Chapter 5: Search Techniques and Operations

5.1 Overview

5.1.1 Chapter 4 described how to determine the optimal area where the available search effort should be deployed. Once the optimal search area has been determined, a systematic search for the search object should be planned. Before a search operation takes place, the search planner should provide a detailed search action plan to all involved, specifying when, where and how individual search assets are to conduct their search operations. Coordination instructions, communications frequency assignments, reporting requirements, and any other details required for the safe, efficient and effective conduct of the search must also be included in the search action plan.

5.1.2 As a minimum, developing a search action plan consists of the following steps:

a) Selecting search assets and equipment to be used;

b) Assessing search conditions;

c) Selecting search patterns to cover the optimal search area as nearly as may be practical;

d) Dividing the search area into appropriate sub-areas for assignment to individual search assets; and

e) Planning on-scene coordination.

***Note**: RCC Australia uses a computer-based program to design search areas, assign search patterns, allocate assets to a search area and create briefings for search assets. The program uses the same data as is provided in this Manual.*

5.2 General Guidelines for Searches

Overview

5.2.1 As discussed in the previous chapter, a search typically involves three stages including the immediate response, a search based on a nominated area either side of track, and a search based on a mathematically derived search area. This applies equally to aviation searches as well as maritime searches, whether using oceanic principles or those of the coastal search plan. The following sections describe these stages in further depth.

Stage One Search. Immediate response

5.2.2 The stage one or initial search normally consists of:

a) A visual search along, and possibly also parallel to, the track of the missing craft;

b) Action to detect a signal from an emergency beacon;

c) Formulation of a rescue plan;

d) Coordination with Police, Airservices Australia and other agencies as appropriate; and

e) For over water searches, dropping of SAR datum buoys to establish drift.

5.2.3 The stage one search may comprise:

a) Single or multiple Track Line searches;

b) Implementing procedures to detect a signal from an emergency beacon, such as monitoring by aircraft flying over the area; tasking a dedicated search unit; monitoring by aircraft or vessel on a visual Track Line search; monitoring by passes of the satellite system;

c) Developing a rescue plan to return survivors to a place of safety;

d) Preparing aircraft with SAR droppable supplies;

e) Arranging observers; and

f) Gathering intelligence relevant to the search.

5.2.4 The SMC should consider:

a) Diverting aircraft or ships if they are available;

b) Tasking aircraft from an SRU or local resources where the urgency of the situation and the locality will determine the assets to be used;

c) That a surface response for search or rescue may be required;

d) That the height and track spacing of search aircraft can be higher than book values as there is an expectation that an active target may be available to assist;

e) That the coverage factor should generally not be less than 0.5; and

f) The use of electronic or thermal imagery equipment.

Stage Two Search. Nominated Area Either Side of Track

5.2.5 A stage two search is normally not required for a maritime incident. During stage two, the search area is normally 10 NM either side of the missing craft's track. It may be reduced or extended either side of the track after consideration of the following factors, as applicable:

a) The height and speed of the missing aircraft;

b) Possible actions of the missing craft during an emergency, e.g. an aircraft searching for a suitable area to land or attempting to reach land if flying over water;

c) A ferry flight using GPS;

d) A scenic flight; and

e) Drift, if applicable.

5.2.6 A Stage Two search may comprise:

a) A number of aircraft and surface units assigned an area (normally ten legs) to conduct a visual search;

b) Helicopters assigned a specific area to conduct a visual contour search;

c) Arranging observers;

d) Provision of a dedicated communications aircraft;

e) Preparing and deploying aircraft with SAR droppable supplies;

f) Provision of a surface search and or rescue response;

g) Establishment of a Forward Command Post or Forward Field Base;

h) Implementing a structured rescue plan;

i) The use of thermal imagery to locate the target; and

j) Establishing an intelligence cell.

5.2.7 The SMC should consider:

a) Drift if the search is over water and it begins more than four hours after Splash Time;

b) Location of deployed SAR Datum Buoys to establish water movement;

c) Exercising caution in using aircraft with an endurance of less than four hours;

d) Increasing the distance either side of track following an unsuccessful search or searches;

e) Ensuring the search area includes the possible departure path and the approach pattern areas at both the departure and destination aerodromes; and

f) Increasing detection time over rugged terrain or rough seas.

Stage Three Search. Mathematically Derived Area

5.2.8 A Stage Three search is a further development of Stage Two, where the search area is expanded to cover the probability area calculated by reference to the missing craft's and search aircraft's navigation errors, modified by intelligence and any allowance for drift. This probability area will be expanded after each successive search, thus increasing the total area being searched and incrementally increasing the POD over the centre of the search area.

5.2.9 The SMC should consider:

a) The on-going availability of search aircraft;

b) Provision of a suitable surface response;

c) The on-going availability of search crews, including pilots and observers;

d) Accommodation and financial arrangements for observers if operating away from home base;

e) Logistical support including availability of fuel for search aircraft if operating from more remote airfields;

f) Refining rescue plans including deployment of rescue units to the area if considered beneficial;

g) Location of deployed SAR Datum Buoys to establish water movement;

h) Further deployment of supply dropping aircraft; and

i) Any further avenues to obtain intelligence.

5.3 Search Area Coverage

General

5.3.1 Once the search area has been determined, a systematic search for the target should be planned. Factors such as the weather conditions, time available for search, aircraft speed, search altitude, sighting range, size of target, etc, should be taken into account. These factors are related but some may be more important than others. In planning a search operation, the SMC should endeavour to meet the requirements of the more important factors while satisfying the requirements of the others as far as practicable.

5.3.2 Search Area coverage is the systematic search of selected areas of land, or water, to ensure the optimum probability of detecting the object being sought. The factors affecting detection capability have been reduced to four inter-related expressions. The terms and their symbols are:

a) Sweep Width (W)

b) Probability of Detection (POD)

c) Track spacing (S)

d) Coverage Factor (C)

5.3.3 The type and number of available search aircraft will be a factor in determining search area coverage. More time will be required to search a large area thoroughly when there are limited numbers of search aircraft available unless the distance between successive sweeps of the area is increased. This is not desirable since it would reduce the probability of detecting the target. It may, therefore, be necessary to seek additional search aircraft from other sources. It is usually preferable to cover a search area from the beginning with an adequate number of search aircraft.

5.3.4 When the aircraft operate far from their home base, consideration should be given to them being redeployed at an advance base so that more time will be available for the search and less time will be spent on flights to and from the search area.

5.3.5 An adequate number of well-placed, trained observers as well as altitude and speed of the search aircraft are important factors determining the POD of a target. A slow aircraft will increase the chance of detection of the target.

Sweep Width (W)

5.3.6 Sweep Width, "W", is a function of Search Visibility. It is the ideal width of the area that should be scanned after the appropriate correction factors have been applied.

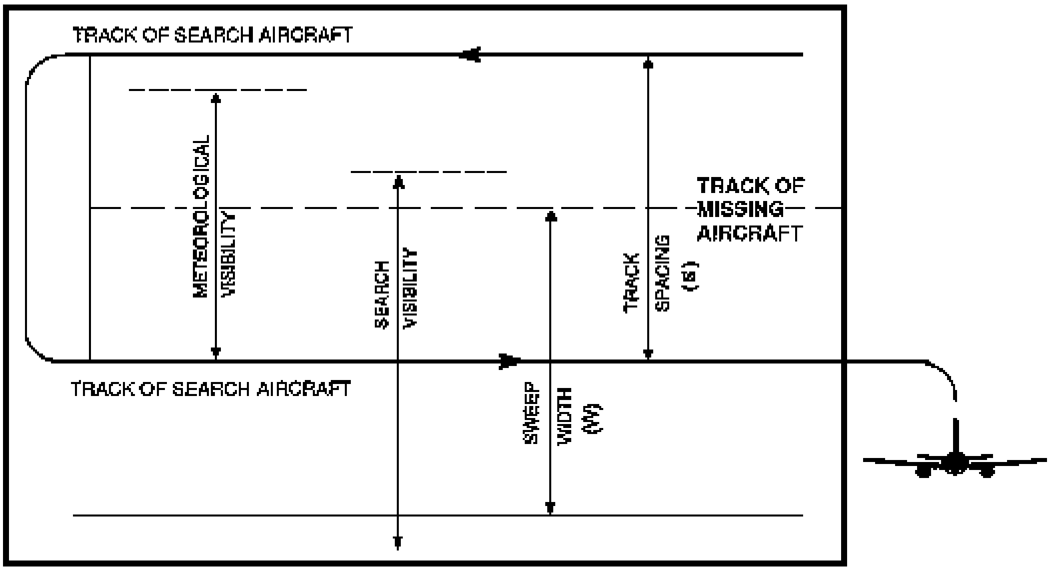


Figure 5-1 Sweep Width

Factors affecting Sweep Width

5.3.7 Search visibility and sweep width are equally split across the search track of a searching unit (refer Figure 5-1). Search visibility is the range within which a particular search target has a reasonable probability of being detected. Search visibility as affected by the numerous factors discussed below will constitute sweep width.

Type of Target

5.3.8 The sweep width will depend on the type, size, colour and shape of the target, its colour contrast with the surrounding medium, amount of freeboard, and whether or not the target is moving. Targets may vary from wreckage of an aircraft on land to a person in the water. All targets should be sought from a direction in which they receive the best illumination, colour brightness or contrast. Over water, this is usually the direction in which whitecaps can be seen at the farthest distance.

Meteorological Visibility

5.3.9 If visibility conditions are poor, the subsequent reduction in sweep width and POD may cause an interruption or necessitate a suspension of search effort, e.g.:

a) Fog makes visual search ineffective if not impossible. Only an electronic search to determine the approximate position of the target, or, perhaps, a ground search, may normally be an appropriate option;

b) Smog and haze may reduce the effectiveness of daylight search and, to a lesser extent, night signals;

c) Low clouds may render search ineffective or impossible;

d) Precipitation reduces visibility; and

e) Terrain or Sea Condition.

Type of Terrain / Conditions of the Sea

5.3.10 The type of terrain to be searched obviously affects the ease with which the search target will be detected. The more level the terrain the more effective will be the search. Not only can the search aircraft maintain a constant search altitude, but also there is less likelihood that undulations or irregularities on the terrain surface will hide the distressed craft, wreckage or survivors. Thus calm water areas and flat deserts are easier to search than rough seas or rolling hills, while rugged mountain areas are the most difficult. The more trees, vegetation, rock outcroppings and other surface irregularities that exist on land, the more difficult will be the search. Likewise the more whitecaps, wind streaks, foam streaks, breaking seas, swell systems, salt spray and sun reflections, the more difficult will be a search over water.

5.3.11 In addition, patches of seaweed, oil slicks and flotsam may be mistaken for liferafts, or worse, a liferaft may be mistakenly identified as seaweed or flotsam. On a glassy sea any object, or disturbance, will probably attract the attention of the eye. On a glassy or smooth sea accompanied by a swell system, chance of detection is also good, being lessened primarily by the intervals in which the object is in the trough between swells. During such intervals, the object may be hidden from the observers of a low-flying search aircraft or the lookouts of a ship. With small targets on glassy seas, however, difficulty will be experienced in detection due to the reflections of sun, sky and clouds on the sea surface.

5.3.12 The presence of whitecaps and foam streaks on the water breaks the uniformity of the surface and markedly reduces lookout effectiveness. As the whitecaps become more numerous, the probability of detecting a small object becomes less. With numerous whitecaps and foam streaks in a heavy, breaking sea, even very large objects are difficult to detect, and small objects are unlikely to be detected at all.

5.3.13 With high winds, which accompany rough seas, visual aids are rendered less effective. Dye marker tends to dissipate rapidly and smoke signals cling close to the surface and cannot be differentiated from the foam streaks. The reflection of the sun off the breaking seas and whitecaps tends to dull the perception of lookouts to visual signals. With high winds, the wind-driven salt spray constitutes a very real visual obscuration due to both a reduction in visibility and the accumulation of salt on the search craft's windows.

5.3.14 Rough seas also adversely affect radar detection due to the large amount of sea return on the scope, and the fact that small targets in the trough of a sea cannot be detected.

Search Aircraft Speed

5.3.15 At low search altitudes the speed of the aircraft will affect the sweep width due to the angular velocity of targets moving through the radar scanner's field of view, blurring of targets at very close ranges, and decreasing the exposure time of targets to the scanner. Generally, higher speeds will increase the adverse influence of these factors at search altitudes below 500 feet.

Fatigue Factor

5.3.16 The effectiveness of observers depends on the number available, their experience, alertness, physical condition, incentive and the suitability of observing positions. The speed at which the search unit moves also has a direct relationship to the effectiveness of the observers' overall performance.

5.3.17 If feedback from the search unit indicates that search crews were excessively fatigued, use a correction figure for fatigue and reduce the sweep width by 10 percent (multiply the uncorrected sweep width by 0.9).

Search Aircraft Height

5.3.18 Several factors; the prime ones being the size and nature of the target being sought, and the surface conditions surrounding the probable location of the target dictate the selection of the search height. Recommended search heights for particular targets are listed in Table 5-1.

Over Water	**Recommended Height**
Survivor without raft or dye marker	Below 500FT
Survivor in raft without dye marker, or signalling equipment	800-1500FT
Survivors with dye marker	1000-2000FT
Survivors with signalling equipment and/or radar reflector	1000-3000FT
Over Land	Recommended Height
Level terrain with little or no foliage	1000FT
Level terrain with heavy foliage	500FT
Mountainous terrain (height selection governed by turbulence and foliage density)	500-1000FT

Table 5-1 Recommended Search Heights

5.3.19 Meteorological conditions must be taken into account when selecting search heights. Turbulence, cloud base, and visibility, are the chief considerations.

5.3.20 For reasons mostly related to the apparent movement of the surface below a search aircraft, certain minimum heights are recommended according to an aircraft's speed. They are:

a) 2000 FT, where the speed exceeds 200 KTS; and

b) 1000 FT, where the speed is between150-200 KTS.

5.3.21 Advantage should be taken of the characteristics of helicopters to search at low level, possibly in conjunction with fixed wing aircraft operating at higher levels above. This practice is supported by resolutions A.225 (VII) - Homing Capability of search and rescue aircraft and A.616(15) – Search and rescue homing capability.

5.3.22 Search heights will be quoted as height above ground level (AGL) or above mean sea level (AMSL).

Cloud Cover

5.3.23 The greater the amount of cloud cover, the less will be the ambient light in the search area. This has a detrimental effect on the sweep widths of surface targets. In addition the variable surface shadows caused by scattered or broken clouds make it more difficult to visually detect targets due to the constant dulling effect of the shadows and the mottled appearance of the surface. Although a high, solid overcast will eliminate glare, shadows and reflection from the surface, this advantage is not as large as the detrimental effect of less ambient lighting.

Position of the Sun

5.3.24 Objects are seen at a greater distance when looking down-sun as opposed to up-sun particularly when the sun is in a position to reflect from water. With a clear sky and a bright sun, search conditions are at an optimum between mid-morning and mid-afternoon when the sun is high. Waterborne objects that have a high free board may sometimes be seen even in the sun's glare. Bright sunlight is especially detrimental when haze is present, due to the diffusion of light. Colour contrast is lost when looking up sun, with the result that small objects merge into a confused pattern of glaring light and shadow. Down-sun the sea appears much darker, glare is absent, haze is more transparent, and coloured objects show a marked contrast to their background. Observers forced to look into the sun suffer loss of visual acuity, and may fail to detect an object. When possible, search legs should be orientated to prevent observers having to look directly into the sun. If this is not possible observers should be equipped with sunglasses.

Day and Night Factors

5.3.25 In some conditions of wind and sea, daylight visual aids may be ineffective. The heliograph is an exception, but sunlight cannot always be expected. Sea conditions and wind have little effect on a night flare search, or on lights. When high winds and seas prevail, night search techniques usually offer the best POD. The quantity of pyrotechnics available to survivors is usually limited, and survivors are unlikely to fire pyrotechnic signals until sighting the lights of the search unit. For this reason sweep width for a night search should be based, not on the expected sighting range of the pyrotechnic aids, but on the range at which survivors may see the navigation lights of the search unit. On entering a search area, search units should turn on all possible lights, and from time to time display searchlights, or landing lights, to facilitate sighting of the search unit by survivors; however observer night vision needs must be taken into account. Ships in a search area should be asked to make smoke at intervals, during daylight hours.

First Search Light / Last Search Light

5.3.26 Times of first and last light at the departure and destination points may limit the time available in a search area when all or part of a flight is governed by Visual Flight Rules.

5.3.27 Any limitations to visual searching indicated in a search forecast must be allowed for at the planning stage.

5.3.28 The 45-minute periods after sunrise and before sunset are considered unsuitable for daylight visual searching due to visibility restrictions produced by the low elevation of the sun, causing lengthy shadows.

5.3.29 These periods are therefore commonly discounted for visual search at the planning stage. The periods may, however, be varied at the SMC's discretion to accommodate local conditions. There may be other factors arise that impact upon search planning with greater moment thus indicating the relative suitability of visual search during some or all of these periods.

5.3.30 Within proximity of the equator, where the apparent movement of the sun is at a greater angle to the earth's horizon and its rising and setting phases more rapid, these periods are less critical.

5.3.31 Examples of local factors that may need to be considered in the context of available search light are:

a) A search over tropical rain forest may best be started at dawn in consideration of a likely deterioration in local weather conditions later in the day;

b) A search of the western slopes of steep sided valleys may best be delayed until mid-morning; and

c) A search of steep eastern slopes may best be abandoned earlier than 45 minutes before sunset.

5.3.32 Time available to aircraft outside the periods suitable for visual search may be utilised in other ways, for example, beacon homing, radar search or FLIR search.

Miscellaneous Factors

5.3.33 Among the miscellaneous factors affecting sighting are shadows cast by clouds, rain showers, large patches of seaweed, and pure chance. Shadows cast by scattered and broken clouds are a distracting influence on the observers. Rain showers can result in areas not being searched effectively, as the object of search may be hidden by a squall. Despite all other factors, some sightings are made as a result of pure chance. An observer may just look at the right spot at the right time, conversely a momentary lapse on the part of the observer may allow the object of search to be passed unseen. The only safeguard against this possibility is to make repeated searches of an area if sufficient search units are available, and the use of the maximum number of observers.

5.3.34 Searches begun early in the day, or extending late in the day have reduced chance of success in wooded terrain due to the shadows cast by the trees and the oblique angle of the sun. These areas are preferably searched when the sun is higher in the sky. Likewise because of the sun, mountainsides may be better searched in the early or late in the day depending on the direction the particular slope faces.

5.3.35 Different search heights will produce different sweep width values. It is good practice to calculate sweep widths for several search heights, enabling the search planner to select a sweep width to suit a search height dictated either by the target, or one best suited to the search aircraft to be used.

Sweep Width Calculations (W)

5.3.36 Tables of uncorrected sweep width values and correction factors are provided in Appendix I Tables I-3 to I-6. The sweep width used in planning and evaluating the search is computed as the product of the uncorrected sweep width and all the correction factors that apply. When using Table I-7 of the Appendix for weather correction factors use the worst case. Therefore if the wind is 10 knots but the sea is 5 ft, use the figures in the second row.

Track Spacing (S)

5.3.37 **Track Spacing (S)** is the distance in nautical miles between adjacent search legs. The desired track spacing is a function of detection capability. The more difficult the target to detect, the closer the search legs should be. Decreasing the track spacing increases the POD, but at the expense of reducing the area searched in a given time. There is a limit to which S may be reduced due to the limits of search unit navigation ability and accuracy. The optimum track spacing is one, which permits the maximum expectation of target detection in the available time, or is consistent with the economic employment of search units. Whenever possible Track Spacing (S) should be used that is equal to the Sweep Width (W).

***Note**: For the coastal search model, the following standard track spacings are recommended on search objects less than 30 feet high.*

5.3.38 **Good Search Conditions**. In conditions where the wind speed is less than 15 knots and/or visibility is greater than three (3) NM, use a track spacing of up to three (3) NM by day or night but reduce the separation depending on the size of the search target. After dark, the effect of the searchlight should be considered.

5.3.39 **Poor Search Conditions**. Where winds are greater than 15 knots and /or visibility is less than three (3) NM but greater than one (1) NM, a track spacing of one (1) NM should be considered by day or night but reduced depending on the size of the search target. After dark, the effect of the searchlight should be considered.

5.3.40 **Person in Water**. When searching for a person in the water it should be assumed that the person is not wearing a floatation device and will therefore be more difficult to detect. For good search conditions a track spacing of 0.25 NM should be considered. For poor search conditions, the track spacing should be reduced as appropriate, taking into account the visibility and the navigational and operational capabilities of the search units.

Note The track spacing suggested is given as a guide only. The track spacing used in any one search will be decided by the SMC in consultation with the OSC taking into consideration all the available information at the time.

Coverage Factor (C)

5.3.41 The quality of coverage for any sweep depends on the relationship between Sweep Width and Track Spacing. The relationship is termed Coverage Factor.

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

5.3.42 The relationship between Sweep Width and Track Spacing determines the Probability of Detection (POD).

5.3.43 Higher coverage factors indicate a more thorough coverage. Higher values of C offer a higher probability of target detection, however the higher POD is not proportional to the extra search effort required.

5.3.44 Whilst a coverage factor of 1.0 is most desirable there are occasions when terrain, time limitations, large search area, or shortage of search craft, prevent its attainment. For such occasions an alternative approach must be used that balances the factors of available search hours, size of area and C.

5.3.45 A coverage factor of less than 0.5 is unsatisfactory in itself.

Probability of Detection (POD)

5.3.46 Probability of detection (POD) is the statistical measure of search sensor detection performance. It is a function of sweep width and track spacing. It is a conditional probability meaning that search planners assume the search target is in the search area.

5.3.47 A definite POD exists for each scan made by a search observer or piece of detection equipment. The probability that a contact will be made in a single scan of a point on the surface is called the instantaneous POD. The instantaneous POD, repeated by successive scans as the search unit moves along the track, develops the probability pattern of a given search. The POD is not uniform over the swept area. In general, it is highest near the search unit and decreases with distance from the search unit.

5.3.48 POD is a function of the coverage factor (c), which itself is derived from the relationship of sweep width to track spacing; and the total number of searches in an area. For repeated searches of the same area, the cumulative POD is obtained by making use of the average coverage factor. The application of this concept results in a progressive increase in the POD of a target in the most likely sector of the search area by repeatedly searching the original area within progressively larger areas, a part of each overlaying the original. Thus there results an aggregate POD after successive searches of part of a probability area. For each successive search, the safety factor is increased, and, as a result, the size of the probability area is enlarged. It is not to be thought that early search effort should be restricted in anticipation of the benefits of the expanded search technique; these will take time to accrue, and time, in the rescue of survivors, is of the essence. Neither should a particular search be prolonged unnecessarily in similar anticipation. Still, the concept of expanded search does allow flexibility in search planning in as much as the desired quality of search, if unattainable on account of limitations in the availability of search units, may be attained by repeated effort, while ensuring that the most likely area is rapidly and repeatedly covered.

	Coverage Factor 1	Coverage Factor 0.5
Initial Search (R1)	78% POD	47% POD
First Expansion (R2)	95.6	71.9
Second Expansion (R3)	98.9	85.1
Third Expansion (R4)	99.7	92.1
Final Expansion (R5)	99.9	95.8

Table 5-2 Coverage Data Example

5.3.49 The data in Table 5.2 confirms that by making five searches of the initial probability area, each to a coverage factor of 0.5, the cumulative POD (95.8%) is only slightly less than if the same five searches had each been made at a coverage factor of 1.0, (99.9%). The search effort in the former case would have been considerably less in terms of aircraft hours than in the latter. Further, a significantly larger area surrounding the initial probability area would have been searched, albeit at a progressively diminished level of intensity.

5.3.50 From the foregoing, it is apparent that for prolonged and repeated searches when aircraft numbers are limited, a coverage factor of 0.5 offers a reasonable coverage of an expanded area resulting, over time, in a good POD. Search of areas at a coverage factor less than 0.5 is not recommended.

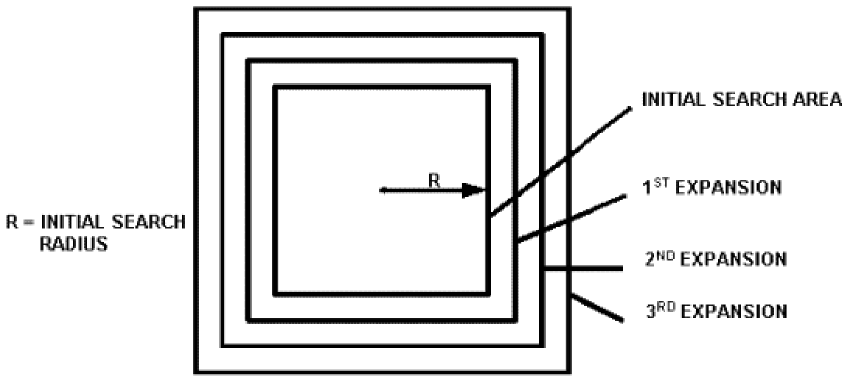


Figure 5-2 Search Area Expansion (Not to Scale)

5.3.51 Statistically, the target is more likely to be nearer the last known position, or datum, than in the outer reaches of the expanded search area. Application of the expanded search concept ensures that the greatest search effort is concentrated over the most probable position of the target where the POD is highest. Clearly, the expanding search procedure is best suited to situations where the approximate position or, at least, the planned track of the distressed craft is known.

5.3.52 When using POD Graph in Appendix I, the POD for any particular search is obtained by reference to the appropriate Search graph line depending on the search conditions apparent. For repeated searches of the same area, enter the graph with the average coverage factor and refer to the graph line relevant to the overall number of searches to obtain cumulative POD. The results are shown as:

1ST Search	Coverage Factor	0.5
2nd Search	Coverage Factor	0.7
3rd Search	Coverage Factor	0.3
4th Search	Coverage Factor	0.2
5th Search	Coverage Factor	0.3
		2.0
Over 5 searches, the average coverage factor =		0.4

5.3.53 In entering Graph 2 with an average coverage factor 0.4, the cumulative POD after five searches may be read off from fifth search graph line as 92%.

5.3.54 The projected value of the POD may be used by an SMC in deliberation of track spacing. Use of POD may also be conveniently made in describing the results of a search, or part of a search, to interested persons not familiar with search planning techniques.

5.3.55 Should the target not be located within the fully expanded probability area, the SMC must decide whether to continue searching it, recalculate the probability area using alternative data, or recommend the termination of search effort.

Accuracy of Navigation by Search Units

5.3.56 The navigational accuracy with which a search aircraft is able to reach a search area and fly a search pattern has an important bearing on the coverage of the area and the POD. Dead reckoning navigation alone generally produces poor results. Map reading can be effective but normally only over land or coastal areas in visual meteorological conditions. In areas where navigation aids are limited, search patterns should be selected so that greatest possible use is made of them. Aircraft with area navigation capabilities can be used for all search patterns in all areas. Alternatively, patterns providing a reference point or a visual navigation aid, e.g. a vessel or a smoke float should be considered.

5.4 Search Patterns

General

5.4.1 The selection of a search pattern is very important and should only be made after all factors have been considered. The search pattern selected should meet the following criteria:

a) **Suitability**: It should permit the search to be completed within the time limits;

b) **Feasibility**: It should be within the operational capability of the available search units;

c) **Acceptability**: The expected result should be worth the estimated time and effort;

d) **Safety of the search units**: Close attention should be paid to air traffic in the area of the search. Normally more than one aircraft should not be assigned to a search area segment at the same time. Multiple aircraft operating in the same search area distracts aircrew attention from the search and decreases the flexibility to respond to sightings and drop markers or flares, if required. This does not preclude an electronic search from taking place at high altitude while a visual search is done at a lower level.

5.4.2 To assist with the pilot's responsibility of maintaining separation from other aircraft, the SMC may consider assigning aircraft in adjacent search area segments different search heights, the same creep direction and different start times.

5.4.3 Non-search aircraft can be informed about the search by the issue of a NOTAM.

5.4.4 Non-search aircraft can be excluded from the search area, or informed about the search activity by the issue of a NOTAM.

5.4.5 The choice of search pattern is the prerogative of the SMC, who may elect to use only one pattern or several patterns simultaneously but in different areas. A series of search patterns may be used in sequence for the same area, e.g. track crawls, sector search. The following factors will influence the SMC's selection of search pattern:

a) The accuracy of the distress position;

b) The size and shape of the search area;

c) The number and type of SRUs available;

d) The enroute and on-scene weather;

e) The distance between search area and SRU base;

f) The availability of navigation aids in the search area;

g) The size and detectability of the search object;

h) The desired probability of detection;

i) The limitations of time; and

j) The terrain of the area where the search will be conducted.

5.4.6 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.

5.4.7 There are six main groups of search patterns:

a) Track line;

b) Parallel track (search legs are aligned with the major axis of an individual search area);

c) Creeping line (search legs are aligned parallel with the minor axis of an individual search area);

d) Expanding square;

e) Sector; and

f) Contour.

5.4.8 When it is known, or likely, that an emergency radio beacon may be available in the target vessel or aircraft or to the survivors, an electronic search using an appropriate pattern, (e.g. track line search), should be carried out by at aircraft flying at a high level. This may occur at the same time as a visual search is carried out at a lower altitude or on the surface. In planning this search the coverage and possibility of detection by the Cospas–Sarsat system may be considered. It is also valuable to consider the location of the incident and the possibility of overflying aircraft detecting a signal.

5.4.9 Maritime units may search relatively small areas. This type of search is generally very thorough and provides a greater chance that the target will be detected.

Navigation of SAR Units

5.4.10 The navigational accuracy of available search units is a primary consideration for selecting the types of patterns to be used, particularly if the available search units are aircraft. While the accuracy of navigation of surface craft is generally not too great a problem, aircraft present a more difficult picture due to drift from prevailing winds.

5.4.11 The probability of detection curve is valid only when the search pattern tracks are accurately followed.

5.4.12 Significant errors will result from accumulated errors in turns and from wind forecast errors, especially for high-speed aircraft. Consideration must be given to selecting the type of pattern, which gives minimum turns and maximum search leg lengths in order to reduce turning errors and to make it easier for navigation, observations and corrective action. However, there may be a limit to the maximum search leg lengths when the search area covers water surfaces with strong currents or with high survivor drift rates. In these circumstances aircraft search legs are usually limited to 30 minutes or less of flying time if the legs are oriented across the drift direction. This is to avoid the possibility of the survivors drifting from one side of a track to beyond the next search track by the time the search aircraft returns to that same general area. A more satisfactory solution to this problem is to orientate the search legs with the drift direction.

5.4.13 Greater search accuracy is obtained when visual, radar or radio navigational aids are within reception range of search units or when aircraft are equipped with area type navigation equipment (RNAV) e.g. GPS or Inertial Navigational Systems (INS).

5.4.14 When dividing up the total search area into areas for assignment to individual SAR units it should be kept in mind that elongated search areas are covered better navigationally than small square areas. When two or more search aircraft are available, elongated search areas are preferred.

Parallel Track Search Patterns

5.4.15 Parallel track search patterns can be used for searches involving one or a group of search units and are the simplest patterns available. The coxswain of a search vessel steers straight courses or legs, each leg being one track spacing from the other. The legs are parallel to the long side of the search area.

Parallel Track Pattern Single Unit

5.4.16 This pattern is conducted by a single unit. The SMC will detail the area to be searched by giving depth and distance, visual reference points or latitude, longitude if the Search Unit is so capable.

Parallel Track Pattern Multi-Unit

5.4.17 This is based on the same principle as the single unit search, except that more than one boat is searching in line abreast, one track spacing apart. It is particularly useful when a number of search units, fishing boats or pleasure craft are available for searching an area and can be instructed what to do by radio. The OSC will direct the search from his position with all turns and distances taken from the OSC's vessel.

Creeping Line Patterns

5.4.18 These are the same type of searches but the legs are parallel to the short side of the search area. These patterns would be used when there is a stronger probability of the craft in distress being closer to one end of the search area. The search unit begins the pattern at the end of the search area where the target is most likely to be. These patterns can also be used both in single and multi-unit searches.

5.4.19 The multi-unit creeping line pattern is used when there are five or more search units available in a search of a high probability area for small size targets, such a person in the water. This pattern concentrates the search units in the datum area and is structured to avoid gaps developing at the end of each sweep.

5.4.20 Search units pivot on the second search unit. By the time the first, second and third vessels take up their allotted positions, the fourth and fifth search units will have moved with the prevailing drift to position them at the top of the next sweep. This method will ensure total coverage of the search area, however, it must be borne in mind that this pattern is slower than other patterns and requires a greater degree of coordination by the OSC.

Night Time Consideration Multi-Unit Searches

5.4.21 Extreme care should be taken during multi-unit searches to maintain the observers' night vision whilst working in close proximity to search lights. The operators of searchlights should always remain aware of this concern and direct the search light from a bearing right ahead to a bearing of approximately 45° to port or starboard.

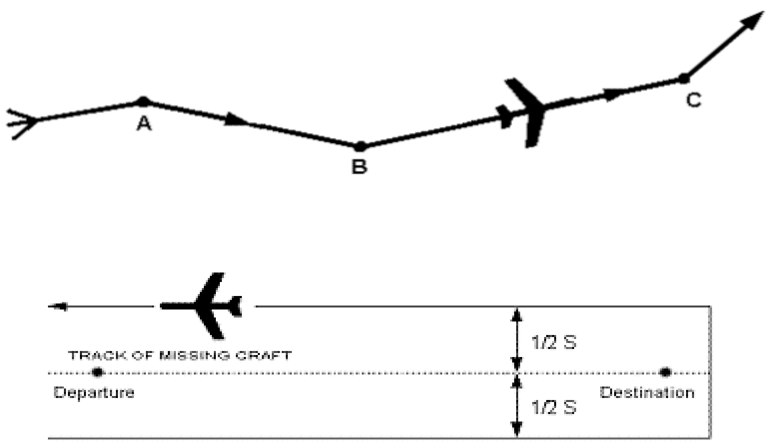
5.4.22 For small targets such as a person in the water, search unit track spacing must be adjusted so that the beams of the searchlights maintain a good overlap at all times.

5.5 Visual Search

Track Line Search

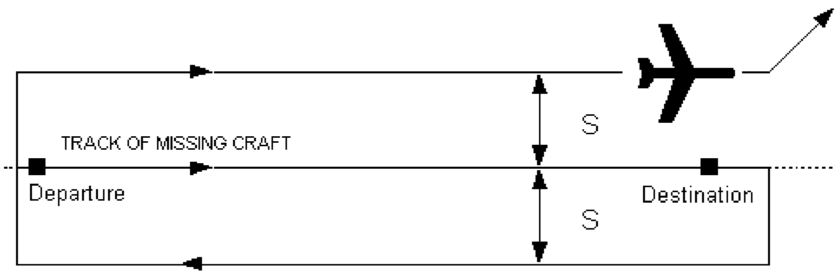
5.5.1 This procedure is normally employed when an aircraft or vessel has disappeared without a trace. It is based on the assumption that the target has crashed, made a forced landing or ditched on or near the intended route and will be easily seen, or that there are survivors capable of signalling their position by a flashing lamp or other means. It consists of a rapid and reasonably thorough search on either side of the intended route of the target, normally at a height of 1000 to 2000 FT during day or at 2000 to 3000 FT at night. A track line pattern is often used as an initial reaction to a distress situation, the second, intensive phase being introduced on the failure of the track line search.

5.5.2 Aircraft and ships following the same route as that of the missing aircraft or ship should be asked if they are available to divert to assist in the search for the target. For ships, this will mean diverting to intercept the most probable track line of the target. For aircraft, this type of search should be regarded as additional to searches by SAR units, as an enroute aircraft may not be entirely suitable as a search platform due to its performance, configuration, endurance, navigational capabilities or lack of observers.



Where search aircraft returning back along track.

Figure 5-3a Track Line Search



Where search aircraft not returning back along track

Figure 5-3b Track Line Search

Parallel Track Pattern

5.5.3 Parallel track patterns are normally used when:

a) The search area is large and the terrain is relatively level, e.g. desert and maritime areas;

b) Uniform coverage is required; and

c) The location of the target is not known with any precision.

5.5.4 Search legs are aligned parallel to the major axis of the individual search area. The pattern is best used in rectangular or square areas. It is a very suitable pattern for a search conducted over water. The search aircraft proceeds from one corner of the search area maintaining parallel tracks, the first of which is at a distance equal to one-half the track spacing from a side of the area. Successive tracks are maintained parallel to each other and one track spacing apart. This type of search may be carried out by one aircraft or by several aircraft following parallel tracks or each searching smaller rectangular areas separately.

5.5.5 When aircraft search hours and adjacent traffic permits, turns will be conducted outside the search area boundaries as shown in Figure 5-4. This allows observer rest and crew position changes.

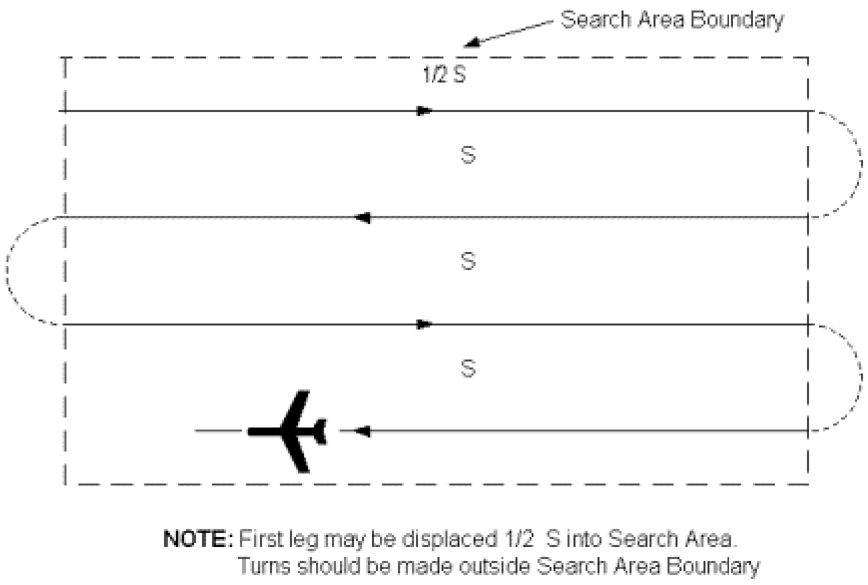


Figure 5-4 Parallel Track Search Pattern

Drift Compensation

5.5.6 In maritime areas where there is a high drift rate, care must be taken to ensure the target does not drift out of a SAR unit's area. This problem occurs when the rate of creep of the SAR unit is less than the rate of drift of the target.

5.5.7 When this condition exists some methods of resolving the problem are to:

a) Align the SAR units search legs with the drift vector;

b) Use shorter legs for the SAR unit to increase the rate of creep; and

c) Increase the SAR unit's speed.

Expanding Square Search

5.5.8 This procedure is referred to as an expanding square search as it begins at the reported position or most probable location and expands outwards in concentric squares. It is a very precise pattern and requires accurate navigation. To minimise navigational errors, the first leg is usually oriented directly into the wind.

5.5.9 The square search pattern is used when the target is known to be in a relatively small area, no more than 15-20 NM from the start point.

5.5.10 The first two legs are held to a distance equal to the track spacing and every succeeding two legs are increased by another track spacing. Turns may be to the left or right, depending upon the observer positions.

5.5.11 For successive searches, the direction of the search legs should be changed by 45 degrees. The final track should be the same as the initial search track from the start point. The number of search legs may be 5, or, increasing by increments of 4, 9, 13, 17 etc.

5.5.12 Scanning should start at a distance of "S" before reaching the most probable position to avoid leaving an area not scanned near the start point. Observers should be briefed to pay particular attention to the areas outwards of each turn to avoid leaving areas not scanned.

5.5.13 The search should be planned so that, whenever possible, the approach to the most probable position, and the first leg, is made into wind as shown in Fig 5.5.

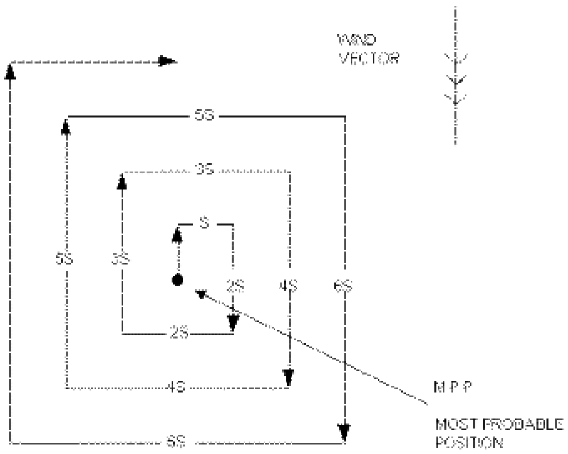


Figure 5.5 Expanding Square Search Pattern

5.5.14 Table 5-3 may be used to determine the number of search legs (N) and total track distance (D), given a particular radius (R) and selected practical track spacing (S),

e.g. if R = 10NM and practical S = 2NM, then N = 21 and D = 240NM. The total track distance can then be used to determine whether a suitable SAR aircraft has sufficient endurance to effectively complete the task.

Note *The total track miles that an asset has available on search can be calculated by multiplying the effective time available on search (from Worksheet 6: actual search hours (ASH) – 15%) by asset search speed.*

5.5.15 Maritime surface SAR units are not normally assigned a radius in excess of five mile.

RADIUS (NM)	S=0.5		S=1		S=2		S=3		S=4		S=5		S=10	
	N	D	N	D	N	D	N	D	N	D	N	D	N	D
1	9	12	5	8										
2	17	40	9	24										
3	25	84	13	48	5	16								
4	33	144	17	80	9	48	5	24						
5	41	220	21	120	9	48	9	72						
6	49	312	25	168	13	96	9	72	5	32				
7	57	420	29	224	13	96	9	72	9	36	5	40		
8	65	544	33	288	17	160	13	144	9	36	9	120		
9	73	684	37	360	17	160	13	144	9	36	9	120		
10	81	840	41	440	21	240	13	144	9	36	9	120		
11			45	528	21	240	17	240	13	192	9	120		
12			49	624	25	336	17	240	13	192	9	120		
13			53	728	25	336	17	240	13	192	13	240		
14			57	840	29	448	21	360	13	192	13	240		
15					29	448	21	360	17	320	13	240	5	80
16					33	576	21	360	17	320	13	240	9	240
17					33	576	25	504	17	320	13	240	9	240
8					37	720	25	504	17	320	17	400	9	240
19					37	720	25	504	21	480	17	400	9	240
20					41	880	29	672	21	480	17	400	9	240

Table 5-3 Number of Search Legs in Expanding Square Search given Radius

Table Notes*:*

1. Do not interpolate.

2. Tabular values of D are based on the search aircraft completing the search at the boundary of the square area. To achieve this, the final 3 search legs of a square search pattern are of equal length.

Sector Search

5.5.16 This pattern may be employed when the position of distress is known within close limits and the area to be searched is not extensive. It is simple to execute, is likely to provide greater navigational accuracy than a square search and, because the track spacing is very small near the centre, it ensures a high probability of detection in the area where the target is most likely to be located.

5.5.17 A suitable marker is chosen as a datum and navigation aid on each search leg. For practical purposes, the datum may be moved a mile or two, either at the planning stage or on scene, to take advantage of a prominent landmark well suited as a navigation reference. When using the pattern over water, it is useful to drop either a visual or electronic beacon to mark the datum. Adjustment for total water current is automatic and only leeway need be separately considered.

5.5.18 Trained crews using an aircraft with capable electronic navigational equipment should only be used to fly this search.

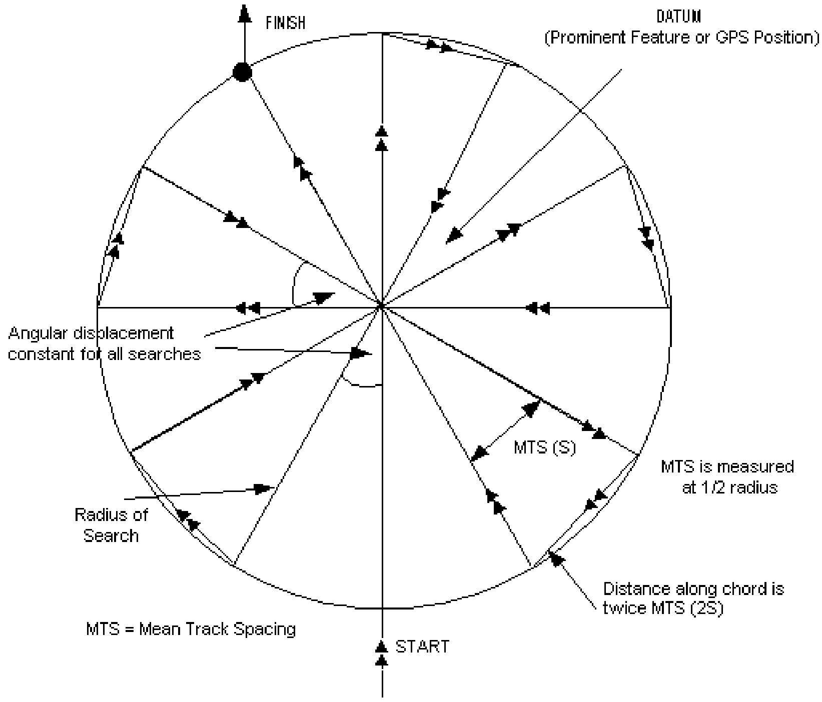


Figure 5-6 Sector Search Pattern

5.5.19 Each search leg is separated by an angle based on the maximum track spacing at the end of the legs and the search radius. For convenience, the angular displacement between each search leg and the distance required to fly the pattern for various track spacings and search radii may be extracted from Table 5-4 Sector Search Calculations

5.5.20 The table makes use of Mean Track Spacing (MTS) as a basis for deriving angular displacement and distance to be flown. MTS is the track spacing at a distance of half the radius of the search area from the datum. The table may also be used to determine the track spacing that can be used for a given track distance and search radius.

5.5.21 The search start point may be either on the perimeter of the pattern or over the datum depending on the approach track of the search aircraft and the orientation of the first leg. To keep track computation simple, the first leg may be oriented to the north but this is not essential. Successive tracks may be calculated by adding 90 degrees plus half the angular displacement to the previous track, and so on. The length of the cross leg is twice the mean track spacing.

5.5.22 The coverage factor, obtained using sweep width information and mean track spacing, may be used to determine the POD.

5.5.23 If a further sector search is necessary, it should be carried out on tracks plotted halfway between the tracks of the pattern followed during the first search:

SECTOR SEARCH CALCULATIONS (This table must not be interpolated)								
S	1		2		3		4	
R	Deg.	D	Deg.	D	Deg.	D	Deg.	D
5	24	90	48	45	72	30	100	30
10	12	330	24	180	36	120	48	90
15	8	720	16	375	24	270	32	210

Table 5-4 Sector Search Calculations

Notes

1. Deg = number of degrees between successive legs

D = total track distance (NM) to complete the search pattern

R= Sector Search Radius

S = mean track spacing (MTS)

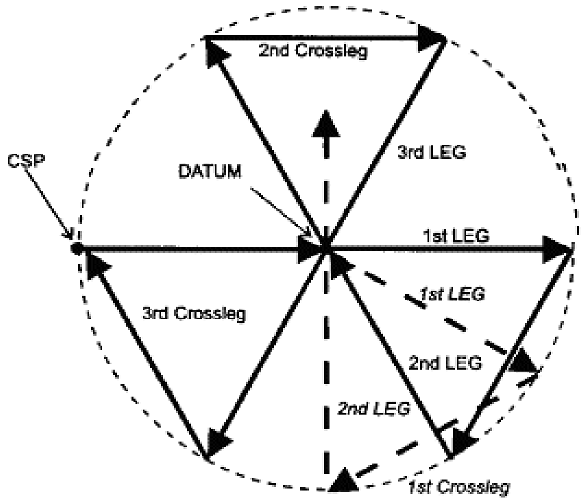
2. The total track miles that an asset has available on search can be calculated by multiplying the effective time available on search (from Worksheet 6: actual search hours (ASH) – 15%) by asset search speed.

Example

An area 10 miles radius is to be searched at a mean track spacing of 3NM. From the table, the angle between tracks is 36 degrees and the total time at 120 knots is 1 hour.

Sector Search Pattern for a Vessel

5.5.24 For vessels search pattern radius is normally between 2NM and 5NM and each turn is 120º. The length of each chord is the same of the radius (R), therefore the total track miles to complete the search area is 9R.



Note *CSP = Commence Search Point*

Figure 5-7 Sector Search Pattern - Vessel

Aural Search by Surface Craft

5.5.25 An aural search by search vessels may also be required at night for person in water situations. Such a search is accomplished by periodically stopping all engines of the search vessel and listening for the calls for help from survivors. The sounding of a ship's horn should precede an aural search in an attempt to attract the attention of survivors.

Note: *The conduct of an aural search may be hazardous under certain conditions and will only be conducted at the direction of OSC, after consultation with the SMC. However, serious consideration must always be given to conducting this search at night for person in water situations, especially where it is thought the survivors may not have any detection aids.*

Searching Coastal Islands and their Foreshores

5.5.26 The searching of coastal islands and their foreshores must always be considered when they are located within the search area, or near to it. Uninjured survivors in sight of land may attempt to make landfall, however they often overestimate their physical capabilities or underestimate the distances involved. Island foreshores may provide evidence of flotsam or debris that may further aid in the SMC's search planning.

5.5.27 In situations where a coastal island lies directly within a search unit's track, it may be necessary to interrupt the progress of the search unit to search the island and its foreshores. Alternatively, a second search using additional search units should be considered.

5.5.28 Surface craft engaged to perform this search must be suitably equipped with adequate depth sounding equipment and remain constantly aware of the dangers involved from operating near to land. If conditions allow, an aural search should be conducted in case survivors are asleep or have secreted themselves to obtain shelter. In these cases the sounding of a ship's horn or other form of noise making may alert survivors to the search unit's presence.

5.5.29 Should an island fall within a high probability area or there is evidence available that may suggest survivors have reached that point, serious consideration should be given to conducting a land search.

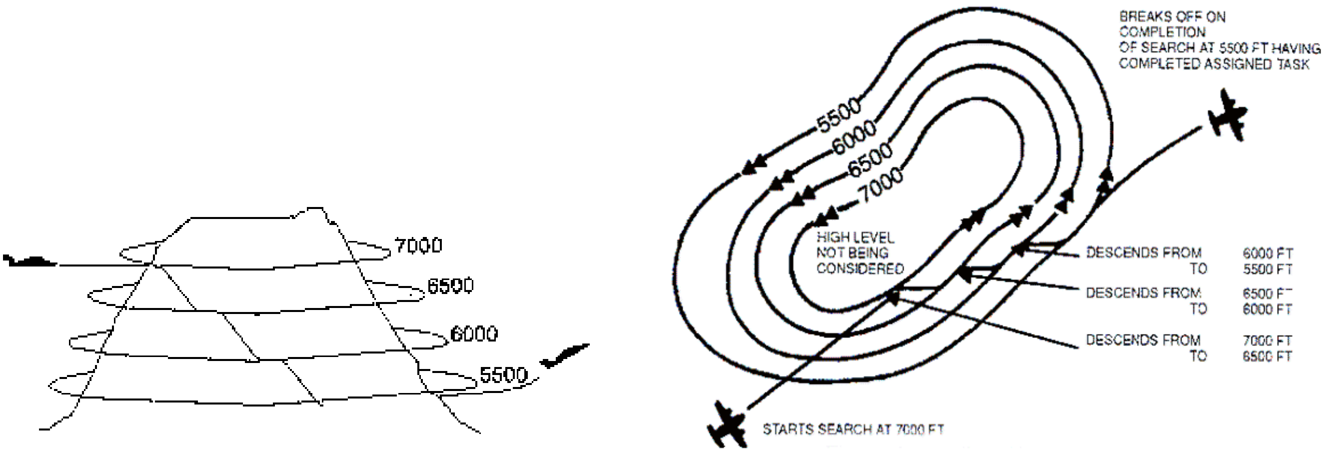
5.5.30 When only a visual foreshore search is considered necessary, it is important that the entry and exit points the search units take when approaching and leaving the island overlap to avoid blind spots developing. Small vessels, or aircraft, especially helicopters, capable of safely flying at low altitudes and speeds, can be used to pass close enough to the shoreline to permit careful inspection and are ideally suited to conduct island and foreshore searches. At night, an aircraft fitted with FLIR would be an advantage. Vessels engaged in shoreline searches must be aware of navigational constraints and any limitations imposed by sea conditions. The SMC should consider the possibility of survivors clinging to buoys or rocks offshore.

Contour Search

5.5.31 Contour search is used to examine mountain slopes and valleys when sharp changes in elevation make other types of search impractical.

5.5.32 The procedure requires that the search aircraft be flown at a selected contour level adjacent to the side of steep terrain, starting at the highest selected level. The search is started above the highest peak with the search aircraft completely circling the mountain at that level. Then the search aircraft descends a planned vertical distance while making an orbit in the direction opposite to the search (forming a figure eight), then it makes another circuit of the mountain, and so on. When there is not enough space to make an orbit opposite to the direction of the search, the search aircraft may spiral downwards around the mountain. If the mountain cannot be circled, successive sweeps at the same intervals should be flown along its side. Valleys are searched in circles, moving the centre of the circuit one track spacing after each completed circuit.

5.5.33 It is common to plan for search aircraft to descend a particular vertical distance between successive sweeps. The vertical distance between contours may be selected on a case-by-case basis after consideration of factors similar to those governing the determination of track spacing, i.e. visibility, nature of terrain, type of target etc.



Elevation view   Plan view

Figure 5-8 Contour Search Pattern

5.5.34 A contour search may be very dangerous. Extreme caution should therefore be exercised when searching mountains and valleys. The following safety matters should be considered:

a) The crew must be very experienced and well briefed and possess accurate large scale maps (1: 100,000 scale maps are recommended);

b) Mountainous search areas should be assigned to multi-engined aircraft whenever possible;

c) During the search, all the pilot's attention will be devoted to flying the aircraft. The pilot must evaluate forward terrain to avoid any hazard such as power lines, cables etc. When searching valleys, the pilot must plan ahead to ensure that the aircraft can either climb out of a difficulty or turn around, knowing at all times which way to turn in case of an emergency;

d) The weather conditions in the search area must be good, including both good visibility and lack of turbulence, and must be constantly checked. Flights in mountainous areas should be avoided when winds exceed 30 knots because downdraughts can exceed 2000 feet per minute;

e) Aircraft should not enter any valley that is too narrow to permit a 180 degree turn at the altitude flown. Searches should be flown close to one side of a canyon or valley so that the entire width may be used if a 180 degree turn becomes necessary. A similar method should be applied when making a contour search of a mountain; and

f) The aircraft should be highly manoeuvrable and have a high rate of climb and a small turning radius.

5.5.35 Orographic turbulence may be found as updraughts on the upwind side of slopes and ridges and on the downwind side as downdraughts. The extent of the effect depends on the wind speed and the steepness of the slope. Orographic turbulence will be more intense over a rough surface.

5.5.36 The safest crossing of mountain peaks and ridges at low altitude under windy or turbulent conditions is downwind, where any downdraughts will be encountered after the terrain is crossed. If this is not practical, altitude should be increased before crossing these areas. Best procedure in transiting a mountain pass is to fly close to that side of the pass where there is an upwind. This will provide additional lift in case of an emergency. Maximum turning space is available and a turn into wind will be towards lower terrain. Flying through the middle of a pass may be dangerous as this allows the least turning space and is often the area of greatest turbulence.

5.5.37 Should it not be practical to search the entire surface of a mountainous area, a SMC may initiate plans on the basis of certain assumptions, e.g., if limited to VMC, the pilot would neither willingly enter cloud nor descend below the lowest height at which a valley or a gap could be safely traversed. There may, on the other hand, be intelligence information to hand indicating that the pilot did enter cloud, in which case the aircraft may be found at an elevation within the extent of the then existing cloud layer. These possibilities should be examined carefully if it is known that a pilot was flying, or intended to fly, through a valley or gap in the proximity of cloud.

5.5.38 To determine a probability area in such circumstances, a SMC may proceed as follows:

a) Mark the contour line at a level 500 FT higher than the highest level it is considered that the aircraft would have been flown, and colour all areas above this height in RED;

b) Mark the contour line at a level 500 FT lower than the height at which the area could be safely traversed, and colour all areas below this height in GREEN; and

c) The uncoloured area will be the probability area, and, on an appropriate map, may be used as a three dimensional representation of ridges, gullies, etc.

Figure 5.9 demonstrates a resultant diagram after using this procedure.

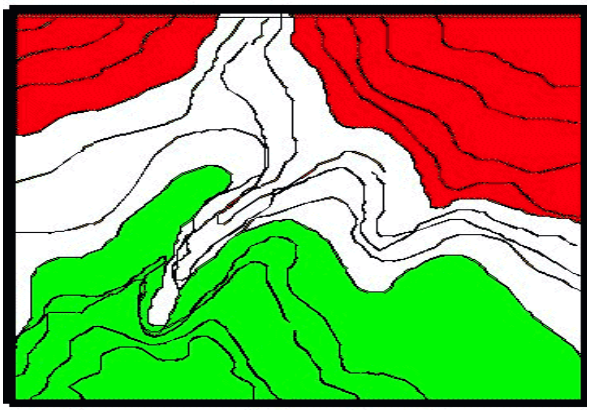


Figure 5-9 Example of Probability Area of Contour Search

5.5.39 Crews must be well briefed and possess accurate, large-scale maps showing the contour lines. (1:100,000 is the smallest practical scale). Crews shall be reminded to make all positioning turns away from the mountainside and to exercise extreme caution when searching valleys where climb-out or turn-around is difficult or impossible.

5.5.40 As with other forms of search, an accurate account of the areas actually searched is required by the RCC. The search crews should plot actual areas covered as the flight progresses. Areas that have been searched should be shaded in on a large-scale topographical map, leaving the unsearched area outlined.

5.5.41 Only one aircraft shall be assigned to an area at any one time.

Searches in Mountainous or Rugged Terrain

5.5.42 Searches by fixed wing aircraft become ineffective over certain types of terrain. Helicopters should be tasked for these areas. Individual areas may be defined by using:

a) Squares or rectangles; or

b) Geographical areas, referenced to geographical, topographical or man-made features.

5.5.43 Points to note:

a) An area of approximately 20 – 30 square nautical miles is a good size, depending on the type of helicopters available and the transit distance;

b) A number of sorties will normally be required to complete each area;

c) The closer a refuelling point can be established to the area the better; an oval or open area in town is suitable;

d) A Forward Command Post or Forward Field Base is very desirable; and

e) If using non-geographical areas, i.e. squares or rectangles, GPS is required.

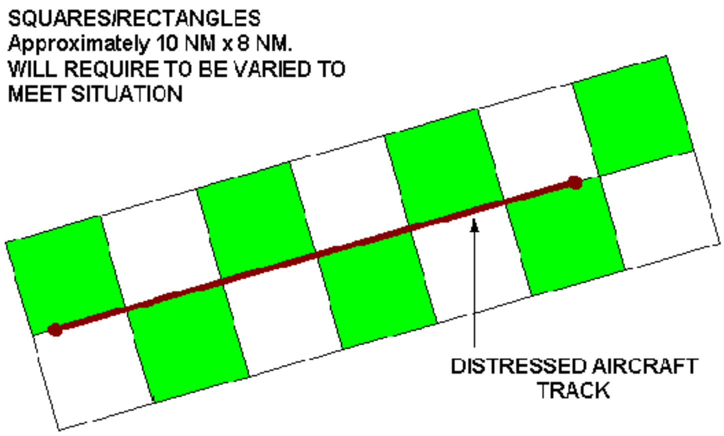


Figure 5-10 Helicopter Search Area

Line Abreast Helicopter Searches

5.5.44 Where a small area requires a saturated visual search the use of helicopters on an “emu-hop” or line abreast search is an effective search method.

5.5.45 This search is best achieved by assembling all search units at one location for briefing by Forward Command Post/Forward Field Base personnel or the assigned On Scene Coordinator.

5.5.46 When on task, the assigned coordinator should ensure all search units keep their position, and care is exercised with any target inspections.

Irregularly Shaped Areas

5.5.47 The foregoing method of allocating aircraft assumes a regularly shaped search area. At times it is more practical to define search area boundaries by geographical features. In these situations, it is frequently impossible to set out geometrically aligned, regularly spaced search tracks. Pilots should be briefed to make every effort to conform to the standard patterns but it may be necessary, at times, to leave the execution of the search pattern to the discretion of the pilots.

5.5.48 Some difficulty may be encountered in determining the extent of an irregular area to be allocated to any one aircraft.

5.5.49 Search effort should be calculated on Worksheet 6 in the prescribed manner and a process of estimation, based on the worksheet calculations, and, if necessary, trial and error, adopted to fit aircraft into suitable areas.

5.5.50 When allocating irregular sectors, it is good practice to allocate somewhat smaller areas than were they regular to make allowance for positioning turns and additional manoeuvres.

5.6 Flare Searches

General

5.6.1 Military aircraft may be capable of conducting a Flare Search at night. The procedure is appropriate to night time operations when it is known that survivors are equipped with distress signal flares. The military authority concerned will decide the practicality of such a search.

5.6.2 The search is flown at 5000 feet or below the cloud base, if lower. The crew fires a green flare every 3-5 minutes after entering the search area and at each turning point of the search pattern.

5.6.3 The frequency with which flares are fired from the aircraft should ensure that survivors could sight at least two successive flares. The survivors are expected to respond to green flares by firing their own red flares. The crew will acknowledge the sighting of the distress flares by firing a succession of green flares and switching on the aircraft's landing lights.

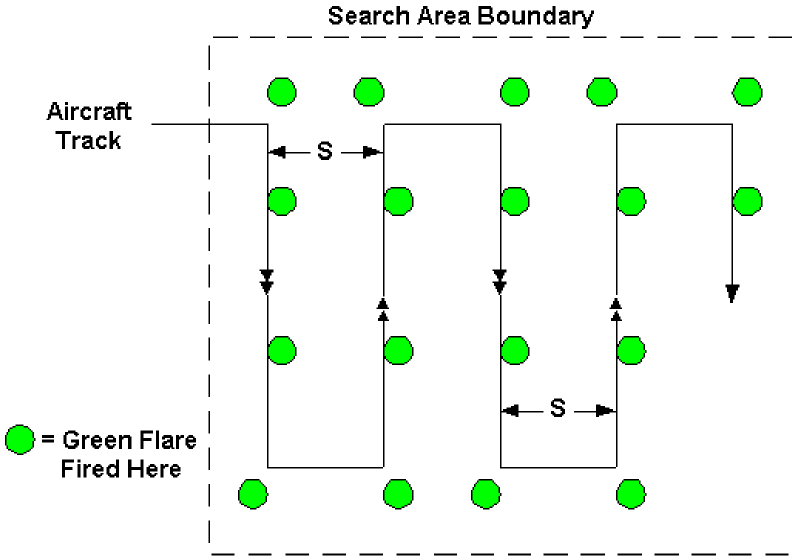


Figure 5-11 Flare Search Pattern

5.6.4 The spacing between adjacent tracks (S) will depend upon visibility. The quality of pyrotechnics available to survivors is usually limited and survivors are unlikely to fire flares until sighting the lights of or flares from a search aircraft. For this reason, sweep width for a flare search should be based on the range at which survivors may see the search unit. On entering a search area, search units may turn on all possible lights and from time to time display search lights or landing lights to facilitate sighting of the search unit by survivors. However, night vision of on-board observers needs to be taken into account.

5.7 Electronic Searches

General

5.7.1 Distress beacons are carried by ships, aircraft and land parties and operate on one or more of the international distress, safety and calling frequencies. When activated to indicate a distress situation, they emit a characteristic signal. The signal serves, in the first instance, to alert to a distress situation and, during an ensuing electronic search, as a homing beacon. The equipment can be activated either manually or automatically as a result of immersion in water or on impact.

5.7.2 The RCC shall use whatever resources are required to locate a distress beacon even if it is believed to be an inadvertent activation.

5.7.3 Another authority, (e.g. ACMA or the police) is not to be given a large area in which to locate a beacon. SMCs should use aircraft to isolate an area as precisely as possible, then request determination of exact location by a cooperating authority.

Beacon Types

5.7.4 Today’s technology takes most of the ‘search’ out of search and rescue through the utilisation of satellites and evolved radio distress beacons. There are three types of beacons that are carried, and in some cases, are mandated by law, that can be detected by satellite.

5.7.5 ELT (Emergency Locator Transmitter) is the name given to an aviation distress beacon carried by aircraft, these operate on 406 MHz, with some transmitting on 121.5 MHz for final stage homing.

5.7.6 EPIRB (Emergency Position Indicator Radio Beacon) is the name for a maritime beacon. A specific feature of an EPIRB is that it should be able to float upright. An EPIRB operates on 406 MHz with some transmitting on 121.5 MHz for final stage homing.

5.7.7 PLB (Personal Locator Beacon) is a beacon designed for land use and also operates on 406 MHz, with some transmitting on 121.5 MHz for final stage homing.

5.7.8 Beacons operating on 406 MHz have no audio signal but transmit in microbursts. Transmitted data, generally, cannot be monitored or interrogated by aircraft as the signal is generated by chip as a discrete data-package. Homing on 406 MHz beacons can be achieved by using specialised airborne equipment or by homing on the beacons’ supplementary low-powered 121.5 MHz transmitters. The Australian Standard for 406MHz beacons requires that beacons manufactured for use in Australia be fitted with a 121.5 MHz transmitter to provide a homing signal. AMSA Dornier aircraft and a few civil SAR aircraft can home and decode 406 signals.

Beacon Transmission Characteristics

5.7.9 The range at which a beacon may be detected varies considerably, being dependent on a number of factors:

a) Surrounding terrain - the range will be extended if the transmitter is located on the top of a mountain or hill and reduced if located in a valley, on a hill-side or mountain-side, amongst trees or bushes, or in a rain forest;

b) Power output of the transmitter;

c) Condition of the beacon - if a transmitter's aerial or aerial lead has been broken or disconnected, it will, if the unit is otherwise serviceable, still transmit but its range may be reduced to 1 km or less;

d) Nature of surrounding surface - the range will be reduced if the transmitter is operated in dry, sandy country unless placed on a good earth mat, e.g. a space blanket, aircraft wing, or similar reflective surface; and

e) Presence of interference - interference sources can cause beacon-like transmissions, e.g. strobe and navigational lights.

5.7.10 A transmitter operating over water or relatively flat country will emit a radiation pattern approximately circular in horizontal cross section. However, if activated in rough country, between trees or amongst wreckage, its radiation pattern will be interrupted by obstructions and shaped as a series of irregular lobes. Flying a track that cuts these lobes, a pilot will hear the signal while within their coverage but receive only noise or hash between them.

5.7.11 Depending on the aircraft's distance from the transmitter and the particular pattern of the lobes, the period during which the signal is heard will vary from a few seconds to several minutes.

5.7.12 It should be noted that when a beacon is placed above a water surface, lobes are formed in the vertical plane, one additional lobe for each 112 cm that the beacon is located above the water level. The presence of vertical lobes will be indicated by variations in the received signal. Regardless of aircraft heading, the signal will fluctuate, and may disappear completely, for a distance of several miles.

5.7.13 When a buoyant beacon is radiating in rough seas, its aerial may dip into the waves. This results in the swept tone missing a beat or two without any increase in hash. There is little discernible effect on the radiation pattern should an aerial be bent or otherwise distorted, provided it is clear of the water.

Beacon Search Procedures

5.7.14 Searches to identify and locate signals from emergency beacons will normally be initiated immediately following the confirmation of the receipt of a beacon signal. Electronic searches may be supplementary to visual searches. Rescue planning must be commenced with all beacon activations.

5.7.15 When it is known or believed that an aircraft or persons in distress are equipped with a beacon, an electronic search at a high level should be initiated immediately. In addition to beacons designed for operation by survivors, many aircraft carry ELTs that start operating automatically when G forces reach a certain level, such as in a crash.

5.7.16 The electronic search should not preclude the initiation of a visual search at lower levels since the success of an electronic search depends on a beacon actually radiating a signal.

5.7.17 When tasking aircraft to search for a beacon signal, it may be necessary to select a search pattern from one of those already described. The most commonly employed are the track line and parallel track patterns. Track spacing should take into account terrain and the height of the aircraft and Table 5.5 lists suggested maximum track spacings.

ALTITUDE AGL/AMSL FT	MOUNTAINOUS DENSE TIMBER NM	PLAINS or DESERT NM	MARITIME NM
1000	2	10	20
5000	10	20	50
8000	15	25	60
10000	20	30	70
15000	30	60	100
20000	40	80	150
30000	50	100	180

Table 5-5 Suggested Maximum Track Spacings for Aircraft Conducting Beacon Searches

Note *Beacon search altitude should, initially, be as high as possible for the aircraft tasked, subject to air traffic and meteorological conditions.*

5.7.18 Pilots should be briefed to disable the receiver squelch, if fitted, and to leave it disabled throughout the search for a beacon signal. On modern receivers not fitted with squelch control, it may be possible to use the test switch to achieve the same end.

5.7.19 When searching for beacon signals on 243.0 MHz over water, the track spacing quoted in Table 5.5 should be reduced by 20%.

5.7.20 When searching over mountainous terrain, it is recommended that the track spacing approximates the lesser of that listed for "heavy timber, jungle or mountainous terrain" and the distance between ridges. The search pattern tracks should, as far as possible, be oriented parallel with the ridges.

Locating a Beacon Signal Source by Homing Devices

5.7.21 A number of civil and military aircraft are fitted with direction finding equipment that enables a pilot to home onto the source of a beacon signal and fix its position.

5.7.22 RCC staff are not required to be familiar with the equipment or to brief pilots for in-flight operation. Procedures have been developed to localise the position of a radiating beacon when homing devices are not available and the only information available are reports of beacon signals being heard.

5.7.23 A number of agencies and volunteer organisations also have hand held homing devices.

Aural Location of Beacons

5.7.24 Aural procedures are based on the assumption that an undistorted radiation pattern is very nearly circular.

5.7.25 Some guidance on the flying of aural searches for beacons is given in AIP/ERSA. Whenever possible, RCC Australia shall individually brief pilots unfamiliar with the procedure.

Maximum Radio Signal Range Calculations

5.7.26 By using the following formula:

Maximum Range (in NM) = $1.2 \times \sqrt{h}$

Where: h = height/altitude of the receiving antenna in feet;

5.7.27 The theoretical maximum range of the transmitter may be calculated, or for search purposes, the theoretical maximum distance at which a beacon signal may be received given the receiving antenna’s height above ground level.

Note: *The transmitting antenna is assumed to be at ground level.*

5.7.28 The area in which the transmitter is located may be determined by plotting a circle, with radius equal to the calculated range, from the position at which the beacon was heard. The intersection of circles plotted from two or more hearing positions will result in a fix of the probable position of the transmitter.

Signal Heard, Signal Fade Plotting Method

5.7.29 From reports of "signal heard" (SH) and "signal fade" (SF) positions received from aircraft flying at a constant level, it is possible to determine the limits of a beacon radiation pattern.

5.7.30 En-route aircraft may be very helpful in this respect. They should be asked to monitor 121.5 MHz and report the positions where the signal was first heard and where it faded. Lines joining the positions at which the signal was first heard (SH) and the positions at which it faded (SF) form chords of a circle, the perpendicular bisectors of which should intersect at the location of the transmitter. When three or more position lines are obtained in this fashion and plotted, it is most likely that a "cocked hat" will be formed, the centre of which should be taken as the MPP of the beacon. An example of a two position line fix is shown in Figure 5.12.

5.7.31 It is not recommended to join SH and SF positions from different aircraft due to variations in the aircraft's receiver sensitivity, and variations in altitude between different aircraft. Both these factors will alter the effective radiation pattern of the beacon.

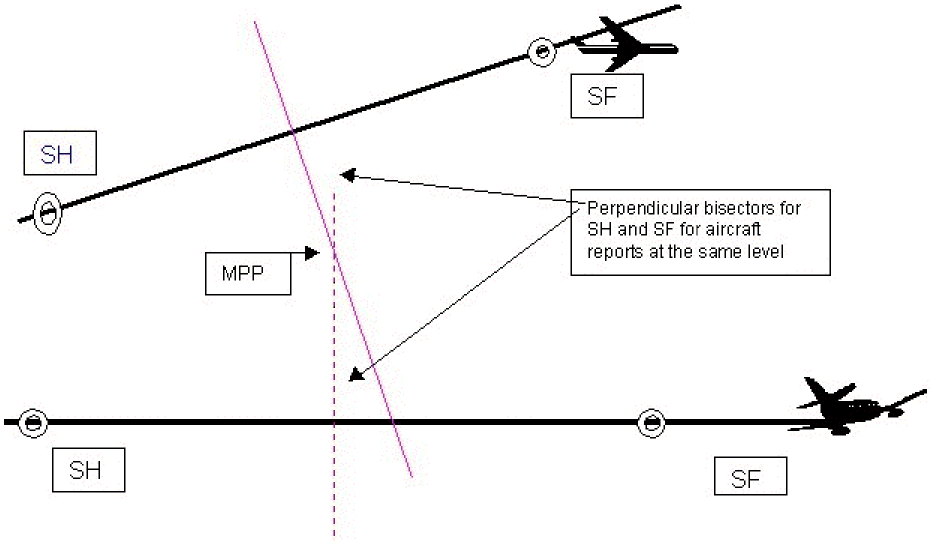


Figure 5-12 Signal Heard and Signal Fade Plotting

De-tuning Method

5.7.32 Detailed instructions for the use of the De-tuning Method is set out at AIP/ERSA and in the SAR Manual for SAR Unit Pilots and Dropmasters.

Hill Shading

5.7.33 When a beacon has been localized to a general area of mountainous terrain, it is possible to eliminate smaller specific areas by flying the search aircraft over specific sectors. For example, along valleys, around isolated hills etc, noting those areas where the signal is not heard or where it cuts out sharply as a result of shading.

5.7.34 When a more precise target area has been isolated in this way, the de-tuning method or visual search may be employed to pinpoint the exact site.

Locating a Signal from the Ground.

5.7.35 Ground parties may be able to locate the source of a signal using a portable Aviation Band Multi-channel AM VHF Radio. If the radio is tuned to 121.55 MHz or 121.45 MHz and a signal is heard, it is likely that the source of the signal is within 100 meters. Progressive detuning whilst retaining the signal will locate the source of the signal.

5.7.36 If a beacon signal can only be heard on 121.5 MHz, the beacon is some distance away. Using a building or obstruction as a shield, if the signal is lost the building or obstruction is between the receiver and the beacon. It is also possible to use the body as a shield by holding the receiver to the chest. The signal should be weakest with the back to the signal.

5.7.37 To check individual craft as the source of a signal, a domestic FM or AM radio is likely to receive the signal if placed within a few metres of the source. Also the aerial may be removed from an Aviation VHF radio, if the signal is still received the source is very close.

Search by Radar

5.7.38 Radar may be primarily used for maritime searches. Most available airborne radar would be unlikely to detect typical search objects on land except for metal wreckage in open areas such as desert.

5.7.39 The sweep width and track spacing to employ will depend on the type of radar, height, environmental clutter and noise, radar cross-section of the target, radar beam refraction due to atmospherics and operator ability. W and S should be agreed between SMC and operator.

5.7.40 It should be noted that when the wave height increases to above one to two metres, the probability of detecting a small object rapidly decreases for most radar and consequently so does the sweep width. The probability of detection of a small target rapidly decreases.

5.7.41 The altitude used should normally be between 2,500 and 4,000 ft for small search objects and a maximum of 8,000 ft for large search objects.

Search by Infra-red Devices

5.7.42 Infrared (IR) devices such as IR TV cameras or Forward Looking Infrared Radar (FLIR) are passive detection systems used to detect thermal radiation. They operate on the principle of detecting temperature differences to produce a video picture. Therefore, IR devices may detect survivors by their body heat.

5.7.43 IR devices are normally preferred for night use. Search height should normally be 200 to 500 FT for small targets such as persons in the water, and up to a maximum of approximately 1,500 FT for larger targets or those having a larger heat signature. The track spacing can be based on consultation with the operating crew and taking into consideration the effective detection range as provided by the manufacturer.

Night Vision Goggles

5.7.44 Use of night vision goggles (NVGs) can be effective in search carried out by various types of search units.

5.7.45 The following factors may influence the effectiveness of NVGs for searching:

a) NVG quality;

b) Crew training and experience;

c) Environmental conditions, visibility, moonlight, cloud coverage, rain;

d) Level and glare effects of ambient light, natural and artificial;

e) SAR unit speed;

f) Height of the observer above the surface;

g) Surface conditions (like snow), and sea state;

h) Size, illumination, and reflectivity of the search object. The presence of reflective tape greatly enhances detectability; and

i) Types of survival equipment or light sources used by the survivors.

5.7.46 Glare should be minimised as much as possible within the facility where the NVG users are stationed. This may involve opening or removing windows where practicable. Also proper scanning techniques are important for reducing the adverse effects of moonlight or artificial light sources like, lighthouses, offshore rigs, ships, navigation and strobe lights.

5.7.47 Visible moonlight can significantly improve detection of unlighted search objects when using NVGs. Search object light sources, like strobe or similar lights, or even cigarettes, can greatly improve detection even in poor visibility conditions.

5.7.48 RCC staff should be aware that sweep width needs to be discussed with the crew conducting the mission and modified according to the conditions encountered in the search area.

5.8 SAR Unit Selection and Characteristics

Overview

5.8.1 The selection by SAR staff of available SAR units to be used in SAR operations should take into account the following considerations:

a) The need to reach the distress scene quickly; and

b) Suitability for at least one of the following operations:

i) Provision of assistance to prevent or lessen the severity of accidents;

ii) Conduct of a search, primarily by air but with the assistance of marine or land units as required;

iii) Carriage of supplies to the scene of an accident and, if necessary, delivery of supplies; or

iv) Execution of a rescue, (by marine and land units or by helicopters; and as required fixed wing aircraft to provide guidance to units or to relay communications).

5.8.2 In coordinating a search, the SMC, as guided by local procedures, may charter, arrange or request the provision of suitable aircraft or resources. RCC Australia can assist with advice on suitable aircraft for SAR operations (see Chapter 1.2.41 *Assistance to Other SAR Agencies*).

Air Assets

5.8.3 Many types of aircraft will be suitable as SAR Units with little or no modification. However, care should be taken to ensure that, even in an emergency, safety of flight is the primary consideration and should never be compromised. The normal operational and technical limitations of an aircraft, as well as the qualifications of the crew, should be carefully noted by the SMC. SMCs must ensure they are cognisant of the factors relating to the aircraft and crew that may compromise the conduct of the SAR mission.

5.8.4 Some specialist SRUs that have undergone training from RCC Australia are organised in Tiers and can be fixed wing aircraft or helicopters. The tiers relate to the capabilities and training of the aircraft and crews. Aircraft should be used where the tier relates to the capability required for the task with due regard to responsiveness and availability. Tier capabilities are detailed in Table 1 in Appendix M. SRUs are strategically located around Australia as shown in Figure 1 in Appendix M to ensure the best coverage of the area of responsibility.

5.8.5 When chartering aircraft for use as SAR Units, SAR staff shall, whenever practical and effective, select aircraft from trained SAR/Emergency operators including;

a) Search and Rescue Units (SRUs); and

b) Police and State Emergency Service aircraft.

5.8.6 Advice on suitable aircraft can be obtained from RCC Australia (see Chapter 1.2.41 *Assistance to Other SAR Agencies*).

5.8.7 If additional aircraft are required, call out could be made according to the following priority bearing in mind suitability, location and availability:

a) Domestic commercial aircraft,

b) Coastwatch aircraft,

c) ADF aircraft,

d) Scheduled Regular Public Transport (RPT) aircraft, and

e) Private aircraft.

5.8.8 When the circumstances are appropriate, SAR staff may seek assistance from foreign aircraft.

5.8.9 Private aircraft may be used when so situated as to more readily effect the saving of life, operated by crew having particularly valuable local knowledge of the area to be searched, or when no other commercial aircraft are available.

5.8.10 As a general rule, slow aircraft or aircraft capable of reducing speed to 100 - 150 knots are most efficient for visual searches. Small and partially hidden targets are easily missed at higher speeds and faster aircraft may be subject to operational limitations making them unsuitable for low-level flights. Nevertheless, fast and or highflying aircraft also play an important role in search operations, for instance when these aircraft carry out:

a) An electronic (radio) search to home on distress signals; and

b) An exploratory sweep of a large search area simultaneously with a search by a slower aircraft flying at lowers levels, a method that is particularly effective in maritime or other flat and unobstructed areas.

5.8.11 The suitability and efficiency of an aircraft for search, support and rescue operations will depend on which and how many of the following desirable features it possesses:

a) Operational characteristics:

i) Safe low-speed and low-level flight capability;

ii) Short take-off and landing (STOL) capability;

iii) Sufficient range to cover the area, with due regard to the location of redeployment bases;

iv) Manoeuvrability, especially for searches in mountainous areas; and

v) Payload capacity.

b) Equipment:

i) Suitable navigation and instrument flying aids;

ii) radio equipment capable of receiving and homing on emergency radio signals; and

iii) adequate communications equipment;

c) Availability of good observation posts;

d) Suitability for the delivery of supplies, emergency equipment and personnel; and

e) Facilities for the treatment and carriage of survivors.

5.8.12 The SMC shall select aircraft for use as SAR Units after consideration of the following factors:

a) Type of search necessary;

b) Type of terrain;

c) Type of navigation involved;

d) Need for dropping supplies;

e) Disposition of aircraft with respect to search area;

f) Crew experience and familiarity with the area;

g) Weather conditions at and en route to search area; and

h) Rescue considerations.

5.8.13 Aircraft not equipped with radios should not be used on SAR operations except as a last resort.

5.8.14 Fast, high flying aircraft equipped with homing and or direction finding equipment that have the operational flexibility to descend to low level for final search are recommended for beacon searches.

5.8.15 Seaplanes and amphibians are useful for search or for carrying supplies and personnel over water. Their use as rescue units or carriers of personnel is limited to operations in lakes and river areas, or sheltered waters and bays. Under favourable weather and sea conditions, suitable seaplanes may also be used for rescue operations in protected waters, e.g.. large lakes, bays, shore areas etc. Rescue operations on open water or at sea are generally only feasible for large seaplanes designed for rough-water work.

5.8.16 Helicopters are particularly useful SAR units as their slow speed and ability to hover make them suitable for search as well as rescue operations, particularly where small targets are sought or close scrutiny of terrain or sea is required. They also have the ability to land in a confined area and, in some instances, to operate from some vessels.

5.8.17 Some helicopters are fitted with winches, floats or equipped for flight in instrument meteorological conditions (IMC) and at night giving them an added advantage for search and rescue response. Turbulence, gusting winds and icing are conditions that the SMC should consider when determining helicopters as appropriate SAR units.

5.8.18 Ship based aircraft operate with great flexibility at sea because they have the advantage of a well equipped and mobile base.

5.8.19 Where terrain and vegetation is such that a contour search is necessary, preference should be given to:

a) Helicopters;

b) High-performance short take off and landing (STOL) aircraft; or

c) Light, manoeuvrable twin engine aircraft.

5.8.20 Where possible, single engine aircraft should be restricted to areas where the terrain would permit forced landings.

5.8.21 When possible, consideration should be given to engaging aircraft capable of carrying at least four observers in order to permit rotation and rest.

5.8.22 Where possible, landing sites should be as close to the distress scene as possible. The landing area selected should be clear of loose articles that may be blown into the air by the rotor downwash. On beaches, it is best to use the water’s edge to form one side of the landing area. Communications should be established with the aircraft before its arrival and the pilot briefed on the landing site. If the pilot is unfamiliar with the location, a description of the area using large geographical features may need to be passed. If possible, a number of people should be deployed to secure the area before the aircraft arrives so that no one enters the landing area until the rotors of the aircraft have stopped or the pilot indicates that it is safe to do so. If the landing area is in a populated area, extreme care should be taken to ensure that no children run toward the aircraft once it has landed. When communicating with the aircraft, it is important to inform the pilot of any obstacles in the immediate area. This is especially applicable to wire strung between trees and power lines as these types of obstacles are difficult to see from the air and present a danger to the safe operation of the aircraft.

5.8.23 Fixed wing aircraft that can land close to a distress site can speed up the evacuation of survivors rescued by helicopter, rescue party or other means.

5.8.24 All flights for search and rescue purposes are to be planned and undertaken in compliance with Civil Aviation Regulations (CARs). In the case of a SAR event where safety of life is at stake and exemptions from regulatory requirements maybe necessary and appropriate for the pilot to undertake the mission, the SMC shall review with the pilot all possible risk factors. It is the pilot's responsibility to ensure that dispensations are obtained from those officers holding the power to delegate under CARs.

5.8.25 It is the SMC's responsibility to provide a complete brief of the situation, including any hazards such as adverse weather or conditions, to the pilot so that a pilot can make an independent decision to become involved in the incident dependent on aircraft capabilities and their own competence.

ADF Air Assets

5.8.26 The RAAF maintain one aircraft on SAR standby for support to any ADF SAR event that may occur. This asset can be requested for DACC 2 tasking through RCC Australia and HQJOC. The SMC should plan on a minimum response time from receipt of orders to take off of three hours and a maximum of twelve. Response times will vary due to the availability of SAR qualified crews and the location of the SAR stand-by aircraft. Often the response will prove more rapid than indicated by these guidelines but planning should be predicated upon these times.

5.8.27 Aircraft on SAR standby at RAAF bases are a C130H or C130J Hercules or an AP3C Orion. The standby role can be transferred from one aircraft to the other at short notice due to operational or maintenance requirements. The Joint Control Centre (JCC) will act as the POC for information regarding the RAAF standby aircraft through the AOC.

5.8.28 Other military aircraft suited to civil SAR operations may be available subject to HQJOC approval.

5.8.29 Stocks of droppable supplies are held at various RAAF aerodromes, details of equipment held and aircraft capabilities can be found in Appendix N.

Control of ADF Aircraft

5.8.30 RAAF aircraft assigned to SAR operations coordinated by the RCC will always remain under ADF Operational control. In addition to normal service channels, ADF authorities may exercise operational control of SAR aircraft through the Defence Communications Station Australia (DCSA). DCSA is located in Canberra but has transmit and receive nodes in Exmouth, Darwin Townsville, and Riverina. DCSA provides Voice Contact Nets (VCN), discrete nets and telephone patch facilities on HF radio voice channels. Control of ADF aircraft may also be exercised using SATCOM, or Satellite phone, depending on the aircraft fit.

Use of Customs Coastwatch Aircraft

5.8.31 An SMC may seek assistance from Customs Coastwatch aircraft through RCC Australia. RCC Australia will request assistance in sourcing aircraft through Customs Operations Centre. Where a specific type of search is required, e.g. Radar or night, RCC Australia will consult with Coastwatch and the contracted provider to ascertain the best response.

Maritime Assets

5.8.32 Search operations are generally best carried out by aircraft while rescue is best carried out by helicopter, marine craft or land assets. However, it will sometimes be necessary to use marine craft or land assets for some search efforts, particularly when weather conditions prevent or hamper air search, when the location of the distress scene is known with reasonable accuracy, or the location is remote and non-aviation assets are best placed to render assistance.

5.8.33 The speed of marine craft is usually their maximum speed possible under the prevailing sea conditions. Generally, small boats search at 15 –40 kts and larger vessels search at 10 – 30 kts. At these speeds, excellent coverage for small targets is possible. However, the area that can be searched is limited due to the low level of the vessel and the earth's curvature. Tables 1-3 and 1-4 at Appendix I provide uncorrected visual sweep widths for visual search over water at eye heights of eight and fourteen ft and from the height of a merchantman's bridge.

Category	Abbreviation
Rescue boat - short-range coastal and/or river craft	RB
Rescue vessel - long-range seagoing craft	RV

Note *The boat/vessel's speed may be inserted, e.g. RB(14) or RV(10).*

5.8.34 The abbreviations listed in the table above may be used when referring to vessels made available for SAR purposes:

5.8.35 Rescue vessels can participate in operations at considerable distance from their base. Their main design requirements are good manoeuvrability, seaworthiness, long range, relatively high speed and sufficient size to accommodate survivors and equipment. Naval vessels, offshore lifeboats, seagoing tugs, customs and pilot launches and patrol boats are of particular value because of their special equipment, including communications equipment, and trained personnel.

5.8.36 Generally, the strategy for sustenance and rescue of survivors of accidents in oceanic areas will depend upon aerial supply drops and or deployment of parachute rescue personnel pending rescue by ship or helicopter.

5.8.37 Rescue boats such as lifeboats, patrol boats and crash boats are short-range vessels capable of operating a limited distance off shore in good sea conditions. Pleasure craft, yachts or rigid inflatable boats fitted with an outboard motor could also be used provided they carry appropriate equipment.

5.8.38 Other sources of maritime assistance may include:

a) Naval vessels;

b) Customs vessels;

c) Merchant vessels;

d) Fishing vessels;

e) Police vessels;

f) Volunteer marine rescue groups e.g. Volunteer Coast Guard;

g) Harbour craft, ferries, pilot launches and tugs;

h) Oil drilling rigs; and

i) Offshore oil industry support vessels.

Naval Vessels

5.8.39 When available, it is usually preferable to use naval vessels for SAR operations. The training and discipline of naval crews, communications fits and other specialised equipment with which the ships are fitted makes naval vessels eminently suitable for SAR operations. Some naval vessels can also be more freely used for combined aircraft surface vessel search operations than merchant vessels. In the event of a major operation a navy vessel may be appointed Coordinator Surface Search and coordinate the activities of other vessels.

5.8.40 HMA Ship responsibilities on receiving an Alerting or Distress message are contained at Appendix O.

Customs Vessels

5.8.41 Customs vessels are also patrolling the approaches to Australia and, where available, can be used to assist with SAR. In a similar way to Customs aircraft, an SMC may request the assistance from Customs vessels through RCC Australia.

Use of Merchant Shipping

5.8.42 Some ships do not maintain a continuous communications watch and consequently must be alerted by means of an automatic alarm system. As this system is traditionally employed only for emergencies involving the safety of human life, the decision to request its use must be made advisedly and responsibly. Actual requests for use of the automatic alarm shall be limited to genuine emergencies.

5.8.43 Knowledge of the positions of merchant ships is of considerable value in SAR operations as merchant ships are often the nearest means of rescue during an incident off shore. The International Convention for the Safety of Life at Sea (SOLAS) contains an obligatory provision for the captain of a vessel to proceed with all speed to the assistance of persons in distress at sea, provided the safety of his ship or crew is not compromised. At all times the safety of the vessel and crew is the responsibility of the master and RCCs should ensure this responsibility is not compromised. In a distress situation, where doubt exists as to a vessel’s intentions, the master should be requested to advise his intentions and confirm that he is responding. Given that a master is not obliged to respond to situations that are not distress, during these situations the master should be requested to divert and assist if practicable. When vessels are known to be proceeding to assist, it is encumbent on the RCC to ensure that only the most suitable vessel or vessels are used and to release other responding vessels as soon as possible.

Equipment for Marine Craft

5.8.44 In the case of oceanic SAR operations, it is desirable that the ship(s) used are fitted with basic equipment appropriate to the task: navigation aids, communication equipment and life-saving and rescue items, (e.g.: inflatable life rafts, signalling devices, line-throwing apparatus, non-sparking boat hooks, rescue baskets, litters, boarding ladders and scrambling nets).

5.8.45 Some larger merchant vessels and all service ships will possess equipment for rescue operations. However, additional assistance and supplies, particularly medical, may be required to sustain survivors until they can be landed at a point of safety or transferred to an evacuation vehicle.

5.8.46 Depending on the distance from the coast, inshore rescue craft may be available to assist and will be coordinated through the State or Territory Police.

Land Search Facilities

5.8.47 Search by land facilities alone is usually impractical for large search areas but it can be conducted in most weather conditions and can provide complete coverage of a confined area that cannot be thoroughly searched from the air. Land parties are also critical in operations where the search is carried out from the air and rescue by land facilities.

5.8.48 Police authorities undertake the responsibility for coordination of land search.

5.8.49 The need for coordination between land rescue units and search aircraft should be considered, and plans should cater for the need for two-way radio communication. There may also be a need in remote areas to keep land units supplied with fuel, water and food by means of airdrops.

5.8.50 When the survivors are located, the SMC should liaise with the police commander with a view to expediting the return of survivors to a place of safety. Consideration should be given to aircraft relay and the use of suitable motor transport: ambulances, four-wheel drive vehicles, buses, etc.

5.8.51 Specialist police and military land parties are equipped with material useful to the SAR role. It is desirable that land SAR units be equipped with basic navigation aids, two-way communication equipment, sufficient clothing, medical supplies and rations to reduce the need for air drops and specialist equipment appropriate to the unit's particular role.

5.8.52 The Land Operations Manual should be referred to for procedures with regard to land search techniques, planning and conduct.

5.9 Search Unit Allocation

Introduction

5.9.1 Before committing resources to an intensive search, an evaluation should be made of the total search effort required and the contribution that may reasonably be expected from each search unit.

5.9.2 When assessing available search capacity, care must be taken not to over-estimate either the time that a particular aircraft and its crew can spend in a search area or the capability of the observers to remain effective over long periods of flight time.

5.9.3 Failure to make a sound estimation of these factors may result in one or more of the search units being unable to complete its allocated task and the efficiency of the entire effort being seriously compromised.

Aircraft Capability

5.9.4 Search aircraft are expected to comply with the rules for navigation as stipulated in AIP or the appropriate military documents, including limitations on crew times and navigation.

5.9.5 Guidance on the limitations on search time for defence crews should be sought from the relevant controlling authorities. CARs and CAOs govern civil operations.

5.9.6 As a general principle, search aircraft of the smaller variety should be planned in such a way that a rest period on the ground is possible after about two hours of searching.

Calculation of Search Time Required

5.9.7 There is a simple but important formula that should be used to quickly calculate "search ability" and thus gives practical answers to these typical questions:

a) How long will it take to search the whole area?

b) I've got 6 hours, how much of the area can I search?

c) We've got 5 hours and 4 boats, what track spacing must I use?

d) We've got to cover the area by 1600 hrs, how many craft will I need?

5.9.8 The factors to be considered are:

a) The area to be searched in square nautical miles

b) Time in hours

c) Velocity, the speed(s) of the unit(s) (added together)

d) Track spacing in nautical miles

Note *If any three are known then the fourth can be calculated using the formula:*

A = TVS (A TV Station)

Example 1: How long will it take to search an area 25 NM by 10 NM using a track spacing of 5 NM in a craft with a speed of 10 Knots.

$T + \frac{A}{VS}$ and do the sum $\frac{25 \times 10}{5 \times 10} = 5$ hours

5.9.9 If diverting from the assigned pattern track to investigate a sighting, the search unit must fix its position with care. This is to ensure if the sighting is not the target, the search unit can return to and resume the assigned search from the position at which it diverted.

Calculation of Search Time Available

5.9.10 When evaluating the search time available from search assets, certain factors must be taken into account, where applicable:

a) Total endurance;

b) Transit time;

c) Necessary fuel reserves at final destination;

d) First and last light at departure and destination aerodromes, unless flight:

i) Is permissible and practical under Instrument Flight Rules (IFR); or

ii) Night Visual Flight Rules (VFR) operation is possible;

e) Weather conditions in the search area, and destination points, and any requirement for holding fuel or alternate aerodrome for aircraft.

f) Any other operational limitations; and

g) Investigation time while on search provides an allowance for investigating sightings and navigating turns at the end of search legs. It is normally 15% of the time available but may be increased where terrain or conditions dictates.

5.9.11 In most cases, time in transit to the search area may be calculated using speed and the distance between the points of departure and destination and the mid-point of a search area.

5.9.12 For aircraft, when wind speeds are high, it may be advisable to compute a ground speed for use in transit-time calculations. This is especially appropriate for aircraft with low TAS. In a situation where an aircraft will depart from an aerodrome on one side of its allotted area, conduct its search, then recover to an aerodrome on the other side of the area, if the tracks are aligned with or against the wind direction, calculation of ground speeds is proper.

5.9.13 Fuel reserves shall comply with current regulations for the category of flight. The variable reserve allowance for IFR operations is not applied to the time spent in a search area (i.e.: it is only applied to the transit times).

5.9.14 Operational factors may limit the search time available from a specific aircraft, examples being the time at which an aircraft will become available, distance from mandatory servicing facilities, and other commitments of the operator that may require the return of an aircraft at a particular time.

Investigation Time

5.9.15 A search asset may sight objects that require investigation; therefore an allowance for the time taken to investigate must be made. The basic allowance is 15% of total time available in the search area, but the SMC may decide to increase this figure. The number of sightings investigated by previous search crews will influence any such decision. These, in turn, will be influenced by the nature of the terrain, the amount of flotsam on the sea etc. Over heavily timbered, mountainous terrain, the allowance may need to be as high as 50% of total search time.

Effective Search Time

5.9.16 Effective search time is the resultant of the actual search hours (ASH) available minus the investigation time.

5.9.17 After making allowance for "investigation time", it may be convenient to convert the effective search time to an equivalent time at 120 Kts before calculating the size of the area to be allocated to any given aircraft.

5.9.18 The conversion is made by using the formula:

$$T \text{ (hours at 120Kts)} = \frac{\text{Search TAS x Effective Search Time}}{120}$$

5.9.19 Example: If an aircraft can be in the search area for a total time (ASH) of six (6) hours at a TAS of 180 Kts and 15% is allowed for target investigations, then 5.1 (6 hrs – 15%) hours may be planned for actual searching. The equivalent time at 120 Kts would be:

$$\text{Hours at 120 Kts} = \frac{180 \times 5.1}{120}$$

$= 7.65$ Hours

5.9.20 When obtaining data about aircraft availability, special consideration should be given to the speed at which the aircraft will be flown whilst on search. In general, to provide for optimum scanning by observers, search aircraft should fly as slowly as possible. There are, however, other aspects to be considered, particularly the time available for search and the need to cover the area expeditiously. It may be beneficial to discuss these interacting considerations with operators. Some aircraft operate in excess of 120 Kts when on search; although this is less than optimum, logistic considerations may dictate the use of these speeds.

5.9.21 When the track spacing to be assigned to each aircraft has been decided, the area each aircraft can cover may then be calculated from the formula: A = TVS.

Comparison of Search Time Required and Time Available for Search Aircraft

5.9.22 Comparison of the search time required with that available, (both denominated at 120 Kts), will reveal whether the aircraft resources available are enough, too much or too little.

5.9.23 At this point, a critical decision related to aircraft allocation may be made. The time required for search is directly related to track spacing; track spacing, in turn, is directly related to search height. It is feasible, therefore, that despite first indications that insufficient resources are to hand, timely coverage of the whole search area could be achieved by the available aircraft for the sake of a higher-than-optimum search height.

Sufficient Search Time for Search Aircraft

5.9.24 Having calculated the time available from each search aircraft and converted it to time at 120 Kts, it is possible to calculate the area that each aircraft can cover, and to allocate a specific sector of the area to each aircraft.

5.9.25 Various factors may influence the positioning of search aircraft in the area. These include:

a) The type of aircraft;

b) Time of arrival in the search area;

c) Supply dropping capability;

d) Navigation capability;

e) Suitability to a particular type of search;

f) Search height, or speed limitations; and

g) Location of recovery aerodrome.

5.9.26 When the search area is shaped as a trapezium, (as it usually is in a "last report/missed report" SAR situation), it is simplest to start allocation from the wider end of the area, as follows:

a) The distance D1 should be measured;

b) Consider the area that can be searched by the first aircraft to be allocated;

c) Divide this by the distance D1, and thereby determine the width of the resulting rectangular search area. This width may then need to be adjusted so that the number of legs to be flown will be complete;

d) Consideration should also be given to the location of the departure and recovery aerodromes relative to the search area. If they are on opposite sides of the search area, the number of legs should be odd, if on the same, even. In any case, this relationship may require a further adjustment to the number of legs to be flown; and

e) By multiplying the number of legs by the track spacing, the width of the area to be assigned may be deduced. Repeat the procedure for areas A, B, C etc.

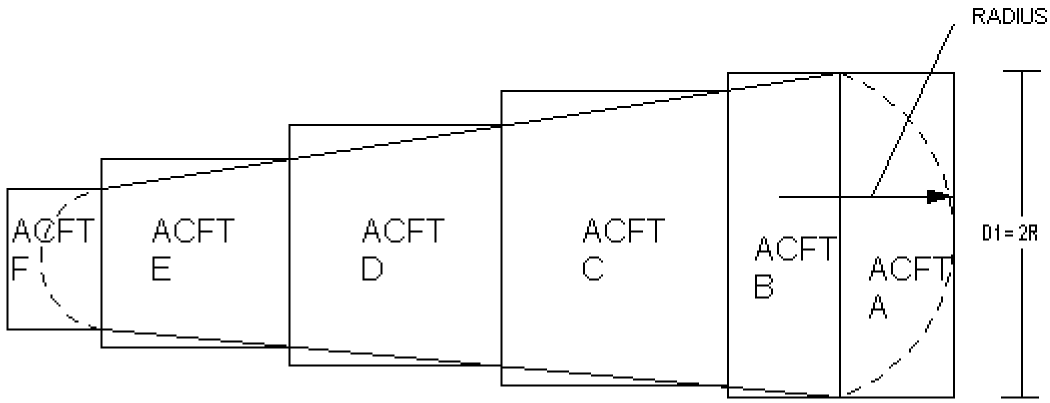


Figure 5-13 Allocation when Sufficient Search Time is Available

5.9.27 It is apparent from Figure 5.13 that this method of allocation results in small areas of individual search areas extending beyond the limits of the original search area. To reduce the incidence of unnecessary areas being searched, the length of D1 may be reduced to the diameter of the larger circle of probability. The length of the major axis of ensuing search areas will remain at this reduced length until the centre of the larger circle of probability has been included in a specific search area.

5.9.28 Little can be done to eliminate other portions of the rectangular areas that extend beyond the probability area, except perhaps, to split large areas into smaller sections, or use different allocation methods.

Over Sufficiency of Search Time

5.9.29 To employ time in excess of that required for first search coverage, several alternatives may be considered, e.g. first and second searches may be conducted simultaneously thus increasing the probability of detection or adjacent search areas may be overlapped. Other options include a reduction in track spacing and a reduction in sortie times to lengthen search crew rest periods.

Insufficient Search Time

5.9.30 A more normal situation is that insufficient time is available to complete the first search of the probability area in due time. When this occurs a compromise must be devised.

5.9.31 In reaching a compromise, the probability area may be reduced, the track spacing may be increased, the search height may be increased or a variation may be made to a number, or all, of these factors. The methods for variation of search area size and track spacing will now be considered.

5.9.32 By reducing search quality to the point of C = 0.5, that being taken as the minimum acceptable value, a suitable combination of area, track spacing and search height may be calculated to best utilise limited resources. Application of the expanding search concept will ensure good coverage over ensuing sorties.

5.9.33 Worksheet 5 (Appendix K) has been constructed to assist in the determination of variable search parameters to achieve the best possible compromise:

a) Section "A" is a statement of desired area and track spacing for a specified search height, associated coverage factor and POD;

b) Section "B" records the maximum area that can be searched if the practical track spacing (S) is used. The C and POD, in this case, will be identical to "A"; and

c) Section "C" records the widest track spacing required to search the whole of the area with the available aircraft hours, the resulting C and POD.

5.9.34 Having established the extremes of optimum track spacing and adjusted area (section B), and optimum area and adjusted track spacing (section C), it is appropriate to decide on the best possible option. This may be either one of these extremes or a compromise solution that requires amendment of each of area, track spacing and search height.

5.9.35 Section "D" may be used to examine the values of C and POD for various combinations of area and track spacing. It is good procedure, as a first step, to calculate the values necessary to achieve C = 0.5 and then look for a solution of compromise that results in a value of C between 1 and 0.5. The process may be repeated for different search heights before making a final decision.

5.9.36 With the area and track space determined, it is appropriate to calculate the area capable of search by individual aircraft then allocate them accordingly.

Allocation Variations to Suit Particular Aircraft

5.9.37 An improved search plan may result from the assignment of individual track spacings and or search heights to particular aircraft. These adjustments may arise after consideration of the need for separation of search aircraft and each aircraft's search TAS, search height limitations and turn diameter. Variations specified, as a result of these considerations, should be gauged against the calculated practical track spacing to indicate resulting C and POD.

5.9.38 An overall POD may be obtained by calculating C for each individual search aircraft then determining a weighted average of these coverage factors to arrive at an overall figure for C and POD. These, although of little value to an SMC in their own right, may be included in a Situation Report or prove beneficial when determining the cumulative POD for a number of searches.

Allocation Chart Presentation

5.9.39 It is desirable that as much pertinent information as possible be depicted on a chart. All appropriate information may be plotted on one chart or it may be divided according to type and plotted on discreet charts. In either case, data may be plotted directly onto charts or on transparent overlays.

5.9.40 Individual aircraft search areas shall be identified by a "letter number", e.g. "A1".

a) The letters used shall start at "A" and progress through the alphabet. If there are more than twenty-four aircraft on search, then double letters shall be used.

b) The number will indicate the day of the search, (not the sortie number or the search number). For example, the first aircraft tasked on day one of a search would be given "A1"; the twenty-fifth would be given "AA1". The first aircraft tasked on day two would be given "A2"; the twenty-sixth would be given "BB2". Numbering will recommence with the first daylight search on each successive day.

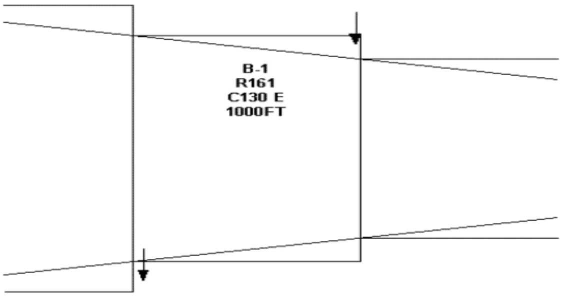


Figure 5-14 Information Displayed on Allocations Chart

Note *The letters I and O are not used to identify a search area because of the possibility of confusion with 1 or 0 (zero).*

5.10 SAR Crew Briefing

General

5.10.1 Comprehensive briefing and de-briefing of search crews is a vital component of search planning. They are time consuming processes, and in the case of briefing, preparation must commence at an early stage and, whenever possible, in good time before departure. It must be appreciated that many personnel engaged for search operations are neither trained for nor experienced in the search role. Field SAR personnel shall therefore be given every opportunity to familiarise with all relevant details of the distress. All instructions for the SAR operation shall be clearly and precisely presented.

5.10.2 The officer appointed to the briefing task, must be thoroughly familiar with the overall plan and individual search unit tasks.

Search Briefing

5.10.3 Comprehensive briefing of search units is vital to every search operation. The SMC should be satisfied that the briefings are well prepared, and that where group briefings are to be conducted, the venue is suitable for the purpose.

5.10.4 Briefings for marine units will cover similar topics to those given to air and land units, but there may be less opportunity for face to face briefing. Briefing Officers should be aware of the difficulties inherent in briefing indirectly and the increased potential for misunderstanding.

5.10.5 Similar arrangements shall be made for debriefing SAR units.

Search Area Description

5.10.6 There are many ways of describing search patterns and the boundaries of search areas. In selecting the method to be used, RCC staff must consider the SAR knowledge of the recipients and the method to be used for the transmission of the information.

Geographical Coordinates

5.10.7 This is the generally accepted method of designating an area, the corners of a search area being defined by latitude and longitude. To avoid confusion, the positions should be listed in a clockwise sequence, ending with a repeat of the initial coordinates. The disadvantages of this system are the possibilities of error in measurement and transmission.

Universal Grid Reference

5.10.8 The Universal Grid is overprinted on all charts of the JOG series and is also shown on the majority of larger scale maps.

5.10.9 The grid consists of numbered blue lines spaced 1000 metres apart at chart scale, both vertically and horizontally. Instructions for its use are printed in the margin of each sheet.

5.10.10 Another grid system may be encountered on earlier editions of the R502 series and the associated large-scale maps. This is based on a military 1000-yard grid and is overprinted in black. The method of use is similar in both cases. Some maps show both grids.

5.10.11 When using grid references, it is essential to identify the map used by name and edition number.

5.10.12 It should be noted that the military might use a numerical system of sheet reference in combination with the grid reference. If this method is encountered, it will be necessary to seek interpretive guidance from a military source.

Track Line

5.10.13 A track line search may be designated by stating relevant points along the track together with the width of coverage, for example:

"Fly a track 4 NM each side of a line between 16° 20’ S 135 ° 15’ E and 17 ° 50’ S 137 ° 28’ E."

Landmarks

5.10.14 Description of a search area by way of natural or man made boundaries is particularly suitable when describing mountainous areas. Care must be taken to be precise. Vague descriptions such as "7 NM SSW of..." shall not be used. Proper direction in this case would be by way of positive bearing and distance, i.e. "bearing 202 (T) from Dixon Island at 7 NM".

Search Pattern Abbreviations

5.10.15 The international abbreviations are normally not used to brief domestic aircraft. Other RCCs may use the abbreviations when sending a briefing to an Australian SAR unit. If this briefing is to be forwarded to a SAR unit, RCC Australia should ensure the pilot fully understands the type of search required.

Search Aircrew Briefing

5.10.16 A written record shall be kept of all briefings given to aircrew and other units. Filing a copy of the Search Briefing Form most conveniently satisfies this requirement.

5.10.17 Search Briefing Forms shall be prepared for each aircraft task and dispatched or handed to the pilot in command or their delegate personally.

5.10.18 When the task for a search aircraft is amended, a hard copy amended briefing will be sent, where possible, to the aircraft crew otherwise it may be passed verbally, either directly or through a third party. Where a third party is used a hard copy of the amended briefing will be sent to that party. Confirmation will be obtained from the search crew that they have received and understood the amended briefing.

5.10.19 When pilots or their delegates are unable to personally attend for a briefing, the information may be dispatched by facsimile, email or telephone. The facsimile or email methods are preferred as the opportunity for errors of understanding is minimised and the transmission of maps, diagrams and other relevant hard-copy material can be achieved.

5.10.20 A pilot is, whenever possible, to be given a copy or reproduction of the relevant portion of the map in use by the RCC; it shall show the assigned search area and those areas adjacent to it.

5.10.21 Care must be taken in determining whether maps in use depict elevations in metres or feet. Pilots shall be left in no doubt in this regard.

5.10.22 In any case, where it is not possible to provide a pilot with a map or reproduction thereof, the briefing officer shall determine the maps and editions available to the pilot and ensure that the crew is totally aware of the areas, locations, and features that RCC Australia requires it to search. The briefing officer shall make every effort to eliminate any possibility of errors due to differences in data on the respective maps.

5.10.23 A briefing shall include the following factors:

a) Full description and nature of the distress, and details that are already known not to be of any significance to the present search should be pointed out;

b) Present and forecast weather conditions to, from and in the search area and at destination and alternate aerodromes;

c) Search area and any description of clues that may indicate the presence of the target;

d) Instructions concerning the flight to and from the search area including route and levels;

e) Search task, including patterns to be flown and method to record areas searched;

f) Other aircraft in or near the area;

g) Communication procedures, frequencies to be used and controlling authority;

h) Frequencies to be monitored for transmissions from survivors;

i) Details of droppable supplies to be carried and any special dropping procedures;

j) Action to be taken on sighting the target;

k) Distress signals and visual codes;

l) Location and means of debriefing, including details of information which will be required;

m) Restricted airspace or airspace arrangements; and

n) Observer arrangement and the requirement to ensure they have a copy of the briefing. Where an observer leader is available, he should brief the observers.

5.10.24 A Flight Debrief Form should be supplied with the Aircraft Search Briefing Form.

Search Aircraft Operations

5.10.25 Pilots shall be briefed that before beginning a search, they should have established communications (air to ground, air to air and onboard), have observers in position and be listening on any special frequencies. Pilots shall be instructed that after becoming airborne, if it appears necessary for search height or track spacing to be modified, the RCC should be advised accordingly.

5.10.26 Before beginning a search, the aircraft should be flown at search height for a time to familiarise observers with the apparent size and appearance of known objects on the surface. Observers may also develop an appreciation of distances at height, bearing in mind the planned limit of scan.

5.10.27 Aircraft that are engaged on a beacon search should start the search procedure at the highest practicable cruising level unless a small probability area has been defined when a search may start at a lower level.

5.10.28 Pilots or navigators should log all areas, heights and appropriate times, and indicate on a map the areas covered by the search.

5.10.29 When an object is sighted that requires investigation, the pilot should, if possible, mark the aircraft's position before deviating from track to ensure that it will be possible to resume track at the correct place. The use of GPS navigational equipment facilitates this.

5.10.30 In marginal visibility and when the aircraft carries no markers, the crew can keep a target in sight by executing a turn with the target in the approximate centre. When the target is further away, the observer should keep the general area of the sighting in view and call out the position or distance as the pilot turns the aircraft towards the sighting.

5.10.31 In sighting a missing craft or survivors, the pilot should pinpoint the position, advise the RCC and survey the surrounding area with a view to assisting those who will be required to proceed to the scene later. When a target is sighted over water, the position should be recorded by GPS or if possible, be marked by some form of sea marker, smoke float, buoyant light or dye marker.

5.10.32 It is desirable that continuous aerial surveillance be maintained over the location of the craft or survivors.

5.10.33 It is particularly important that continuous surveillance is maintained at sea, subject only to consideration of aircraft safety. Whenever possible, should a pilot be forced to leave the scene before the arrival of a relief aircraft, a buoyant radio beacon should be dropped, with the GPS position recorded.

5.10.34 The need to dispatch additional aircraft to the scene should be considered as early as possible to avoid survivors being left unattended and to avoid the problem of relocation.

Communications Relay Aircraft

5.10.35 A dedicated communications aircraft should be used when communications are expected to be poor in the search area, for example:

a) HF is the only means of communication;

b) The search is of a large scale;

c) It is necessary to improve information feedback into the RCC;

d) It is necessary to improve information flow to search assets;

e) Search aircraft are operating without contact with the ground station; or

f) It is the best method of maintaining communications with survivors or ground search parties and ground rescue units.

5.10.36 A communications relay aircraft will normally be a suitably equipped SRU aircraft or military aircraft, have a minimum crew of pilot and radio operator, and have good on scene endurance.

Top Cover Aircraft

5.10.37 The provision of a top cover aircraft should be considered during operations that may expose helicopters to undue risk.

5.10.38 The SMC is to discuss the requirement for a top cover aircraft with the pilot in command of the helicopter. The decision to task a top cover aircraft can be made by the SMC alone or on request by the helicopter pilot in command.

5.10.39 Circumstances that may require the provision of a top cover aircraft may include:

a) Helicopters operating over water, although this will vary with the type of helicopter involved;

b) Helicopters operating at or near the limit of their endurance;

c) Helicopters operating in poor or marginal weather conditions; and

d) Helicopters operating at a rescue scene presenting special dangers, e.g. at night.

Note *If in doubt, consult the helicopter crews.*

5.10.40 Aircraft tasked for top cover should be an SRU aircraft carrying supply drop equipment suitable for the environment. The primary tasks of the top cover aircraft will be to:

a) Provide navigation assistance to the helicopter to locate the target;

b) Provide communications assistance to the helicopter; and

c) Provide immediate assistance by way of supply drop should the helicopter ditch.

Maritime Search Crews

5.10.41 When maritime units are used for search operations, staff of other SAR authorities, i.e. police and military, may brief the search crews. The coordinating SAR authority shall require copies of briefing forms issued on its behalf to ensure that personnel are adequately briefed on all matters relevant to units' tasks. Maritime units must be capable of carrying out the operation safely in the prevailing and forecast weather and sea conditions in the area.

5.10.42 All search preparations should be completed before the surface units enter the search area including the establishment of communication with the agency coordinating the surface search and other units (surface or air) participating in the search. Search crews should be briefed on:

a) SAR frequencies and homing equipment monitored;

b) Observers positioned; and

c) Rescue gear made ready.

5.10.43 A surface unit carrying out a systematic search of an area with no visual reference points should maintain a dead reckoning (DR) plot of the last known position of the target, its own position, and the position of other ships and aircraft in the vicinity. The plot should also show date, time and possible drift of the target or survivors. Areas searched should be plotted on a chart.

5.10.44 To attract the attention of survivors, a surface unit should, if practicable, periodically make its presence known by making smoke during daylight and, at night, by rotating a searchlight beam around the horizon or, if clouds are low, by directing the searchlight vertically. When visibility is restricted, the engine should be stopped periodically to listen for shouts or whistles from the survivors.

5.10.45 Observers should be stationed as high as possible to increase the sighting range. Observers on board surface units can also use the scanning techniques used by aircraft observers.

Land Assets Employed in the Search of an Aircraft

5.10.46 When land assets are used for search operations, the state or territory police or ADF SAR authority will conduct briefings. Search by land parties is normally only employed when aerial search is not possible or has been ineffective or when a closer examination of a certain area is desirable. It can be effective in forests, jungles and mountainous areas. Land assets may be used for both search and rescue.

5.10.47 RCC Australia staff shall ensure that the coordinating authority is adequately briefed on the following:

a) The current situation;

b) A description of the missing aircraft, and a photograph if available;

c) Details of the persons on board;

d) A plan showing emergency break in points for the aircraft (if available);

e) An instruction that unless accompanied by an Transport Safety Investigator, the aircraft wreckage is to be disturbed as little as possible;

f) An instruction that unless on the direction of a coroner or a representative of ATSB the bodies of dead persons should not be moved except to the minimum extent necessary to extract survivors from the wreckage;

g) The need to carry standard navigation and communication equipment and air to ground signal codes and materials;

h) Details of communications arrangements;

i) A warning that team members must not smoke, nor use naked flames near the wreckage;

j) Information concerning any dangerous cargo known to be aboard an aircraft. In the case of a military aircraft, the need to exercise extreme care on account of ejector seats (being powered by explosives) and the potential incidence of ammunition, bombs, torpedoes, rockets, carbon fibre, noxious gases, poisonous substances etc;

k) Note: Contact with gases and substances associated with wrecked military aircraft can be lethal. Before approaching a military crash site, clearance shall be obtained from the responsible military authority; and

l) an instruction that the wreckage must not be left unattended until taken into custody by a representative of ATSB, or placed under guard by the police.

Note *More complete information on the responsibilities of ground parties upon locating a crash site is contained in the booklet Civil and military aircraft accident Procedures for Police Officers and Emergency Services Personnel.*

5.10.48 RCC staff shall ensure that land parties are aware that serious hazards to health and safety may exist at aircraft crash sites. Ground personnel have been injured and become ill and died as a result of crash damage, fire of composite materials, exposure to gases and poisonous substances. Certain radioactive substances may exist in military aircraft structures. Carbon fibres are electrically conductive and may short-circuit nearby electrical equipment. It is repeated that for the safety of ground party personnel, it is imperative that clearance be obtained from the responsible military authority before approaching a military crash site.

5.10.49 At the request of a land party operating in unfamiliar terrain, an aircraft may be provided to enable the unit leader to make an aerial reconnaissance of access routes in difficult terrain.

5.10.50 It may be necessary to position an aircraft over a crash site after the arrival of a land asset, to relay radio messages, or to interpret and relay ground signals.

5.11 SAR Crew Debriefing

Overview

5.11.1 Full and proper de-briefing of search units is as important as the briefing process. Included in the briefing shall be instructions on the de-briefing procedure to be followed on completion of the search task. Where possible, blank debriefing forms will be given to the aircrew. A careful interrogation and evaluation of each search crew's effort is essential for intelligent forward planning.

5.11.2 Where a FCP or FFB is established, pilots, observer leaders, surface search unit leaders and others shall be instructed to attend after their sortie for de-briefing.

5.11.3 Reports are required on anything that the search teams themselves consider pertinent, and may include:

a) Report on actual weather conditions;

b) Positions at which sighting investigations were made;

c) Descriptions of items which were investigated;

d) Accurate description of areas searched and not searched with an assessment of the effectiveness of the search;

e) Results of monitoring of radio frequencies;

f) Any operational difficulties encountered; and

g) Observer debrief forms when available and completed.