

This page covers the basic principles of Search Area Coverage

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## Overview

Search Area Coverage (SAC) is about the development of a plan, or plans, for the deployment of appropriate and available search units to cover pre-determined search area(s) using an appropriate Search Pattern or

combination of patterns. The search area(s) will have been determined in the Search Area Determination (SAD) phase

## **Considerations**

As a minimum, the Mission Coordinator (MC) must consider the following during the SAC phase:

- The overall plan (given the available units and time)
- Selecting the appropriate search unit(s)
- The target(s) and the detection method(s) upon which to base the search
- The calculated and the achievable area coverage and associated search effectiveness
- The changing search area size, shape and position during the search and consequent search area and search pattern options
- Single or Multi-layered Search?
- Search area identity and description
- Instructions to search units.

## **Overall Plan**

During the search area determination phase, the MC should already have considered the type and duration of search required and be aware of the number and type of available search units. The SAC phase is all about the selection of and how best to deploy search units to conduct an effective sweep of an area or areas in order to provide the maximum possible chance of detecting and recovering survivors in the circumstances and environmental conditions

Once the search area has been determined, the MC will need to consider the basic search plan. Factors to consider will include:

- Area - is a Rapid Response search or a more complicated area search required?
- Time - how much is available or how long should the search take?
- Units available - if a non-Rapid Response area, will a single unit suffice or will the area need to be covered by multiple units?
- Multiple units - would a single or a multi-layered search be best?
- Search pattern(s) - which would be most suitable?

Of all the factors involved in search planning, one or more may prove overriding in a particular situation and sometimes so much so that the others can be regarded as secondary or even disregarded entirely. These overriding

or 'controlling' factors are the ones that are given the most consideration when developing the attainable search plan

It must be appreciated that the emphasis on any one factor will usually be at the expense of others, and the MC must prioritise and decide which factors are the most important. Once this is decided, the search effort is planned to meet the requirements of the controlling factors, taking into account the other factor requirements as much as possible

## **Importance of Time**

Time is probably the most significant factor. Any delay or misdirected effort will diminish the chances of locating survivors. Whilst a sound search plan and good search conditions are desirable, positive and timely action is required and the effort expended in developing a search plan should not be at the expense of search time

Also, if information is sparse or difficult to gather, the MC should not delay unduly and consider initiating an initial Rapid Response or a Track Line search whilst additional data is being obtained and a more extensive search planned. This is, in principle, akin to the well known Hasty Search concept employed for land searches

## **Search Duration**

The search duration (i.e. how long the search will take) is also critical as this will have an impact in a number of areas

The MC must not fall into the 'SARIS' trap of assigning a search unit's on-scene endurance as the search duration if this is not appropriate. On-scene endurance is just a measure of how long the unit can be in the area before it needs to return to base. A surface unit in particular may have many hours on-scene endurance but unless this is the limiting factor, e.g. it only has 30 minutes left before it needs to return to refuel, the search duration should be based on other critical factors such as search crew fatigue, survivability, remaining daylight etc.

The search duration must be reasonable and achievable. Expecting the two-man crew of a small surface craft to conduct a four hour search for example is unreasonable

The MC must apply practical common sense when determining search duration and if necessary consult with the unit commander. A number of short searches is often a much better and more practical option than one long search

## **Search Unit Selection**

The MC should know the types and numbers of available search units. It may be however that not all available units are appropriate given either the circumstances (e.g. close inshore, far offshore) or the environmental conditions (e.g. wind & sea state) and so it is a matter for the MC to decide which units are useable and which are not

Where there are large areas to be searched, it is usually a case of the more the better. This is not always the case though. For a small around-the-datum Rapid Response area search for example, it can be that deploying a single unit into the search area is the most effective - and the safest!

The capability of the available search craft is the most important factor that must be considered by the MC when assigning search areas. In order to attain the optimum search effectiveness from a search unit, the MC/search planner needs to be fully aware of each unit's capability

## **Search Unit Considerations**

### **Limitations**

The limitations of facilities is also an important factor for the MC to consider, particularly if making a choice of the most appropriate search unit from amongst several that are available

A helicopter for example may not be the best choice to conduct a visual Rapid Response Sector Search for a person in the water – the area may be too small and the search pattern too tight for the aircraft to make the turns required. It may also not be able to allow the pattern to follow the drift of the target, as is the requirement for such a search. Similarly, an ILB may not be the appropriate resource for a Rapid Response search in the vicinity of an overfalls area if the tide is 'wrong'

### **Target Detection Capability**

The ability of a unit to detect the target is also an important factor. This is particularly so if for example time or visibility is limited and the requirement is for an electronic or a detection aid search to be undertaken

It may be that the choice and/or availability of resources is limited. Where this is the case, the MC may have to base the search plan on the capability of the unit(s) rather than the optimum desired

### **Suitability**

When considering assigning search craft to search areas, care should be taken to ensure that they are used only for searches for which they are technically and operationally suitable and that the Track Spacing is navigationally achievable

An ILB for example would be unsuitable for a radar search in a force 8 and a Track Spacing to two decimal places would be inappropriate for a leisure craft

### **Identifying the Target(s)**

It is critical that at the outset of the SAC phase, the MC/search planner considers what the target or targets of the search will be, as this will have a major influence on the resulting search plan(s)

If there is only one known, or possible, target then the SAC phase is relatively straightforward. Regardless of the number of targets, the MC/search planner must ensure that all information about it/them is gleaned so that the search plan will be as effective as possible. Basic information on size, colour, potential detection aids, electronic devices etc. is critical as these are directly related to detection

### **Multiple Targets**

There may be occasions when more than one target is a possibility e.g. a sinking vessel that may or may not be afloat, a liferaft and/or persons in the water

In such circumstances, the MC/search planner should consider:

- if there are sufficient search craft available, conduct simultaneous searches for each target type, within the bounds of safe navigation
- if resources are limited, base the search on the most detectable target

The MC must be very careful with the latter option. The Sweep Width for a vessel will be considerably greater than for person in the water. The latter may be the worst case scenario, but if there is no sound reason for suspecting that this is the case, then a search for the more easily detectable vessel might be the more potentially successful and appropriate option. If the vessel is located, then a search can be conducted for persons if they are not with the vessel

### **Target Detection Method**

This is a very important consideration, but one which can get overlooked. Doctrine and training has traditionally focused on visual searches but there may of course be a number of other ways in which a target might be detected and which need to be considered by the MC

Deciding on the best and most appropriate method of detection to employ and to plan for is critical. The MC/search planner must be sure that the most appropriate and effective method of target detection is being employed in the given circumstances and conditions. Getting this right ensures that the search plan will provide the best possible chance of the target being located

It is very often the case that a target will be detected at a greater distance by methods other than visual observation. Radar or electronic detection distance can for example be many times greater than that of non-aided visual detection. The further away the target can be detected, the greater the area that can be covered in a given time. Electronic searches are also not as susceptible as the visual-based search is to the non-detection of targets due to tiredness or visibility variances etc. If a search is being conducted for a Search and Rescue Transponder (SART) or an Emergency Locator Transmitter (ELT) for example and they are transmitting correctly there is a near 100% probability that, once in range, it should be detected. The only limiting factor will be the human operator

Electronic or visual-aided searches should be considered whenever possible in order to maximize the coverage and reduce the chance of missing targets. Visual searches should never be discounted of course and come into their own when looking for targets which have little or no electronic output or radar profile, such as persons in the water

### **Visual Searches**

There are a number of fundamental factors that will affect the visual detection of a target from the search unit's point of view:

- Large targets will be easier to detect than small targets
- Vessels with a high freeboard should be easier to detect than those with a low freeboard
- Bright and fluorescent colours aid visual detection. Any target will be difficult to detect if it blends in with the background whereas one that contrasts strongly with the background will be easier to see. However, small contacts can only be seen over a small distance no matter how strongly they contrast with the background
- Visibility is fundamental to the effectiveness of a visual search. Rain, sleet, snow, mist, fog, haze, smoke and dust will all adversely affect the ability of a visual searcher to detect a target. This factor will be taken into account when determining the Sweep Width, but conditions can change quickly and it may be that a plan needs to be re-visited if visibility reduces significantly during a visual search
- Sea conditions - calm waters are easier for surface units to search in than rough seas. Targets will also be easier to detect. White caps, breaking seas and reflections of the sun from salt spray etc. all contribute to rendering a search more difficult. Rough seas can also adversely affect radar detection

### **Detection Aided Electronic Searches**

#### **Daytime Aids**

Sea conditions, wind and reduced visibility may considerably reduce the distance at which daylight detection aids may be seen. In conditions of high wind or breaking seas, daylight detection aids may be virtually ineffective. Such conditions are not so detrimental to the effect on night time detection aids

#### **Night Time Aids**

It is important at night to consider the type of vessel and what detection aids it will be carrying. For leisure craft, use the CG66 and SafeTRX. If you can positively identify a commercial vessel, determine whether it comes under SOLAS coded vessels to help determine what detection aids the casualty may have

On clear nights pyrotechnics have been sighted in excess of 40 miles. Even a flashlight has a chance of being seen. For these reasons night searches will

often provide the highest probability of detection. It should be remembered that the survivor's supply of night detection aids is usually limited and survivors will probably not fire pyrotechnics until they either see or hear a search unit

At night, if it is known or even suspected that survivors can make a night signal especially if they are likely to have electronic detection aids, an air search using the appropriate criteria should be conducted especially during the early stages of the search effort

## **Radar**

Rough seas do adversely affect radar detection due to the large amount of sea return (or 'clutter') on the display and the fact that small targets in the trough of a sea cannot easily be detected by the equipment. Even if an object is detected by the radar, has it, or can it, be seen by the observer?

## **Electronic Aids**

The detection of electronic aids such as SARTS, EPIRBs, ELTs etc. is generally not affected by environmental conditions. Transmissions from these devices can however be affected by such things as their position in the survival craft or the condition of their power source. If a search plan is based on electronic detection, the MC must always consider the possibility that the devices or the operators might not be operating to 100% of their capability

## **Forward Looking Infra Red (FLIR)/TV Equipment**

Forward Looking Infra Red (FLIR) produces a picture of various shades according to the temperature of the objects being viewed. The sensitivity of the equipment will determine its capability to measure differences of temperature. It is possible, therefore, to detect targets which might not be visible to the human eye due to poor visual conditions or darkness. It can be used to detect targets over land and sea

In certain conditions a FLIR equipped aircraft can mean the difference between a successful and unsuccessful search. The MC should consider the use of such an aircraft if it is thought appropriate

The parameters for visual search are considered suitable for planning FLIR searches but the aircraft Commander should be consulted with regard to on-

scene conditions, since in conditions conducive to good FLIR operation, detection ranges may well exceed visual range

Generally, the performance of FLIR at night is better than by day since the temperature variation is normally greater. As ambient temperature increases, target definition becomes less well defined

The advantages of FLIR equipped helicopters are:

- the camera has a powerful zoom capability
- also good for searching in daylight overland and cliffs
- good complement to NVG operations especially overland
- targets can be identified from 1000 feet out to 1 nm without need to descend, using camera and FLIR by night;
- radar searches enhanced using TV camera and FLIR
- FLIR / camera can be used for recording pictures for subsequent debriefs and press

## **SRU Factors Affecting Target Detection**

### **Aircraft Altitude and Speed**

Scrutiny of the Search Area Coverage (SAC) Tables will identify an optimum theoretical altitude, or range of altitudes, and speed at which an aircraft will have the best chance of detecting a particular target

When planning a search involving air units, as well as referring to the tables, the MC must be guided by the aircraft pilot or ARCC. Given the conditions, including cloud height, visibility, sea conditions and type of target, they should be able to give an opinion as to the proposed search altitude and speed parameters

Even after consultation and agreement, it may not in the circumstances prove to be possible for an aircraft to search at a particular height or speed due to the actual on-scene conditions, cloud height etc. The MC must take any significant change into account, re-visit the search plan and either change the plan or accept the degradation of search effectiveness

### **Surface Unit Speed**

In general, surface SRUs should conduct their search at a speed that gives crews the best opportunity of detecting the target, together with consideration for the comfort of the crew. It would not be practical for example for an SRU to search for a person in the water at a speed of 30 knots.

There is little or no advantage to be gained in asking a 50 foot lifeboat to battle her way through heavy seas at full speed - the crew will be concentrating on their own safety! On the flip side, there will be a distinct disadvantage in terms of area coverage if the same unit searches at slow ahead in a flat calm

In determining search speed, the MC/search planner must be guided by the conditions on scene and the views of the skipper/Coxswain. Close liaison must be maintained with the vessel during the passage to the search area, especially in heavy weather, so that if necessary the plan can be amended to reflect the actual on-scene conditions before the unit commences the search

### **Area Coverage and Search Effectiveness**

It is important that we are able to measure the theoretical effectiveness of a search. Many factors influence the ability of a search unit to detect a target during a search, but there are basically four main components whose relationship to each other and with the size of the area contribute to and make possible the measurement of the theoretical effectiveness of a search.

These are:

- Sweep Width (W)
- Track Spacing (S)
- Coverage Factor (C)
- Probability of Detection (POD)

#### **Sweep Width (W)**

A search unit has, in theory, the ability to detect a target up to a certain distance to either side (and in some cases, all around). The overall port to starboard distance is known as the Sweep Width. In mathematical terms it is the Detection Distance x 2

The distance up to which a unit should be able to detect a target in the conditions will of course depend on a number of factors such as the height of eye (or altitude) of the observer, the height of the radar scanner, the size of the target, weather conditions etc.

#### **Visual Search**

Every target will have a theoretical maximum distance at which it could be seen visually based on the height of eye of the observer, the size of target and allowing, if necessary, for the curvature of the earth. This figure doubled will produce the maximum possible Sweep Width figure, known as the Uncorrected Sweep Width (Wu). Values for Wu for different targets can be found in the SAC Tables

The actual sweep width on the day and in the conditions, known as the Corrected Sweep Width (Wc), is determined by applying correcting factors for weather, search speed (aircraft only) and fatigue, to the Uncorrected Sweep Width (Wu)

- $Wc = Wu \times \text{Weather correction} \times \text{Speed correction (a/c only)} \times \text{Fatigue correction}$

### **Detection Aid Search**

Use of either day or night time visual detection aids (e.g. para flare, hand flare, orange smoke etc.), will greatly enhance the target's chances of being spotted by a search unit. Values for both day time and night time detection aids are given in the SAC Tables

It should be noted that the figures given for these are the Corrected Sweep Width values and do not therefore need to be corrected

### **Electronic Search**

Searches based on the detection of a target by radar or the detection of an electronic signal (e.g. Radio, EPIRB/ELT) can considerably increase area coverage, which can be a major factor if time is limited or the search area massive. The SAC Tables provide guidance on the Sweep Widths associated with these types of searches

Again it should be noted that the values are for Corrected Sweep Widths

### **Track Spacing (S)**

Track Spacing is the horizontal distance between adjacent search legs. Search legs are the tracks down which a search unit will travel and conduct its search. Track Spacing is a critical element of the search plan as the relationship between it, the Sweep Width and area size will determine how well the area is covered and ultimately how effective the search will be

It is something that can be calculated mathematically, but the MC/search planner must consider the implications on area coverage and adjust the figure if necessary to a) enable the area to be covered and b) provide a practical value for a search unit to follow given its navigational capability

Areas may be searched by successive sweeps of a single search unit (depicted above), or by the simultaneous sweeps of several search units (depicted below)

### Coverage Factor (C)

The Coverage Factor quantifies the relationship between the Track Spacing (the width apart of successive search tracks) and Sweep Width (the width of target detection along the track)

Coverage Factor is a mathematical expression of the relationship of Track Spacing to Sweep Width and is calculated using the following formula:

Coverage Factor =	$\frac{\text{Corrected Sweep Width}}{\text{TrackSpacing}}$	$\frac{C = Wc}{S}$
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#### Track Spacing = Sweep Width

If the Sweep Width and Track Spacing are equal, all of the area is theoretically being searched and the Coverage Factor is 1. The mathematical coverage is 100%

#### Track Spacing Greater Than Sweep Width

If the Track Spacing is greater than the Sweep Width, not all the area is being searched and the coverage Factor will be less than 1. The value of C will give an indication as to the percentage of area actually being searched

<i>Example</i>
Corrected Sweep Width (Wc) = 2.4 NM Track Spacing (S) = 3.2 NM

**Coverage Factor**  $C = 2.4 / 3.2 = 0.75$  (i.e. 75% coverage)

### Track Spacing Less Than Sweep Width

If, on the other hand, the Track Spacing is less than the Sweep Width, some of the area is being covered twice and C will be greater than 1. Again, the value of C provides an indication of the area coverage in percentage terms

#### *Example*

Corrected Sweep Width ( $W_c$ ) = 3.2 NM

Track Spacing (S) = 2.4 NM

**Coverage Factor**  $C = 3.2 / 2.4 = 1.33$  (i.e. 133% coverage)

### Achievable Coverage

The MC/search planner should be aiming to achieve a Coverage Factor of 1 (i.e. have the Track Spacing equal to the Sweep Width) as a minimum

This may however not always be possible given the area size, the number and capabilities of units and the time available. The MC may have to adjust something in order for the whole area to be covered in the time available. If optimum values have been used to calculate the search area and Sweep Width, then the only adjustable element is the Track Spacing

The MC may have to assign a less than ideal Track Spacing in order to ensure the whole area is covered by the SRU(s) in the time available

### Lone Searcher

The Sweep Width and therefore the Coverage Factor values are based on the premise that there are simultaneous sweeps being conducted on both sides of the unit. If however there is only one observer available, there will not be simultaneous sweeps and the effectiveness of the search will be severely compromised. A lone searcher should be able to alternate sweeps from one side to the other, but this can at best only be half as effective as two searchers each concentrating on their own side

If, when it comes to it, there is only one observer alternating their search from side to side, then the Coverage Factor should be halved

## **Probability of Detection (POD)**

If it is taken as a given that the search target is somewhere in the search area, then the probability that it will be detected by search units following their assigned search tracks and in the conditions, is known as the Probability of Detection. It is a mathematical and theoretical measure, expressed as a percentage, of how well an area is likely to be, or has been, searched. Its value is directly related to the Coverage Factor

### **Visual Searches**

Visual searches rely on the receipt of visual input and the interpretation of that input by the human brain. Receipt and interpretation can be affected by a number of factors such as tiredness or physical obstacles (e.g. superstructure etc.) partly obscuring the observers view. An allowance therefore needs to be made for the fact that even if a target is within the theoretical field of view of the observer, detection is not guaranteed

A visual search should consist of consecutive and continual sweeps by the observer of the sea surface from the search unit's side, out to the visibility range for the target which will have been given to the unit by the MC as part of the pre-search brief

The probability of detection of a target is not uniform across the swept area. In general, the POD is highest at short distances from the search unit and decreases with distance. It can also decrease for targets very close to the search unit as they can be literally over-looked

### **Determining POD - Visual Search**

Probability Of Detection (POD) is determined by reference to the POD Graph. Note: The graph is reproduced below for illustration purposes only

POD has a direct relationship with the Coverage Factor. This value must therefore be determined before the POD can be established

As can be seen from the extract, there are a number of curves A – E. Each curve provides the realistic POD for up to five simultaneous (i.e. five layer) searches of an area or five consecutive single-layer searches of the same area

If the search planner develops new search areas each time, then each is considered a first search and curve A is the only one ever used. Curves B to E are only ever used if an area is searched simultaneously by different units, as in the case of a layered search, or if the same area is searched repeatedly

### First or Single Layer Search

The POD figure is arrived at by entering the Coverage Factor on the horizontal axis, reading up to Curve A, and then across to the POD on the vertical axis

Examples			
Coverage Factor (C)	0.7	1.0	1.3
Single/first search curve	A	A	A
POD	62%	79%	90%

As can be seen from the table, with a Coverage Factor of 1, the POD is 79%

### Layered or Repeat Area Searches

When layered or repeat area searches are being conducted by single or multiple units and the Coverage Factor for each unit is the same, the POD is found by entering the table with the Coverage Factor, reading up to the appropriate curve (e.g. Curve D for a four-layer or fourth search), and then across to extract the POD value

If multiple units are searching, and each have different Coverage Factor values, the cumulative POD can be found by reference to the Cumulative POD table or by mathematical calculation

Worked examples are given in the POD Graph page

### AVNST

This section looks at the relationship between area size, unit speed, the number of units, the track spacing and search time and how we can use the

relationship formula to provide us with information on what can be achieved with what is available

The relationship formula is:

- **Area = Velocity x Number of Units x Track Spacing x Time**

This is mathematically expressed as  $A = VNST$ , which can be reduced to  $A = VST$  if only one unit is being considered

- **Area** = search area, in NM<sup>2</sup>
- **Velocity** = search unit's speed, in Knots
- **Number** = number of same or similar units (e.g. ALB + 40 ft cruiser)
- **Track Spacing** = distance apart of adjacent search tracks in NM
- **Search Time** = time actively spent searching, in hours & decimals (e.g. 1.25 Hrs)

Using the Formula

Using the  $A=VNST$  formula and transposing the elements as necessary gives the MC the ability to identify any one of the elements, given the others and to explore the effects on others of changing one or more of the values

Using and transposing the formula will give:

<b>A = VNST</b>	the area that can be covered by the unit(s) in a given time
<b>V = A / NST</b>	the speed the unit(s) need to search at in order to cover an area
<b>N = A / VST</b>	the number of units needed to cover an area
<b>S = A / VNT</b>	the track spacing required in order for the unit(s) to cover an area
<b>T = A / VNS</b>	the active search time required for the unit(s) to cover an area

### **Search Time v Search Duration**

Search Time (T) is defined as:

- the time actively spent searching

Search Duration (SD) is defined as:

- the total time the search will take and includes a 15% allowance for diversions, out-of-area turning etc.

### **Determining Search Time (T)**

Search Time is determined by multiplying the Search Duration by 0.85

- $T = SD \times 0.85$

#### *Example*

The MC is planning for a search from 1500 to 1700

- Search Duration therefore = 2.0 hours

**Search Time (T) = 2.0 x 0.85 = 1.7 Hrs** (1 Hr 42 mins)

### **Determining Search Duration (SD)**

Search Duration is determined by dividing the Search Time by 0.85

- $SD = T / 0.85$

#### *Example*

Area (A) = 16 NM<sup>2</sup>

Unit speed (V) = 10 Kts

Number of units (N) = 2

Track Spacing (S) = 0.4 NM

#### **Search time**

$$T = A / VNS = 16 / (10 \times 2 \times 0.4) = 16 / 8 = 2.0 \text{ Hrs}$$

#### **Search Duration**

$$SD = 2.0 / 0.85 = \mathbf{2.35 \text{ Hrs}}$$
 (2 Hrs 21 mins)

### **Comparing Calculated and Achievable Areas**

The AVNST formula is a very important part of SAC and should be used in the first instance by the MC/search planner to determine what area can be covered by the units available in the time and with the optimum track spacing (i.e. the one which gives a Coverage Factor of 1) and to compare it with the area calculated during the SAD phase

### **Covering the Calculated Area**

If what can be covered matches or exceeds the calculated area, then all is well. The MC/search planner may consider adjusting one or more of the parameters (i.e. search speed, number of units, track spacing or time) if the achievable area exceeds the calculated area. There is no point allowing the search to be of a massively larger area and it may be that reducing the Track Spacing will be a preferred option as this will increase the Coverage Factor and consequently the Probability of Detection (POD)

If the achievable area is less than the calculated area, the MC/search planner needs to consider whether the difference is significant and if it is, whether or not any of the parameters can be adjusted to increase the area coverage. This is where the manipulation of the AVNST formula comes into its own as the MC can use it to see what the individual values of V, N, S & T will be against a pre-determined (i.e. SAD calculated) area

### **AVNST Form**

The SAC Worksheet provides for easy manipulation of the AVNST formula

The final part of the form (Section G) allows the MC to identify the final search parameters that will be used in the search and the effects on the POD

If the optimum values for speed and search time have already been used and there are no more units available, the only option will be to adjust, i.e. increase, the Track Spacing. If this is the only option available, the MC has to accept that there will be a negative effect on the Coverage Factor and consequently on the POD

If the Track Spacing is adjusted, the mathematical value produced by the formula (in Section F of the form) needs to be considered by the MC in terms of whether or not it could be achieved navigationally by the search unit(s). If not, then the figure should be rounded up or down to the nearest practically achievable figure. It is often preferable, particularly when a mid-search datum time has been used, to round the Track Spacing up rather than down, so that a slightly larger area than that calculated in the SAD phase can be achieved. This will provide a small provision for the fact that the actual end-of-search area will in reality be larger than the mid-search area

### **Less Than Optimum Coverage**

The MC/Search Planner should be aiming to achieve as high a POD as is possible given the time and resources available. A Coverage Factor of 1 (POD of 79%) is the absolute minimum that should be considered acceptable

If, after calculation, the Coverage Factor is less than 1, the MC/search planner needs to consider whether or not there is anything that can be done to improve the figure, without compromising the search area if at all possible

The MC has the following options:

- seek and task additional units
- plan a new search based on revised data e.g. more accurate tidal information etc.
- accept a low probability of detection
- reduce the search area

If the MC decides that the only recourse is to reduce the size of the search area, they must be sure that the reduction is based on sound reasoning which will stand up to scrutiny. If an area is reduced the POD of the new area will be greater, but the POD of the excluded area will be zero!

## **Single or Multi-Layered Search**

As mentioned earlier the overall coverage plan needs to be considered and decided on by the MC

The options considered are those of how the area will actually be covered i.e. if it will be searched by one unit or multiple units and if the latter, if a single layer or a multi-layered search would be best

### **Single Layer Search**

#### **Single Unit**

This is the least complicated of all plans and simply involves one unit covering the entire search area using the most appropriate search pattern

A single unit search is generally employed for a Rapid Response search as the area will be relatively small, the search pattern tight (at least initially in the case of an Expanding Square) and there would therefore be safety risks if more than one unit was navigating in the area at the same time

For a non-Rapid Response area, it is generally true that the more units there are the better. It may be however that time constraints and availability of units dictate that a single layer search is the only option

### **Multiple Units**

If there are sufficient resources available, an area can be divided into sub-areas with a separate search unit allocated to each

The illustration below provides an example of a single layer multi-unit search

If all search units are of a similar type as far as Sweep Width is concerned (e.g. 40ft vessel) and the Track Spacing for each are the same, the Coverage Factor will be the same and so an overall POD can be determined - reference Curve A

If the units are of different types, the Coverage Factor cannot be averaged to give an overall POD and it will only be possible to identify the POD for each sub-area

### **Multi-Layered Search**

Another possible option available to the MC given the available resources, is the multi-layered search

The term multi-layered is normally thought of as meaning at different heights i.e. surface units plus air units. Whilst this is true, the term can also be attributed to searches conducted on the same level. Two or more surface units covering some or all of the same area together are in effect conducting a multi-layered search, the layers just happen to be at the same height

The illustration below depicts a multi-layered, multi-level search where five SRUs, namely a Nimrod aircraft, a Coastguard helicopter, Fa warship and a merchant vessel, are searching simultaneously

All of the area is being covered, but to varying degrees by each layer. Some of the area is being covered twice (i.e. Nimrod + warship), some of it three times (Nimrod + warship + CG helicopter) and some of it four times (Nimrod + warship + CG helicopter + merchant vessel). The POD's of these areas will

therefore vary and can be calculated using the multiple unit combined POD methods described earlier

If the MC considers that the target could be in one particular part of the search area, the layers can be manipulated to concentrate effort on that area, whilst still ensuring an acceptable coverage and POD overall

The diagram below shows the search layer coverage for the five-layer multi-layered search depicted above

### **Simultaneous Search Timing**

It must be remembered that where multiple units are being used simultaneously to provide coverage of a larger area, the commence search times and search duration for all sub-areas must be the same

□ Simultaneous searches must start and finish together

The only exception to this would be for 'uncontrolled' additional facilities such as a merchant vessel being used whilst transiting the area, as in the layered search example above

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