	00:33	00:29	00:26	00:23	00:21
140	0.076	01:08	00:55	00:46	00:39	00:34	00:30	00:27	00:25
160	0.086	01:17	01:02	00:52	00:44	00:39	00:34	00:31	00:28

The tables for time speed and distance should be all that is normally required, but crew should also be familiar with the equations;

- SPEED   = $\underline{\text{DISTANCE (in nautical miles) x 60}}$

  (In knots)   TIME (in minutes)

- TIME   = $\underline{\text{DISTANCE (in nautical miles) x 60}}$

  (In minutes)   SPEED (in knots)

- DISTANCE   = $\underline{\text{SPEED (in knots) x TIME (in minutes)}}$

  (In nautical miles)   60

These equations can be represented in the time / speed / distance triangle.
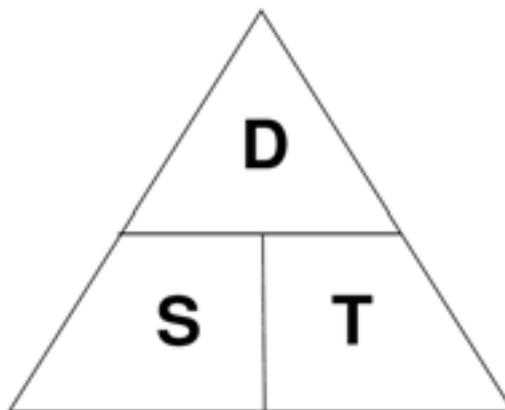
Note

Shore Line, Track Line, and Barrier searches are usually referenced to fixed points such as the land (or to a fixed datum line in the case of a Track Line search). With Sector, Box, or Parallel / Creeping searches it is the water that is being searched.

The speed at which such searches are conducted should ideally be speed through the water, not speed over the ground (SOG) as indicated by a GPS.

In the absence of a log that records water speed, every effort should be made to maintain as constant a speed through the water as possible.

Search Pattern Templates

Sector

The Sector search template contains pre calculated courses based on the initial course being one of the cardinal points of the compass i.e. North, South, East or West.

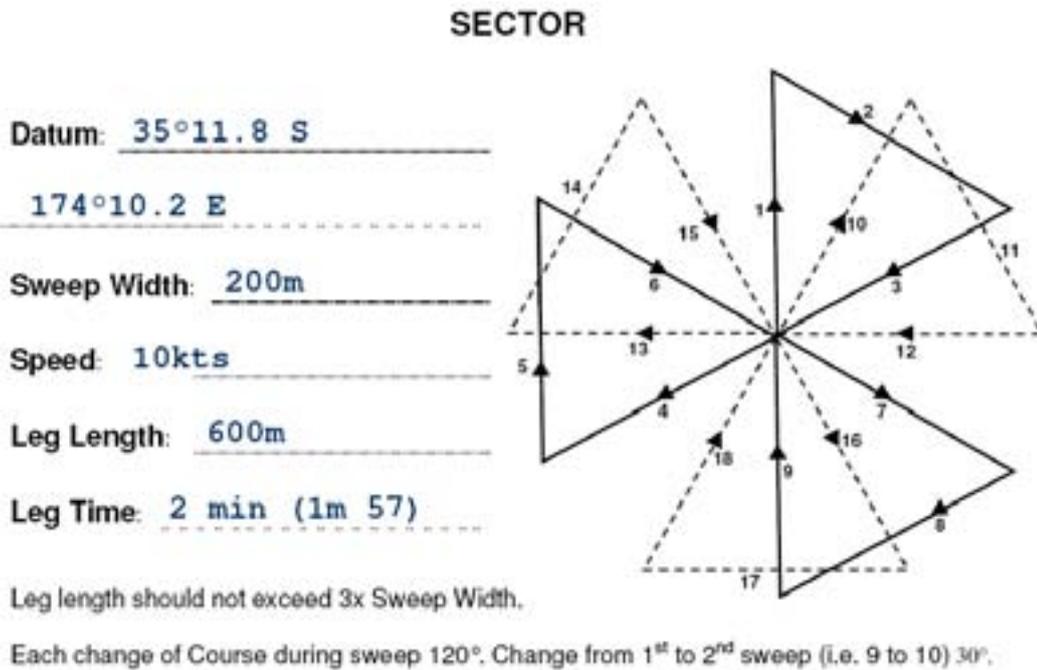Alongside each of the courses is a box for the individual legs if cumulative time is used. It is advisable to cross out or tick each leg once it has been completed.

SECTOR

Datum: 35°11.8 S

174°10.2 E

Sweep Width: 200m

Speed: 10kts

Leg Length: 600m

Leg Time: 2 min (1m 57)

Leg length should not exceed 3x Sweep Width.

Each change of Course during sweep 120°. Change from 1st to 2nd sweep (i.e. 9 to 10) 30°.

PRE CALCULATED COURSES

NORTH 000°				EAST 090°			
1 000°	2min	10 030°	20	1 090°		10 120°	
2 120°	4	11 150°	22	2 210°		11 240°	
3 240°	6	12 270°	24	3 330°		12 000°	
4 240°	8	13 270°	26	4 330°		13 000°	
5 000°	10	14 030°	28	5 090°		14 120°	
6 120°	12	15 150°	30	6 210°		15 240°	
7 120°	14	16 150°	32	7 210°		16 240°	
8 240°	16	17 270°	34	8 330°		17 000°	
9 000°	18	18 030°	36	9 090°		18 120°	

SOUTH 180°				WEST 270°			
1 180°		10 210°		1 270°		10 300°	
2 300°		11 330°		2 030°		11 060°	
3 060°		12 090°		3 150°		12 180°	
4 060°		13 090°		4 150°		13 180°	
5 180°		14 210°		5 270°		14 300°	
6 300°		15 330°		6 030°		15 060°	
7 300°		16 330°		7 030°		16 060°	
8 060°		17 090°		8 150°		17 180°	
9 180°		18 210°		9 270°		18 300°	

Box / Square

The square search templates contain pre calculated courses. These are based on the initial course being one of the cardinal or inter cardinal points of the compass i.e. North, Northeast, East, and Southeast etc.
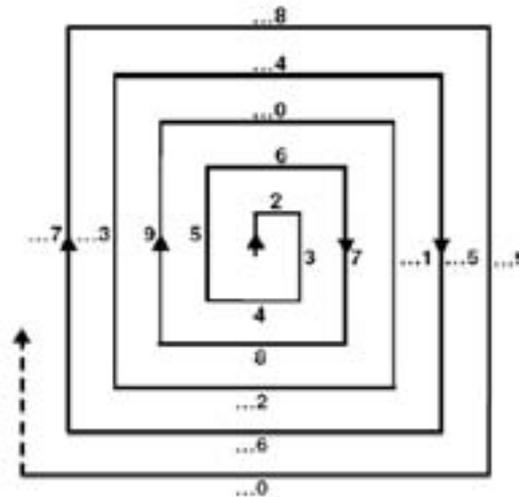
BOX/SQUARE

Datum: ___5 NM SW of___

___Taylor Rk___

Sweep Width (W): ___200m___

Speed: ___12kts___

Initial Leg Time: ___30secs (32)___

PRE CALCULATED COURSES

NORTH 000°	NE 045°	EAST 090°	SE 135°
000°	045°	090°	135°
090°	135°	180°	225°
180°	225°	270°	315°
270°	315°	000°	045°
SOUTH 180°	**SW 225°**	**WEST 270°**	**NW 315°**
180°	225°	270°	315°
270°	315°	000°	045°
000°	045°	090°	135°
090°	135°	180°	225°

Leg	Course		Time	Leg	Course		Time
1	~~045~~	(x...1)	~~30~~	...1		(x...6)	
2	~~135~~	(x...1)	~~30~~	...2		(x...6)	
3	~~225~~	(x...2)	~~1 m~~	...3		(x...7)	
4	~~315~~	(x...2)	~~1 m~~	...4		(x...7)	
5	~~045~~	(x...3)	~~1 m 30~~	...5		(x...8)	
6	225	(x...3)	1 m 30	...6		(x...8)	
7	315	(x...4)	2 m	...7		(x...9)	
8	045	(x...4)	2 m	...8		(x...9)	
9	135	(x...5)	2 m 30	...9		(x...0)	
...0		(x...5)		...0		(x...0)	

Parallel Track / Creeping Line

There are two separate templates for a Creeping Line or Parallel Track - one for a pattern where the first turn is to starboard, the other when the first turn is to port.

In most cases it is unnecessary to write down the course, distance, and time for each individual leg. With an extended search however there is always the chance of the sweep width or track spacing being altered to accommodate other vessels joining the search or a change in visibility / sea state.

PARALLEL TRACK/CREEPING LINE
First turn to Port

Datum: _35°11.8 S   174°10.2 E_

Sweep Width (W): _200m_   Speed: _10kts_

Track spacing (S): _200m_   Cross Leg Time: _39 sec_

Search Leg Length ....   Search Leg Time ....

C............
T............

C............T............   C............
                                   T............

C............   C............T............
T............

C............T............   C............
                                   T............

C............   C.135°............T............
T............

                     C.315°............T............   C............
                                                         T............

C.045°.....   C.135°............T............
T.39 sec.

                     C.315°............T............   C.045°.....
                                                         T. 39 sec

C.135°....T............