Search Techniques

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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.

Constructive feedback and suggestions for improvements to the SAR Training Matrix is appreciated. Please email feedback / suggestions to sartrainingfeedback@coastguard.co.nz **providing as much detail as possible. Thank you.**

Overview

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

1. Developing the Search Plan

Check out this article 'Search patterns' from Paul Glatzel in RIB International

http://tinyurl.com/a5m2cwk

When planning a search many variables will have to be taken into consideration. These will need to be constantly revised and updated during the search.

1.1 Search Planning Sequence

There are six phases to the planning sequence:

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.

This is the most probable location of the target and can be calculated by 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.

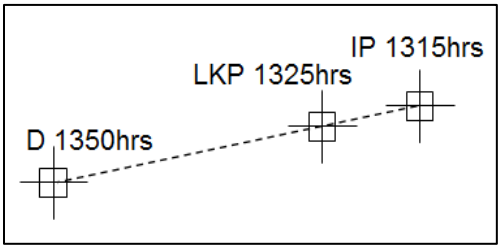
The size of the search area is defined using the calculated datum. Uncertainty over the location of the target at the datum point will result in a minimum search area of 144nm2.

4. Select the Appropriate Search Pattern.
The selection of the appropriate pattern is dependent on datum, size of search area, geographical location, and resources available.

5. Determine the Probability of Detection.
This measure determines the chance of finding the target based on the number of vessels searching and the coverage factor. It measures the effectiveness of the search.

6. Develop a Practical Search Plan.
A practical search plan is a combination of the points above, and the conditions on scene. A record of the key information in any SAROP must be kept on the CRV and updated when required.

2. 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 splash point.

Datum (D)
The most probable location of the target at the time the search commences. This is not the same as the Splash Point as the target may have been subject to drift (due to tide or current and wind) in the intervening time. The datum for the search may be;

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

Leeway can be calculated using the 'Leeway Speed and Divergence Table' from Marine Search and Rescue Management Manual (2010) P113

Target Drift

The direction and distance that a search target is estimated to be moving.
There are two main forces that cause drift;

- *Leeway*. Movement caused by the wind blowing against the surface of the object.
- *Current*. This may be due to tides, sea current, rivers or long shore current.

The Leeway Speed Formula is:

Leeway speed (kts) = (multiplier x wind speed(u) + or – modifier

The Multiplier is the factor applied to wind speed.

The Modifier is the correction factor applied to the leeway speed.

Maximum Detection Range

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

Maximum Detection Distance

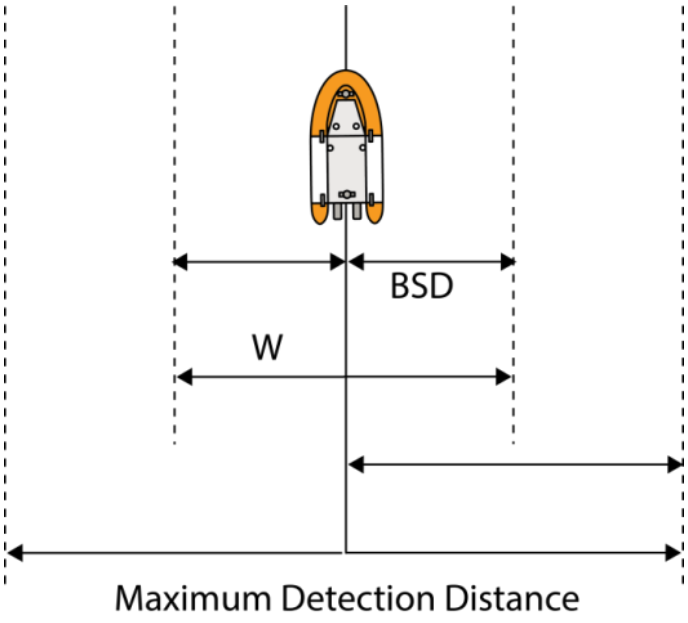
The sum of the maximum detection ranges each side of the vessel.

Beam Sighting Distance (BSD)

The BSD is distance that can be *effectively* searched on either side of the vessel.

Sweep Width (W)

The sum of the distance effectively searched each side of the vessel (beam sighting sum distance x 2).



Activity:
Analysing a scenario

Adapt the positions / location based on local area knowledge for the unit.

Provide copies of a local chart to the crew.

- A distress call was received at 0830hrs (Position A)
- The vessel was sighted again at 1030hrs (Position B)
- The time is now 1330hrs.

- On the chart identify the IP/SP, LKP, D

Identify the Leeway and current used to calculate the target drift and datum

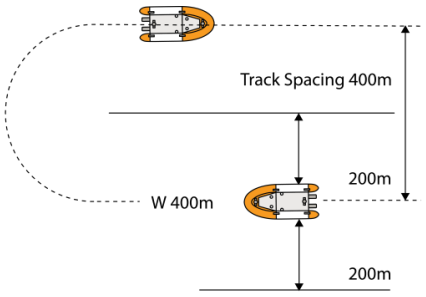
- use prevailing weather, or use local weather knowledge for the scenario – use wind direction and speed typical for the area
- Leeway and drift can be roughly estimated using speed, distance, time formula.
- Show the crew how to more accurately assess leeway and drift.

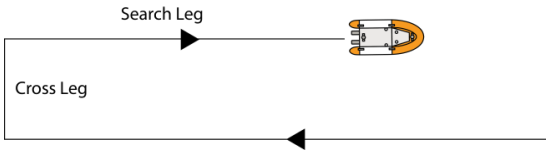
Where would crew place the search area?

Track Spacing (S)
The distance between successive search legs.

Search Leg
Generally the longest tracks in a given search pattern.

Cross Leg
The shorter tracks that connect the search legs.



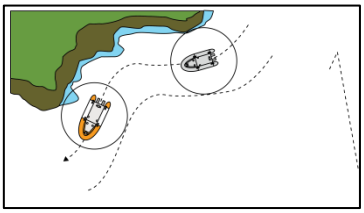


Coverage Factor
A measurement of 'quality' or effectiveness of the coverage in a search area. The coverage is determined by sweep width (W) and track spacing (T). For example;

- 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%)

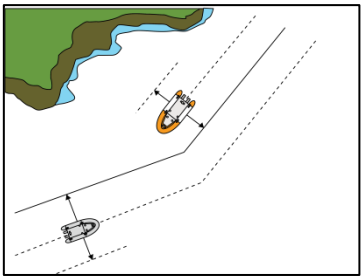
Probability of Detection (POD)
It is based on the coverage of the search area achieved by single or multiple searches with different coverage factors. The POD can be calculated from tables and graphs available in the SAR Management Manual.

3. Search Patterns



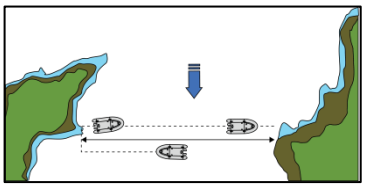
Shore Line Search

Follows the natural contours of the land. Due caution must be taken with regard to any hazards.



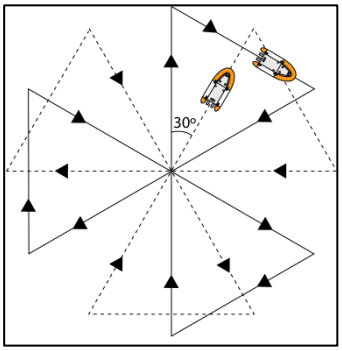
Track Line Search

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).



Barrier Search

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



Sector Search

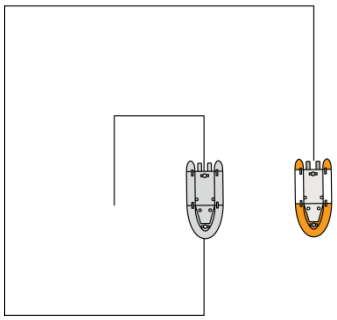
Used when the datum is well established and search area is small. This pattern gives a very high POD, and with pre calculated courses is easily executed.

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 oriented in the probable direction of the target drift. The datum point is marked with a floating datum.

Expanding Square Search

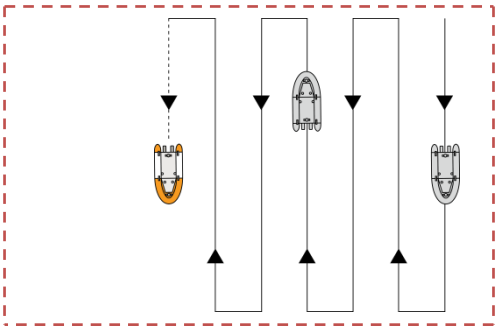
Used when the datum is reasonably well established and not too much time has elapsed. This search does not give as high a POD as a Sector Search.



This search 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 oriented in the probable direction of the target drift.

Parallel Track Search

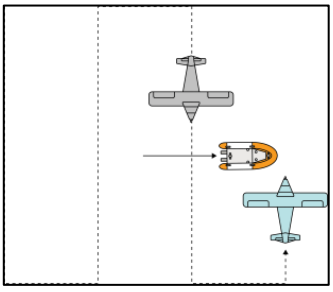
Used when the search area is large and datum not well established. The search legs are parallel to the major axis of the search area. The pattern can be carried out by single or multiple vessels.



Creeping Line Search

Used when the search area is large and datum 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.



Combined Aircraft Vessel Search

The aircraft flies a Creeping Line or 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 midpoint of each of its

"Careful thought is essential when considering search pattern selection and the allocation of specific SAR units to execute these patterns.

Once a large-scale search has been commenced, redeployment of search units or changing assigned patterns becomes complex and should be avoided unless new intelligence indicates such change is mandatory."

From section 5.4.6 National Search and Rescue Manual (2011). NATSAR, Australia.

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.

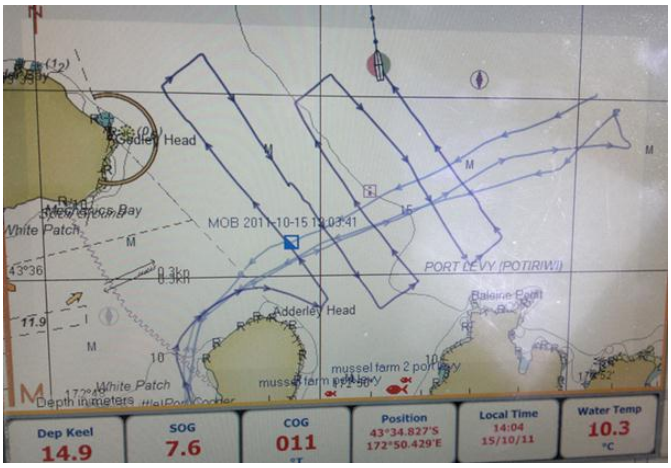
4. Searching and GPS

When searching an area for a target on the water 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.

Electronic aids such as GPS provide navigational data in relation to the seabed not the surface of the sea. The course taken by the CRV through the water will be influenced by wind and current and search patterns will appear distorted.

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 Latitude and Longitude, 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. Don't run a search pattern using the GPS for direction because the coverage of the search area will be affected.

GPS can be used to outline the search area. This can be especially useful in a Parallel Track or Creeping Line Search.

Some chart plotters will allow the operator to draw lines and bearings on the screen which can then become 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 search area regardless of 'zoom'.

Activity:
Searching and GPS

The diagram shows the chart plotter track of a vessel through the water.

Identify;
- Search Pattern
- Track space
- Search leg

The second diagram shows the same search pattern but with a strong tide / current running.
- Have the crew discuss the differences in the two images.
- Discuss why using a GPS for direction can result in significant reduction of the coverage of the search area.

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 Variable Range Marker can be set to show the distance to the edge of the search area.

5. Search Protocols

5.1 Marking the Search Datum

A floating datum can be deployed at the start of some search patterns, such as the Sector or Expanding Square search. When a datum is deployed it is usual to;

- Record the time of the start of the search.
- Enter a waypoint on the GPS.

If the target is not found in the initial search, the floating datum is recovered. The distance from the datum 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 CRVs course can be made to maintain the pattern.

5.2 Pausing or Leaving a Search Pattern

If a search is temporarily suspended for any reason (taking a break to rotate or 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 and track spacing, and the stronger the tide and current then the more important the use of a floating datum becomes.

5.3 Floating Datum

A floating datum is a marker that is deployed in the water. It should be;
Highly visible (brightly coloured with reflective tape and a flag attached).
Have a light or 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.

A floating datum can provide the IMT with crucial real wind and current information.

With a current as little as 0.5kts the body of water will move approx. 200m in ten minutes.

6. 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.

Activity:
Determining Sweep Width

Using the 'Uncorrected Sweep Width' table in the workbook, have crew calculate the sweep width given the following information;

- Target is white fibreglass powerboat
- Has 90HP engine 5POB with PFD's
- Weather is overcast, visibility approx 3NM
- Periods of rain
- Wind is NW 25kt
- Swell is 1.0m SE

Other factors

- List as many factors as possible that may affect sweep width.

How would these factors affect your calculation?

The IMT 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.

6.1 Practical Determination

- Using Radar to verify an objects distance is a useful practice.
- Alternatively an estimate on the objects distance can be made, a waypoint activated and the CRV driven to the object. The GPS will give a reasonably accurate distance travelled by the range to the waypoint.
- Another practice is for the CRV to drive away from the object (typically a small object deployed from the CRV). The time is recorded for the object to be still visible for approximately 50% of the time, which will be the effective sweep width. The comparison of time and speed will give the distance from the object.

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. If the CRV returns to the waypoint to resume the search it will be searching water already searched previously.

6.2 Theoretical Determination

The table of Uncorrected Visual Sweep Width provides uncorrected sweep widths (calm sea, no wind or swell). Below the guidelines are correction factors that can be applied depending on the wind strength and sea state.

7. Establishing Speed

7.1 Time, Speed and Distance Tables

Once a viable sweep width has been established, the next decision is usually what speed should be maintained.

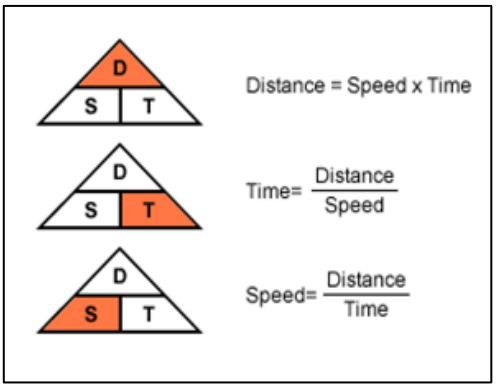
Survivability decreases with the passage of time. Search areas increase with the passage of time.

It should be the fastest speed at which observation is still effective. If the CRVs 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.

Speed and distance tables can be used to calculate the time to complete a search leg at a predetermined speed.



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 or setting up can be time consuming and prone to error. Having an 'easy' time to work with can make all the difference.

8. Search and Rescue Boat Book

The ‘red’ book is usually found on all CRVs. This manual contains search templates, uncorrected visual sweep width tables, speed-distance-time tables and checklists that can be used in SAROPS.