843 Sweep Width (W)

Sweep width (W) is a mathematically expressed measure of detection capability due to target characteristics, weather and other limitations. It is usually expressed in yards for underwater and ground searches; or in nautical miles for other types of searches. Sweep width is the numerical value obtained by reducing the maximum detection distance of any given sweep so that scattered targets which may be detected beyond the limits of W are equal in number to those which may be missed within those limits.

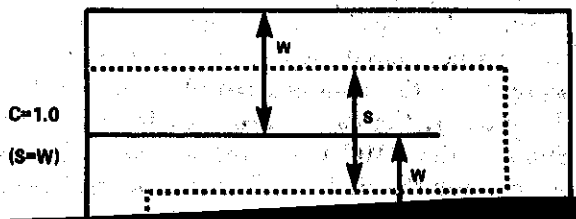
Figure 8–63 graphically presents this concept of sweep width. The number of targets missed inside the sweep width distance is indicated by the shaded portion near the top middle of the rectangle, while the number of targets sighted beyond the sweep width distance is indicated by the shaded portion at each end of the rectangle. Referring only to the shaded areas, when the number of targets missed equals the number of targets sighted, sweep width is defined. (In a strict mathematical sense, the area under the

The quality of coverage for any sweep depends on the relation between the sweep width and the track spacing. For convenience in search planning, this relationship is called coverage factor (C) and is expressed by the following equation:

$$\text{Coverage Factor} = \frac{\text{Sweep width}}{\text{Track spacing}} \text{ or } C = \frac{W}{S}$$

Both sweep width and track spacing are measured in the same dimension (miles or yards) for a given search effort. It can thus be seen that C is a non-dimensional value. C rather than P should normally be passed to the OSC and

COVERAGE FACTOR, $C = \frac{W}{S}$



SRUs in the SAR action message to indicate the coverage required.

Figure 8–64 depicts a comparison of coverage factors of 0.5 and 1.0. Note that the higher the coverage factor, the more thorough is the coverage of the search area. In other words, as coverage factor increases, the quality of coverage is increased.

The coverage factor controls the probability of detection, as shown by the probability curves of figure 8–65. Since C is the ratio of W to S it may also be stated that sweep width and track spacing control the probability of detection.

The probability of detection curves of figure 8–65 provide the probabilities for a single search of an area (first search curve), and for repeated searches (up to five) of the same area.

Since the SMC uses probability to express either the desired search results (before the search), or the obtained search results (after the search), the curves are used in two ways. Suppose the SMC plans for a desired P=78 percent for the first search for a target whose sweep width is 3 miles. Enter figure 8–65 with P=78 percent, move horizontally to the right until the first search curve is intersected. Drop vertically to the bottom scale and extract C=1.0. Since C=W/S, it can be algebraically rearranged to read S=W/C. Therefore the SMC would have to use a track spacing of 3 miles (S=W/C=3.0/1.0=3 miles) to obtain his desired probability of 78 percent. Now suppose that the search unit was unable to use the track spacing of 3 miles and instead used a track spacing of 4 miles. The actual coverage factor obtained by the search craft would be 0.75 (C=W/S=3.0/4.0=0.75).

Entering figure 8–65 at the bottom with C=0.75, move vertically up to the first search curve, then horizontally to the left scale and extract P=65 percent. This is the actual probability obtained by the search unit.

When the probability obtained from an initial search is too low to provide a reasonable assurance that the search target is not in the search area, the SMC must have that area researched. Generally increasing the coverage factor up to 1.0 results in a worthwhile gain in probability. With higher values, the slight additional gain in probability is not worth the greatly increased search effort unless and excess of search units are available.

When repeated searches are employed, the probability is determined by entering figure 8–65 with the coverage factor and the number of searches. However, the coverage factor may be different for each search due to changing sweep widths or track spacings. In this case the average coverage factor for all searches is used, together with the appropriate curve for the number of searches to obtain the accumulated probability of detection. This is not strictly correct but is sufficiently accurate for manual calculations in most cases. For example, suppose five searches have been completed with the following coverage factors obtained:

Search:	*Coverage factor*
1	.5
2	.7
3	.3
4	.2
5	.2

Average coverage factor = 1.9/5 = 0.38.

Entering figure 8–65 with C = 0.38 and using the fifth search curve will provide the accumulated total probability of detection of 92 percent.

The nomograph of figure 8–66 has been developed to eliminate the need to calculate C in most cases. In addition it provides a direct means of comparing the effects of changes in S with changes in P, when sweep width is held constant. This feature is particularly useful to the search planner when he must compromise between his desired coverage of a search area and the actual coverage possible due to various limitations, such as limited search units, time available, etc. This nomograph is based on the curves of figure 8–65. When working with S, W, and P, it is helpful for the SMC to keep in mind that S is associated with the search craft, W is associated with the distressed craft and sensor, and P is associated with the relationship between S and W.

845 Visual Sweep Widths

a. General

Visual search is the oldest as well as the most commonly used method for detecting distressed craft or persons. As a result it has benefited from an extensive amount of research and practical testing, and a large amount of data is available to the search planner. Other forms of search have not been as extensively studied, and therefore require slightly different procedures for obtaining sweep widths. This paragraph summarizes the most recent data on visual sweep widths and discusses various modifying factors.

b. Sweep Width Tables

Tables of sweep widths for visual search targets have been developed. These are presented in figure 8–67. Figure 8–67a tabulates uncorrected sweep widths (W_u) for visual daylight search for rafts, boats and ships. Entering arguments are meteorological visibility, search target, and search altitude. The tabulated values of W_u are in nautical miles.

Figure 8–68 tabulates estimated visual sweep widths for the most common daylight detection aids which survivors or distressed craft may use to attract attention. Figure 8–69 does the same for darkness detection aids. It must be emphasized that these values are based on best estimates and that, if more accurate information is available, it should be used. Also, the values presume good visibility conditions.

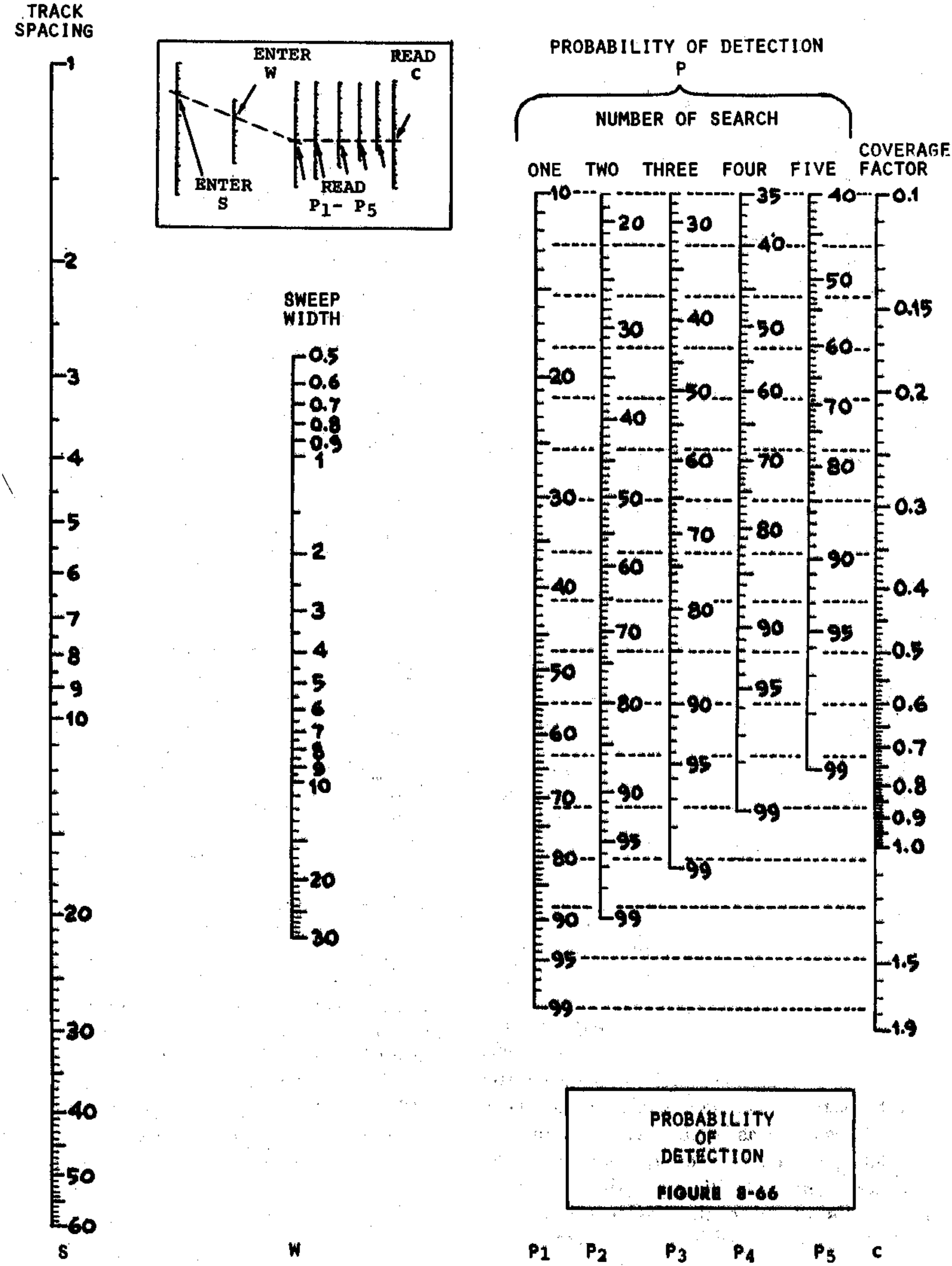
Figure 8–67b provides the whitecap correction factor (f_w) which is applied to the uncorrected sweep widths to correct for wind effects. Naturally whitecap correction factors are only used when the search target is located on a water surface. Note that f_w is less than 1.0 for small targets in calm wind conditions. This is due to reflections from the glassy surface, making it difficult to see them.

Figure 8–67c tabulates lighting correction factors (f_l) which are applied to uncorrected sweep widths to correct for cloud coverage.

The corrected sweep width (W) is therefore obtained from the following equation:

$$W = (W_u)(f_w)(f_l).$$

Suppose the SMC was planning a search for a liferaft and desired to use a search aircraft at



PROBABILITY OF DETECTION

FIGURE 8-66

Most of these factors tend to reduce the corresponding probability of detection. These factors are discussed in their approximate order of influence.

1. Search Target. The detectability of a target (and its sweep width), is significantly related to the target's size, its shape, its distance, its color contrast and brightness contrast with the background, its movement, and its duration of exposure to an observer.

When considering a target's detectability, a general understanding of various terms is useful. When a search scanner can first detect something different from its surroundings, but is unable to recognize what it is, this distance is referred to as the awareness range. As the distance is decreased, the "something different" is recognized as a general category such as a boat or a truck. This distance is referred to as the recognition range. Finally the distance is reached where the target can be identified as a subgroup within its general category, such as a 30-foot cabin cruiser or an M–48 tank. This distance is referred to as the identification range. Most authorities define maximum detection range in terms of awareness, although a few also specify recognition as a requirement. For SAR purposes, only awareness is specified, since it is presumed that a search unit will follow up any detected target, and will both recognized and identify it as necessary.

The amount of freeboard influences detection of marine craft. A large target with little freeboard may not be seen by a surface unit or a low flying aircraft, or may not be seen up-sun under conditions where a smaller target with high freeboard would be detected. Objects with high freeboard are also generally more susceptible to detection by radar.

Color aids detection due to its contrast with the surrounding or background colors. A small target that contrasts in color with the background can often be seen easier than a much larger target that blends with the surrounding medium. However, very small targets can only be seen a limited distance regardless of color contrast. For the color to be effective, the eye must look directly at the target. The color receptors of the eye are concentrated in the center of the retina, and objects that would be seen out of the corner of the eye are unlikely to be seen due to color contrast alone. Yellow, red, or orange colors provide good contrast against a water background. However, yellow and white objects are not seen easily when whitecaps exist. Under such conditions, red appears to be the optimum color. Flourescent colors will be sighted at greater distances than flat or dyed colors. The density of color in fluorescent paint and tapes is so great that color contrast as well as brightness contrast with the background will affect sweep width.

Whether or not a target is moving is also a factor, due to the disturbance in the water or terrain created by such movement. The faster a vessel moves, the greater is the wake, and consequently, the detection range. In over water searching, it is quite common to sight the wake of a fast moving vessel long before the vessel itself is sighted. Any movement by an object in light seas is likely to attract attention; for example, a whale breaking the surface, or seas breaking over a partially submerged derelict. Likewise a vehicle moving over a dusty road will raise a dust-cloud that will be sighted before the vehicle can be seen. High flying aircraft may also be detected from their contrails under certain meteorological conditions. Generally, water wakes, dust-clouds, and contrails are more easily sighted down-sun, whereas the craft's silhouette may be sighted first if viewed up-sun, or within 10 to 15 degrees of the up-sun glitter path if on the water.

Small search objects in high seas and swells are difficult to detect. Under these circumstances search leg headings perpendicular to the seas or swells will prolong the time the objects are visible to lookouts on the beam as the search unit passes.

2. Meteorological Visibility. Meteorological visibility, or meteorological range, is the maximum range at which very large objects such as land masses or mountains can be seen. Reduced meteorological visibility will result in reduced sweep width for any particular object. The detection range of all except the very largest objects (such as mountains) will always be less than the meteorological visibility.

Obscurations to visibility such as haze, smoke, smog, fog, rain, snow, sleet, etc., will all reduce sweep width due to the reduction of maximum detection distances. Smog and haze reduce the effectiveness of daylight detection aids much more than darkness detection aids. Fog may render surface search ineffective. However with shallow surface fog, objects can often be detected from aircraft using near-vertical downward scanning. Precipitation will greatly reduce visibility from an aircraft cockpit, and may prevent scanning in a forward direction. Heavy rain and light snow will also render scanning ineffective from both side and cockpit positions. In addition, scattered showers may hide the target from view at the moment of passing the SRU.

If survivors have high altitude parachute flares or radar chaff flares, low level obscurations become less important. If survivors have radio, radar, or TACAN locator beacons, the problem of visibility is largely eliminated.

3. Terrain/Sea Conditions. The type of terrain to be searched will obviously affect 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 there is less likelihood that the distressed craft, wreckage, or survivors will be hidden by undulations or irregularities on the terrain surface. 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 terrain, 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. 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 lookouts 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.

The presence of whitecaps and foam streaks on the water break the uniformity of the surface and markedly reduce 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. 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 reduction of visibility and its accumulation on the search craft's windows.

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.

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

5. Search Altitude. In general the lower the search altitude, the better will be the chances of detecting a search target. But there are conditions to this statement. Below 500 feet, the search target will pass through the field of vision more rapidly than at higher altitudes, low freeboard search targets are more difficult to sight, terrain irregularities become more pronounced, and pilots tend to concentrate more on their instruments and flying than they would with some altitude for a safety margin. Accordingly, at search altitudes of 500 feet and below, light aircraft or helicopters are best because of the slower search speeds they can maintain.

On the other hand the higher the search altitude, the larger will be the area available to the search craft for scanning and the larger will be the sweep width—up to a certain limiting altitude depending upon the size of the search target, its contrast with the terrain, and the visibility.

Other factors that must be considered in selecting a search altitude are the amount and height of the cloud base, turbulence at various levels, slant range visibility at various levels due to salt spray or other obscurations, and identification ability at various levels. The base of the cloud layer will place an upper limit on altitudes available for visual search by aircraft. A low ceiling of 500 feet over flat terrain or open ocean will not make search impossible, but it will decrease the pilot's search effectiveness due to his concentration on his instruments. For this reason a separate search scanner/observer should always be assigned to light aircraft or helicopters dispatched for search into areas with low ceilings. With patches of cloud below 500 feet, visual flight becomes hazardous and search effectiveness decrease rapidly. As a general precautionary rule, large fixed-wing aircraft should not be dispatched for visual search when ceilings are below 500 feet. (This rule may, of course, be modified by aircraft commanders and parent operational commands.)

The ability to identify all sightings will also place an upper limit on the search altitude. For example, if the search object is a trawler, and a large number of vessels are in the area, a low altitude will be preferable to eliminate having to descend to identify each one sighted. In addition, a low altitude will tend to favor more rapid identification of targets due to the greater familiarity of scanners with objects viewed from low angles. This is especially true for overland searches.

For targets under 30 feet in length, search altitudes below 500 feet are more efficient. Although more terrain is visible to the scanner at higher altitudes, the target itself will be undetectable in the additional terrain. For example, at an altitude of 250 feet, the horizon line to the scanner is about 19 miles. At 500 feet the horizon is extended to about 29 miles. Obviously the scanner will be unable to detect small or even medium sized targets at these ranges. Another consideration is that slant range determines the distance at which a target is sighted, not the ground distance to the target. By using lower altitudes more earth surface is included within the available detection range. As the search altitude is decreased the slant range tends to become equivalent to the ground range, and more terrain closer to search track is available for being searched. Therefore, the coverage tends to be more thorough at lower altitudes. In over-land searches which are conducted at 200 feet altitude, good coverage of an area one-half mile on either side of the track could be expected in rolling terrain with moderate ground cover.

The scanner's efficiency at a given altitude will largely depend upon the apparent size of targets at that altitude. Army field tests have demonstrated that a scanner's efficiency decreased rapidly in overland searches when the altitude was increased above 200 feet up to 2,000 feet. Above 2,000 feet only slight decreases in scanner efficiency were recorded.

The wind velocity in oceanic search areas will place a lower limit on search altitudes for two reasons. First, the amount of turbulence will generally be greater at lower altitudes due to the air/ocean interface. Second, salt spray will dirty an aircraft's windows much quicker at low altitudes with resultant decreased sighting ranges. With winds below 25 knots this problem can usually be ignored. However, with higher winds salt spray will reach altitudes above 500 feet. For example with 50 knot winds, the windows of a search aircraft at 1,000 feet will have to be cleaned about every 30 minutes.

The beam/silhouette relation will influence the altitude selection. For a surface craft, the silhouette (and length) of the search target is more important than its beam. However, as altitude is increased, the beam of the search target on the earth's surface becomes more important because the beam (and length) will determine the size of the target as viewed by the search aircraft.

The target's contrast with the sky or the earth's surface will sometimes determine the best search altitude. For example, suppose the search target were either an airborne distressed aircraft or a drifting balloon. During daylight the search aircraft would normally use an altitude below that of the target since the contrast between the target and the sky is more easily detected than the contrast between the target and the ground. But at night with many stars visible, it may be that the target's navigation lights would be more easily detected if contrasted with the darkened earth's surface, especially if the search area is over oceanic or sparsely populated land areas. In this case a search altitude above the search target would be selected.

This same principle may be applied aboard a surface search vessel. Suppose the vessel were searching for a merchant vessel adrift without power at night. Since the vessel would be unable to use any lights to make itself more visible, the lookout/scanners would be instructed to concentrate their search on the horizon where the contrast between the distressed vessel's silhouette and the sky would be greater than the contrast between the darkened vessel and the dark ocean surface. On the other hand if the distressed vessel were able to illuminate itself, the contrast would be greater against the dark ocean surface than against the lighter sky and low stars. The lookouts would then be instructed to concentrate their search below the horizon.

It is impossible to prescribe a "best" or optimum search altitude for all conditions. The following considerations may be used in determining search altitude.

(a) The smaller the target, or the more difficult the target is to see, the lower the search altitude must be.

(b) The lower the search altitude, then the closer the track spacing must be.

(c) The lower the search altitude, then the slower the search speed must be.

(d) 2,000 feet is the maximum practicable for either day or night visual search.

(e) 200 to 1,000 feet is the usual altitude for daylight overland search.

(f) 500 to 1,500 feet is the usual altitude range for daylight overwater search.

(g) 1,500 to 2,000 feet is the usual altitude range for night pyrotechnic or signal-light search over either water or land.

(h) 800 feet is a typical altitude for medium size targets (e.g. boats) in level, plain terrain such as oceans, deserts, or ice caps.

(i) 400 feet is a typical altitude for medium size targets (e.g., trucks) in moderately changing terrain such as rolling hills.

(j) 200 to 400 feet is the typical altitude range for small targets such as persons, aircraft crashes, one-man rafts, surfboards, etc.

6. Search Aircraft Speed. At low search altitudes the speed of the aircraft will affect the sweep width due to the angular velocity of targets moving through the 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. A more detailed discussion of these factors is included in visual search techniques in Chapter 9.

7. Detection Aid Effectiveness. Low visibility may considerably reduce the distance at which daylight detection aids may be seen. Under some conditions of high wind or breaking seas, daylight detection aids may be virtually ineffective. The signal mirror, or heliograph, is an exception; but necessary sunlight may not be present in the search area.

Sea conditions, wind, and obscurations to visibility have a lesser detrimental effect on darkness detection aids. Even a flashlight has a chance of being seen. On clear nights pyrotechnics have been sighted in excess of 40 miles. For these reasons night searches will often provide the highest probability of detection. If it is known that survivors cannot make a night signal, a widespread night visual air search is futile and unwarranted since detection would be purely a matter of chance. However, if it is known, or even suspected, that survivors can make a night signal, night visual air searches should be conducted during the early stages of the search effort. The survivor's supply of night detection aids is usually limited, and survivors will not fire pyrotechnics until they either see or hear a search unit. It is for this reason that no night detection aid is shown with a sweep width of over 10 miles in figure 8–69.

All search units should attempt to increase their self-illumination upon entering the search area by turning on all possible navigation lights, strobe lights, xenon flashers, landing lights, searchlights, etc. As much lighting as possible should be kept on continuously, consistent with lookout/scanner night vision efficiency and any speed limitations on extended aircraft landing lights. Turning landing lights on when established on a new search leg is a good practice for search aircraft. This will sometimes assist the survivor in timing the firing of his pyrotechnic signal in order to have it ignite ahead of the aircraft, rather than behind or to the side, and thereby have a better chance for it being sighted by the search aircraft.

During daylight-searches, marine craft should make heavy black smoke at intervals to encourage the survivors to activate their daylight detection aids.

When searching for survivors in a canopied liferaft, marine craft should periodically sound a whistle or horn to alert the survivors to their presence so that detection aids can be set off. Care must be used to insure that other marine craft will not confuse such signals with those prescribed by the rules of the road.

8. Position of Sun. The best time for a daylight search is from midmorning to midafternoon when the sun has a high elevation regardless of whether the sun is or is not visible. Objects can be seen more easily and from greater distances when looking down-sun (away from the sun) than when looking up-sun (towards the sun). This is due to both sun reflection from water surface and haze glare. Sunlight reflected from the water tends to blot out a smaller dark area such as would be formed by a raft. However, objects with high freeboard can sometimes be seen even in the sun's reflection path. Bright sunlight is especially detrimental if haze is present, due to the diffusion of light. The veiling brightness of haze is much greater in up-sun areas than in down-sun areas, so that objects on land and sea lose their distinctive colors and may be lost in the pattern of glaring light and shadows. In down-sun areas the terrain or sea is much darker, there is no glare, the haze is more transparent, whitecaps are highly visible, and colored objects contrast with their backgrounds. The adverse effects of up-sun searching are most prominent when the sun is low on the horizon, as it is during the hour immediately after sunrise or before sunset. Figure 8–70a graphically depicts the adverse effect from a low sun on the detection range of a typical search target. Figure 8–70b depicts this effect. When first light searches are conducted, the search pattern should be adjusted to compensate for the reduced detection capability during the critical period. This can be accomplished in two ways. If the search legs are oriented perpendicular to the sun's path, reduce the track spacing by one-half. After the sun has reached sufficient altitude to no longer be detrimental, the track spacing can then be increased to its original value. This method is depicted in figure 8–70c. It should be noted that the search unit is only operating at 50 percent efficiency during this "half–S" search period, and is consuming twice as much time to cover a search as would be required if the sun were higher. The second method is to orient the pattern so that the first leg is in the down-sun direction. Both side and bow observers will be effective on the down-sun leg. However, on the up-sun leg only the side observers will be effective. This method is depicted in figure 8–70d. If the first search leg consumes a long time, say 30 minutes, the worst adverse effects of a low sun right on the horizon will have at least been avoided.

Lookouts and scanners on any type of search unit should always be provided with a pair of dark polaroid sun glasses or goggles. This is of special importance when sun reflection, sun glare, or haze is present in the search area. Lookouts forced to look into the sun, or into the sun's path will suffer loss of visual acuity, and can easily fail to detect an object. In addition, the eyes may be internally sunburned if subjected to strong sun glare and reflections for a few hours.

9. Lookout/Scanner Effectiveness. The effectiveness of lookouts and scanners depends largely on their number, training, alertness, incentive, physical condition, dark adaptation at night, suitability and comfort of their positions, duration of the flight, and the speed of the search craft. The subject of lookout/scanner training, techniques and employment is covered in chapter 9 of this manual.

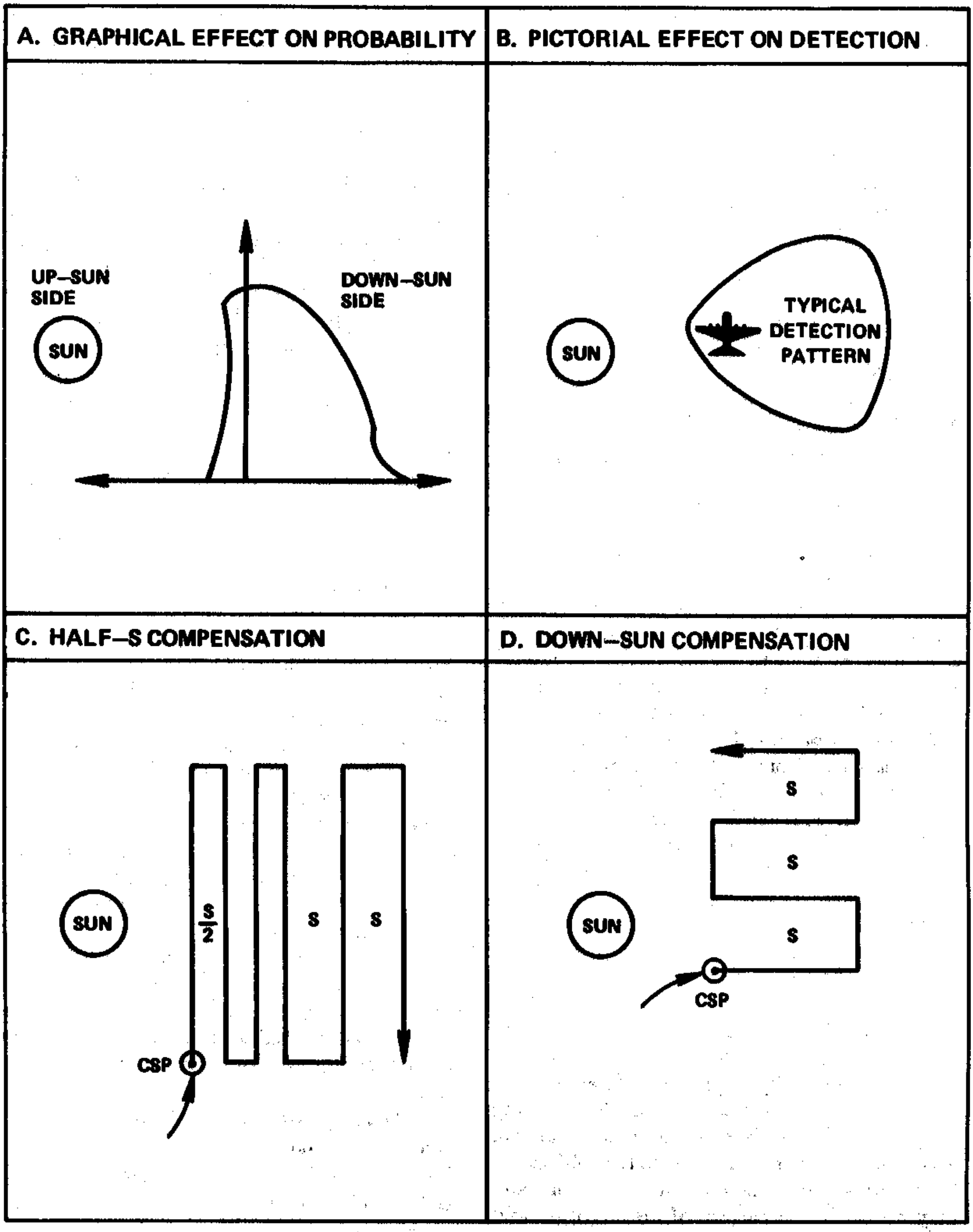

A. GRAPHICAL EFFECT ON PROBABILITY
UP–SUN SIDE
SUN
DOWN–SUN SIDE
B. PICTORIAL EFFECT ON DETECTION
SUN
TYPICAL DETECTION PATTERN
C. HALF–S COMPENSATION
SUN
S/2
S
S
CSP
D. DOWN–SUN COMPENSATION
SUN
S
S
S
CSP

FIGURE 8–70

846 Electronic Sweep Widths

a. General

Sweep width tables for various electronic searches are not as readily available as visual sweep width tables. Yet a sweep width should be developed for all types of searches in order to obtain the probability of detection and track spacing.

Electronic searches include radio, radar, TACAN, magnetic, voltage, radio active and other electromagnetic band searches. Because of the detector equipment involved, infrared and ultraviolet searches could also be placed into this category. By far, the most important of these for SAR are radio and radar.

Under proper conditions, electronic searches are far more efficient than visual searches. Relatively large track spacings can be used in electronic searches and, as a result, high probabilities of detection can be obtained over large geographic areas in a short period of time. Therefore, electronic searches should always be employed anytime it is known or even suspected that the distressed craft or persons may be detectable with electronic means.

b. Electronic Range Limitations

Electronic sweep widths may be affected by:

1. SAR craft's detector power output.
2. Target's power output or reflected power.
3. SAR craft's and target's antennae characteristics.
4. SAR craft's receiver sensitivity.
5. SAR craft's direction finder sensitivity.
6. Environmental attenuation loss.
7. Environmental ambient noise level.
8. Terrain/foliage attenuation loss.

c. Range Data Sources

Detection range information may be available from several sources. If a survivor is equipped with a locator beacon, his parent agency may be able to furnish the SMC with the detection range of the beacon. If a particular type of detection device is to be used during a search by a SAR unit, the operating command of that SAR unit may be able to furnish the SMC with the detection capabilities of that particular device for the type of target in question. Some manufacturers have completed extensive testing of their products, and will be able to provide the SMC with its detection capabilities for a particular type of target. If none of the above sources are fruitful, the SMC may query the actual operators of the detection device to obtain their personal opinion as to the detection capability of the device. As an example, a radar operator who is familiar with his assigned radar should be able to offer a fairly accurate estimate of the probable detection range for specific types of targets. Some squadrons and operating forces have established internal programs for compiling just such information in order to increase their own efficiency in search operations.

d. EPIRB/ELT Sweep Widths

The detection range data obtained from various sources may be reported or tabulated as maximum, average, or minimum detection ranges. These are defined as follows:

Maximum detection range—that range at which a target is first detected which is the maximum of a series of such ranges taken on the target.

Minimum detection range—that range at which a target is first detected which is the minimum of a series of such ranges taken on the target.

Average detection range—that range which is the average of a series of ranges at which a target is first detected.

The following guidelines are recommended for developing an electronic sweep width. They are listed in their order of preference.

1. When minimum detection range is known:
   $W = (1.7)$ (minimum detection range).
2. When average detection range is known:
   $W = (1.5)$ (average detection range).
3. When maximum detection range is known:
   $W = (1.0)$ (maximum detection range).
4. When no detection range is known:
   $W = (0.5)$ (horizon range) see horizon range table (fig. 8–71).

If the search area is in mountainous areas, jungle areas, wooded areas or any other area of vegetation, the above values of W should be reduced by one-half. As a general rule a track

HEIGHT OF EYE VS. HORIZON RANGE

Height feet	Nautical miles	Statute miles	Height feet	Nautical miles	Statute miles	Height feet	Nautical miles	Statute miles
1	1.1	1.3	120	12.5	14.4	940	35.1	40.4
2	1.6	1.9	125	12.8	14.7	960	35.4	40.8
3	2.0	2.3	130	13.0	15.0	980	35.8	41.2
4	2.3	2.6	135	13.3	15.3	1,000	36.2	41.6
5	2.6	2.9	140	13.5	15.6	1,100	37.9	43.7
6	2.8	3.2	145	13.8	15.9	1,200	39.6	45.6
7	3.0	3.5	150	14.0	16.1	1,300	41.2	47.5
8	3.2	3.7	160	14.5	16.7	1,400	42.8	49.3
9	3.4	4.0	170	14.9	17.2	1,500	44.3	51.0
10	3.6	4.2	180	15.3	17.7	1,600	45.8	52.7
11	3.8	4.4	190	15.8	18.2	1,700	47.2	54.3
12	4.0	4.6	200	16.2	18.6	1,800	48.5	55.9
13	4.1	4.7	210	16.6	19.1	1,900	49.9	57.4
14	4.3	4.9	220	17.0	19.5	2,000	51.2	58.9
15	4.4	5.1	230	17.3	20.0	2,100	52.4	60.4
16	4.6	5.3	240	17.7	20.4	2,200	53.7	61.8
17	4.7	5.4	250	18.1	20.8	2,300	54.9	63.2
18	4.9	5.6	260	18.4	21.2	2,400	56.0	64.5
19	5.0	5.7	270	18.8	21.6	2,500	57.2	65.8
20	5.1	5.9	280	19.1	22.0	2,600	58.3	67.2
21	5.2	6.0	290	19.5	22.4	2,700	59.4	68.4
22	5.4	6.2	300	19.8	22.8	2,800	60.5	69.7
23	5.5	6.3	310	20.1	23.2	2,900	61.6	70.9
24	5.6	6.5	320	20.5	23.6	3,000	62.7	72.1
25	5.7	6.6	330	20.8	23.9	3,100	63.7	73.3
26	5.8	6.7	340	21.1	24.3	3,200	64.7	74.5
27	5.9	6.8	350	21.4	24.6	3,300	65.7	75.7
28	6.1	7.0	360	21.7	25.0	3,400	66.7	76.8
29	6.2	7.1	370	22.0	25.3	3,500	67.7	77.9
30	6.3	7.2	380	22.3	25.7	3,600	68.6	79.0
31	6.4	7.3	390	22.6	26.0	3,700	69.6	80.1
32	6.5	7.5	400	22.9	26.3	3,800	70.5	81.2
33	6.6	7.6	410	23.2	26.7	3,900	71.4	82.2
34	6.7	7.7	420	23.4	27.0	4,000	72.4	83.3
35	6.8	7.8	430	23.7	27.3	4,100	73.3	84.3
36	6.9	7.9	440	24.0	27.6	4,200	74.1	85.4
37	7.0	8.0	450	24.3	27.9	4,300	75.0	86.4
38	7.1	8.1	460	24.5	28.2	4,400	75.9	87.4
39	7.1	8.2	470	24.8	28.6	4,500	76.7	88.3
40	7.2	8.3	480	25.1	28.9	4,600	77.6	89.3
41	7.3	8.4	490	25.3	29.2	4,700	78.4	90.3
42	7.4	8.5	500	25.6	29.4	4,800	79.3	91.2
43	7.5	8.6	520	26.1	30.0	4,900	80.1	92.2
44	7.6	8.7	540	26.6	30.6	5,000	80.9	93.1
45	7.7	8.8	560	27.1	31.2	6,000	88.6	102.0
46	7.8	8.9	580	27.6	31.7	7,000	95.7	110.2
47	7.8	9.0	600	28.0	32.3	8,000	102.3	117.8
48	7.9	9.1	620	28.5	32.8	9,000	108.5	124.9
49	8.0	9.2	640	28.9	33.3	10,000	114.4	131.7
50	8.1	9.3	660	29.4	33.8	15,000	140.1	161.3
55	8.5	9.8	680	29.8	34.3	20,000	161.8	186.3
60	8.9	10.2	700	30.3	34.8	25,000	180.9	208.2
65	9.2	10.6	720	30.7	35.3	30,000	198.1	228.1
70	9.6	11.0	740	31.1	35.8	35,000	214.0	246.4
75	9.9	11.4	760	31.5	36.3	40,000	228.8	263.4
80	10.2	11.8	780	31.9	36.8	45,000	242.7	279.4
85	10.5	12.1	800	32.4	37.3	50,000	255.8	294.5
90	10.9	12.5	820	32.8	37.7	60,000	280.2	322.6
95	11.2	12.8	840	33.2	38.2	70,000	302.7	348.4
100	11.4	13.2	860	33.5	38.6	80,000	323.6	372.5
105	11.7	13.5	880	33.9	39.1	90,000	343.2	395.1
110	12.0	13.8	900	34.3	39.5	100,000	361.8	416.5
115	12.3	14.1	920	34.7	39.9	200,000	511.6	589.0

FIGURE 8-71

spacing greater than the computed sweep width is not used.

When searching for EPIRBs/ELTs, if aircraft VHF/UHF antennas are located on top of the aircraft or in the tail, the sweep widths determined by the above rules should be reduced to ¾ of their value.

e. Radar Sweep Widths

Radar sweep widths are determined in the same manner as EPIRB/ELT sweep widths. Factors which influence radar range include such things as sea state, platform stability, air temperature and density, atmospheric disturbances, radar frequency, power output, antenna rotation rate, receiver sensitivity, target reflectivity, and several others.

Rain, water vapor, and other atmospheric precipitation have a drastic effect on radar ranges. Large droplet, heavy rain will cause the greatest attenuation (decrease) of radar ranges, completely blocking the radar signal in some cases. The following conditions reduce the detection range of radar; rain, snow, hail, fog, and humid air. Although the K-band (1.25 cm) radar is the best band for detecting raft corner reflectors, it is also affected the greatest by precipitation. For example, medium rain will reduce K-band detection range by one-half. X-band (3.25 cm) radar is not affected as much as K-band, while S-band (10.5 cm) radar is affected the least by rain, water vapor, and other precipitation.

Some of the larger rafts carried by vessels and large aircraft are equipped with radar corner reflectors. Although this is a useful detection aid, its radar visibility depends upon th existing sea conditions. A wind-blown sea will cause clutter on the radar scope and will reduce the effectiveness of the reflector. Searching downwind or crosswind reduces this clutter, and the detectability of the reflector will be greater when the radar antenna is pointing in these directions. With winds above 10 knots on the water's surface, only the most sophisticated radar will be able to detect a corner reflector. With winds below 10 knots, the following techniques are the most suitable for a radar-only search for corner reflectors:

1. Aircraft altitude between 1,000 and 3,000 feet, with 1,300 feet being the optimum altitude.
2. Radar Tilt = Down two degrees.
3. Antenna stabilization engaged.

Under these conditions, radar corner reflectors have been detected at 20 miles when using weather-type radar. Generally, radar reflectors should be considered as additional aids only, and searches should not be planned for these ranges.

847 Audible Sweep Widths

The SAR System is occasionally called upon to conduct night surface searches for survivors known to be without any type of electronic or luminous detection device or aid. The survivor may have a police whistle or may have to rely entirely upon his own lung power to attract attention. This situation is most common with a man overboard at sea or a person lost in difficult terrain (for example, a lost child or lost hiker). Because of this possibility, SAR personnel should be aware of the possibility of detection by sound and how this may be applied to the searcher's advantage. The distance that a sound will be transmitted through the atmosphere is determined mainly by its initial loudness; reflection from solid, hard surfaces; absorption by air and water particles; refraction from different air temperatures; wind velocity and direction and the frequency of the initial sound.

Several generalities may be established for both the searcher's and the survivor's benefit.

(a) Search units are most effective when downwind of the sound source. Therefore SRUs should concentrate on listening on their upwind side.

(b) Upwind sound range from the sound source may be ¼ of the downwind range when winds of 5 to 10 knots are present.

(c) SRU background noise should be reduced as much as possible during an audible search.

(d) Marine SRUs should stop engines occasionally to permit low decibel sounds to be heard.

(e) Sweep widths are very small.

Since estimations of audible sweep widths are affected by many variables and are very small, searches are usually planned around some other means of detection (searchlight, area lighting) with the possibility of audible signals being considered as an extra benefit.

848 Miscellaneous Sweep Widths

There are several detectors which may be available to the SMC, but their detection ranges, sensitivity, and other data may not be releasable to the SMC for security purposes. The SMC will have to rely upon the operator to compute appropriate sweep widths, track spacings, and probabilities. The following paragraphs are intended to provide the SMC with a general understanding of these detectors.

a. Forward Looking InfraRed (FLIR)

The Forward Looking InfraRed (FLIR) system, a passive detection system, senses objects by receiving thermal radiation and converting the temperature differences into a real time video presentation. The FLIR relies on temperature differences to see in total darkness, through haze, smoke and dust. Objects that appear identical to the naked eye create many levels of brightness and contrast in the infrared system.

b. Magnetic Airborne Detectors

A magnetic airborne detector (MAD) is a passive, airborne detection system designed to detect the distortion in the earth's magnetic field caused by ferrous objects in that field. It is usually employed for the detection of submarines operating beneath the ocean's surface. It is normally carried by ASW aircraft, and has a maximum range of about 1,500 feet below the aircraft. Its effectiveness is reduced by the submersible's orientation with respect to the earth's magnetic field (East-West heading is less detectable), areas of geological magnetic disturbances, and shallow water.

c. Sonar Buoys or Sonobuoys

Sonar buoys may be either passive or active, and may be either directional or nondirectional. Passive, nondirectional sonar buoys will pick up any submerged sound and relay it to listening ASW aircraft. Passive, directional sonar buoys incorporate a rotating directional hydrophone, and would not normally be used for SAR underwater searches until a positive contact with the distressed submersible is obtained. Active directional sonar buoys are expendable miniaturized self-contained sonar sets. These search progressively in a 360 degree circle, and transmit their received, return signals to listening ASW aircraft. Active, nondirectional sonar buoys provide ranging information on underwater targets, but no bearing information, to listening ASW aircraft.

Channel 15 passive, nondirectional sonobuoys are carried by all ASW aircraft and are used for emergency SAR purposes. They transmit on an FM frequency of 172.75 MHz (the second harmonic, 345.5, MHz, can be used for DF purposes) at a power output of one watt, have an operating life of 3 hours, and have a small light for night visual observations. These sonobuoys are dropped prior to ditching or bailing out from an ASW aircraft, and one is normally placed aboard each liferaft following a ditching. In addition they may be air-dropped to survivors on the surface. A microphone is attached to the bottom of the sonobuoy by a long cable, and survivors can transmit voice messages to listening ASW aircraft by speaking into the microphone. ASW aircraft will normally signify receipt of the transmitted message by rocking wings while flying over the survivors in daylight, or by extinguishing external lights at night.

850 BASIC SEARCH PLANNING

a. General

A search plan is required in almost every mission. It may be a very abbreviated plan for a single SRU, or it may be a complex plan involving a large number of SRUs. In any case, a search plan should always be developed by the SMC. Many lives may depend upon the care with which the search is planned and conducted. It is not proper to dispatch SAR units on a search mission with orders only to "search". When a search mission is needed, four things are immediately of vital importance to the SRU for conducting his search:

1. An adequate description of the search target.
2. The search area.
3. The best search pattern.
4. The proper track spacing.

The SMC will most likely provide other information to the first SRU to be dispatched to the search area, but the above four items are the minimum, essential items.

The SMC develops his original search plan on the assumption that sufficient and suitable search units will be available for conducting the mission. This is why it is called the optimum search plan. Once he develops his optimum plan, the SMC must make every effort to obtain the services of the search units he desires. The first search units dispatched are usually the alert SAR units, and these are normally sent to either the datum or on a trackline search. Backup and standby SAR units are the next to be dispatched. If at this point the SMC requires additional SRUs, he will request supplementary search craft from other activities, as discussed in chapter 2. If additional search units are not available, then certain compromises must be made to develop an attainable search plan. These compromises may involve reduction of the search area, reduction of the probability of detection, increase of the SRU track spacing, use of less desirable SRUs, etc.

b. Controlling Factors

When developing a search plan, the SMC must carefully weigh the limitations of time, terrain, weather, navigational aids, search target detectability, suitability of available search units, search area size, distance between search area and SRU staging bases, and the particular probability of detection desired under the circumstances.

Time is of paramount importance, as any delay or misdirected effort will greatly diminish the chances of locating survivors. While thorough mission planning and good conditions for search are desirable, positive and immediate action is required. The SMC should exercise his best judgment and initiate search with a minimum of information and a few SRUs while additional data is obtained and more extensive search operations are planned.

Of all the factors involved in search planning, one or more may prove so important in a particular situation that the others can generally be regarded as secondary or even disregarded entirely. These important factors are referred to as the controlling factors, and are the ones given the most consideration when developing the attainable search plan.

For example, when only a limited number of SRUs are available, the following relationships might exist between datum, search area, time available, and probability:

1. Inaccurate datum requires a larger search area at the expense of time or probability.

2. Limited time available for search requires a rapid search rate at the expense of area searched or probability.

3. High probability of detection requires closetrack spacing at the expense of area searched or time.

The preceding illustrates just a few of the factors that the particular circumstances may dictate as the controlling factors. In any of the above circumstances, additional SRUs would alleviate the situation, but there is a practical limit to the number of search units that can be safely used within a given area. With the realization that emphasis on any factor will usually be at the expense of others, the SMC must decide which factors are the most important. Once this is decided, the search effort is planned to meet the requirements of the controlling factors, while at the same time satisfying the other factor requirements as much as possible.

A controlling factor peculiar to some maritime areas is the drift rate. In cases where a high drift rate is encountered such as in the Gulf Stream, the SMC must allow for sufficient extension of the search area in the direction of drift in order to prevent the target from slipping out of the area during the search, and must plan search legs so that the target cannot slip out of the search craft's track spacing during successive sweeps. The simplest and most effective way of accomplishing the latter is to orient the search legs with the drift direction. If the search legs must be oriented across the drift direction, then they should be no longer than 30 minutes fiying time. If an excess aircraft is available, some form of barrier search may also be established across the down-drift end of the search area as added insurance.

c. Search Concentration

The heaviest search efforts are normally concentrated near the datum, in the area where the target is most likely to be. This concentration is reduced as the distance from the datum increases, since the further the distance from the datum, the less is the likelihood of finding the search target.

d. Search Effort

The search effort to be expended will depend on several factors. Established SAR organizations seldom have enough search units to properly carry out a large scale search without outside assistance. This assistance is available from several sources as detailed in chapters 2 and 3. Usually assistance is obtained from other military commands. However, if called on too often for assistance, the other commands would soon find SAR operations interfering with their primary missions. Discretion must therefore be used in determining the scope of search effort required for the mission. This can be controlled to some extent by varying the rate of expenditure of search effort.

e. Search Effort Expenditure Rate

Some situations, such as a declared distress or an overdue aircraft, call for an initial maximum search effort over wide areas. However, a maximum search effort can not be mounted every time a fishing boat is first reported overdue. Neither can the SMC continue with a routine effort when preliminary searches fail to make contact. The great majority of overdue small boat missions can be effectively handled by a planned buildup of the search effort. By using the repeated expansion concept with a small coverage factor, a reasonable buildup of search effort is possible. This buildup of search effort is combined with an expansion of the search area, and reaches the maximum effort and largest area on the last search. At that time, if no contact has been made with the target, the probability will have been strongly established that the target is not afloat in the area searched.

f. Maximum Search Efforts

When a situation of actual distress is either known or strongly suspected to exist, the time available for search will usually be limited. A maximum search effort must be completed within this time. Quite often a large search area is also involved, further compounding the SMC's problem. The following method has proven successful in approaching this situation.

1. Lay out an area large enough to insure that the survivors are included.
2. Use a track spacing equal to sweep width ($C=1.0$).
3. From the nomographs discussed elsewhere in this chapter, select the number of aircraft hours required to complete one search of the area within the allocated time.
4. Decide the time by which the search must be completed.
5. Dispatch sufficient aircraft to complete one search of the area within the allocated time.
6. If unsuccessful, expand and repeat in accordance with the repeated expansion concept.
7. Do not reorient the search or change search aircraft assignments, if avoidable.

Once a large scale search is ordered and SRUs are dispatched, reorientation of the search area for that particular search launch is both difficult and wasteful. Planning should, therefore, be thorough and then adhered to. The SMC must also resist the temptation to redeploy SRUs whenever he learns of new leads or doubtful sightings. Additional SRUs should be dispatched to investigate leads which come to light after the assigned SRUs have been dispatched.

g. Search Sequence

There is no single sequence of search types, search patterns, etc., which can be suggested as universal. However, figure 8–72 tabulates one search sequence employing various factors and search parameters. Such a sequence would be used where large areas must be searched initially and search craft are limited.

Assume that a commercial aircraft is missing at sea. The most effective search, by far, is an electronic search for EPIRB's. Electronic searches can cover large areas very rapidly with a high probability of detection. Therefore, the SMC in our hypothetical mission launches jet aircraft SRU on a trackline search laterally on both sides of the trackline, at a track spacing of 50 miles.

After the EPIRBs, the next most effective detection aids are the luminous detection aids used at night. The SMC therefore launches

Typical Search Sequence

Search sequence	Search type	Search period	Search target	Preferred aircraft	Speed range	Track spacing	Search altitude
1st	Electronic	Day or night.	Electronic beacons.	Jet	300–600	50	10,000–40,000
2d	Visual aids	Night	Flares, fire, torch.	Turbo-prop	150–300	20	1,500–3,000
3d	do	Day	Mirrors, smoke, dye.	Prop	130–180	10	1,500–2,000
4th A	Visual raft	do	Large raft	Prop, helo	130–180	3	1,000–1,500
4th B	do	do	Small raft	Helo, prop	100–150	1	300–1,000
5th	Visual debris	do	Wreckage, swimmers.	do	75–130	0.3	200–500
Simultaneous	Radar	Day or night	Corner reflector.	Any			

FIGURE 8–72

turbo-prop aircraft SRUs, on nighttime trackline searches during the first darkness period following the ditching. This pattern is also expanded laterally, but at a track spacing of 20 miles. Since the survivors will be in better physical and mental condition during the early stages of their ordeal, the SMC takes advantage of this by launching a night search at his first opportunity. This minimizes the possibility of the detection aids being lost prior to their use, or of the survivors becoming too weak to use them effectively.

The third most effective group of detection aids are the daylight aids such as mirrors, smoke, and sea-dye marker. The first daylight visual search is therefore launched based on this group of detection aids. A larger area can be covered initially by using a 10 mile track spacing. In addition, the SMC is taking advantage of the probable better physical and mental condition of the survivors, in the same manner as he did when he launched his early night search for the luminous detection aids.

If the electronic search, the night visual search and the day visual search for detection aids were unsuccessful, the SMC must next search for the rafts. He assumes that the survivors were able to get into their rafts after ditching, just as he assumed that they were able to use their EPIRBs, luminous detection aids, and daylight detection aids. Therefore the SMC uses slower aircraft at very close track spacing to search visually for the rafts.

If these raft searches were also unsuccessful, the SMC must shift to extremely small track spacing, and search for wreckage, debris, and survivors in the water.

From the second search on, the SMC had also directed that all SRUs conduct simultaneous radar search for raft corner reflectors. But since the corner reflectors have such a variable detection range, he planned his searches on the more tangible effective detection aids of the survivors.

h. Assigning Search Areas

After the SMC has established the overall search area, he divides it into sub-areas suited to the capabilities of each available search craft.

In large scale searches, a subarea will usually be assigned to each major air station or squadron, and each of these commands will then further divide its subarea according to the number of aircraft it is dispatching.

In smaller scale searches, the SMC will usually elect to assign each SRU to its individual search subarea.

Occasionally, the SMC is forced by the press of time to require his OSC to make various search planning decisions, such as the search pattern selection, track spacing, and individual SRU search area assignments. When in this situation, the SMC will normally prescribe the overall search area, and the OSC will decide upon subareas for individual SRU assignment, SRUs which have not been assigned a search area by the SMC, should report this to the OSC upon arrival on scene, and request an assignment from him.

When allocating subareas to individual search craft, care should be taken to insure that each craft is used only for those searches for which it is technically and operationally suitable. For example, if only aircraft were available, the following guidelines would be appropriate:

1. Short-range or medium-range aircraft should be used for areas close to or not far from base.

2. Fast, long-range aircraft should be used for areas which are distant or far off-shore.

3. Aircraft with poor navigational capability should be used in areas with prominent landmarks, or for searches requiring constant visual reference to the ground, as in contour searches.

4. When searches are in coastal waters, search areas should be laid out so that aircraft SRUs can fly their search legs perpendicular to the coast line. This allows obtaining a good fix on the shore end of each leg. Normally, the SRUs with the poorest navigational capability are assigned to coastal areas to take advantage of these periodic fixes.

5. For searches far off-shore, when navigation facilities are limited, the SMC should consider the use of a vessel in the search area as a navigational reference point. Without this reference point, it is likely that the accumulative navigational errors of search aircraft will result in either considerable overlapping or large voids in the area coverage. If no ship is available, multiunit search patterns with two or three aircraft should be used.

The capabilities of the available search craft are the uppermost factor that must be considered by the SMC when assigning search areas. Without this information, the full capability of the search craft cannot be realized, and size of the search areas can be determined only in haphazard fashion. SRU capabilities are discussed in chapter 3.

As a practical matter, the determination of the maximum area for aircraft is made by the aircraft's immediate operational command or station. Knowing the overall subarea assigned to him by the SMC and knowing the capability of his aircraft, the operational commander assigns search limits to his aircraft. If he is unable to cover the subarea assigned him with the aircraft available, he should request additional aircraft from the SMC, who will then probably either assign more aircraft or reduce the size of the subarea.

851 Search Area and Search Time

a. General

This section introduces the nomographs used for solving the search area and search time relationship. These nomographs are divided into solutions for square search areas, rectangular search areas, and circular search areas.

b. Area-Time Formula

All of the square and rectangular search area time nomographs are based on the formula, A=VNST. This formula can be used to determine the area that can be searched in a given time, or the time required to search a given area.

A=Search area size (in square miles).
V=SRU searching ground speed (in knots).
N=Number of SRUs.
S=Track spacing (in miles).
T=Searching time (in hours).

However, this formula does not include the small additional time added by each turn of the SRU's search pattern. When compounded over a full day's search, the total additional time could be considerable. To eliminate this defect, aircraft SRUs should always start their turns 15 seconds prior to the computed time of reaching the end of each leg in the search pattern. Thus, the midtime of the 30 second, 90 degree turn (standard aircraft turn rate) will be the same as the computed time for reaching the end of the leg. By following this procedure, the formula and the nomographs are sufficiently accurate for search planning and search operations.

The formula and the nomographs are also for no-wind and no-current conditions. For search planning computational purposes, wind and currents in the search area can be disregarded, since the longer search legs are usually reciprocals of each other, with the result that any major wind or current effect is canceled out.

The SRU search speed in the formula, and the SRU search scale in the nomographs, are ground speeds (or surface speed for marine craft). When aircraft SRU's are employed, the indicated airspeed (IAS) of an aircraft will approximate the ground speed (GS) over a period of time spent in low-level search. At the altitudes flown in over water visual searches (2,000 feet or below), and in the free air temperature ranges normally encountered at this altitude (+5 to +35), true airspeed (TAS) will be closely approximated by IAS. Therefore GS, IAS, and TAS are usually considered equal for search planning computational purposes. But if the free air temperature is unusually high or low, or if the search altitude is unusually high, TAS can be calculated and substituted for the GS in the formula and the nomograph.

c. Square Search Areas

Figure 8–73, Square Search Area-Time Nomograph, will provide rapid area and time solutions for square search areas. It may be used for land vehicle, marine craft, or aircraft SRU, searching at any speed between 5 knots and 600 knots. Note that related search parameters always lie on three connected straight lines. The following is the recommended sequence to follow to obtain the most effective use of the nomograph.

Assume that the SMC has selected his desired probability of detection (P), obtained the target's sweep width (W) and determined the required spacing (S). First enter figure 8–73 on the right with the track spacing (S) and the SRU's search speed (V), aligning the specific value-points with a clear plastic straightedge. Mark the search rate (area searched per hour, A/T) lightly with a pencil, where the straightedge crosses the A/T scale. Next, enter the left side of the nomograph with the total probable error (E) and the search safety factor (f_s), aligning the specific value-points with the straightedge. Mark the search radius (R) and the search area size (A) lightly with a pencil, where the straightedge crosses the R–A scale. Now, align the marked R–A value-point and the marked A/T value-point with the straightedge. Where the straightedge crosses the time (T) scale, read the time required in hours and tenths. This is the time required to complete the desired search area, using the SRU's search speed and the track spacing required to obtain the SMC's desired probability of detection.

Remember, three straight, connected lines always provide the related search parameters on this nomograph. With practice the light pencil marking can be reduced or eliminated by using the point of the pencil, or the point of a pair of navigational dividers, as a pivot point when realigning the straightedge.

The nomograph can also be used to examine the effects of changing any of the search parameters. For example, suppose the SMC desired to search the complete search area, but was time-limited by approaching darkness. The SMC would then have to accept a greater track spacing with a resultant lower probability of detection. The SMC would enter the nomograph on the left and work all the way across, ending with the required S. That is, he would enter with E and f, mark R–A value-point where the straightedge crosses the R–A scale; pivot the straightedge and align R–A value-point and the available time value-point, mark the A/T value-point where the straightedge crosses the A/T scale; again pivot the straightedge and align the A/T value-point and the SRU's search speed, then read the track spacing (S) required where the straightedge crosses the S scale. This S would be the track spacing required under the time limitations imposed by approaching darkness. The SMC would then use this S and the computed W to find his resultant probability of detection from the S/W/P Nomograph of figure 8–66.

Suppose the SMC had instead decided to reduce the search area and maintain his desired probability of detection—and hence maintain his originally desired track spacing. In this case, the SMC would enter the nomograph on the right and work towards the left, ending with the reduced search area. That is, he would enter with S and V, Mark A/T; pivot the straightedge and align A/T and the available time (T), and read the reduced search area (A) from the R–A scale. (For ease in plotting the reduced square search area, also read the search radius (R) at the same time from the R–A scale.)

A third possible course of action is also open to the SMC under the circumstances of this hypothetical situation. Suppose the SMC had performed both of the sequences above, determining first the increased track spacing with constant search area, and then determining the reduced search area with constant track spacing. Neither solution is wholly satisfactory to the SMC, so he decides to compromise by reducing the search area a little bit, and by increasing the track spacing a little bit. But, by how much? He decides to split the difference. The SMC selects the R–A value-point which is midway between the two previous R–A value-points. He now works towards the right of the nomograph, ending with the compromise value of track spacing. That is, he aligns the midpoint value of R–A with the available time, marks A/T; pivots the straightedge and aligns A/T and V, and reads the compromise track spacing where the straightedge crosses the S scale.

The procedure in the preceding paragraph is the basic compromise method for adjusting search parameters when limitations are imposed upon the SMC. Hold S constant and reduce "A"; hold "A" constant and increase S; split the difference in "A" for a compromise S. This is how the SMC adjusts his desired optimum search plan to obtain his actually attainable search plan.

Limitations of other parameters are handled in a similar fashion. For example, it might be necessary to substitute a slower SRU after a faster SRU had been planned for, to reduce the number of SRUs below that originally planned for, or to change the available search time to either more or less than originally planned for. The nomograph is equally useful to both the OSC and the individual SRU, when they are forced to change the SMC's search plan during its execution due to changing on-scene weather, early departure of SRUs, etc.

Two final items should be noted before leaving this nomograph. First, using the progressively larger search safety factors (f_s) will provide progressively larger search areas, expanding on all four sides, as explained previously. The search area size on the "A" scale is the size of the individual search area for each search; it is not accumulative of preceding search areas. Second, if more than one search unit is being comtemplated for use in the square search area, the vertical scale labeled S can be converted to an "nS" scale simply by multiplying the number of search units (n) by the individual track spacing (S), and then using the product for entering the S scale. For example, if one SRU were assigned to search in the lower half and another SRU were assigned to search in the upper half of a square search area, and both were assigned a track spacing of 8 miles, then an S scale value-point of 16 miles ($nS = 2 \times 8 = 16$) would be used for any nomograph-derived solution.

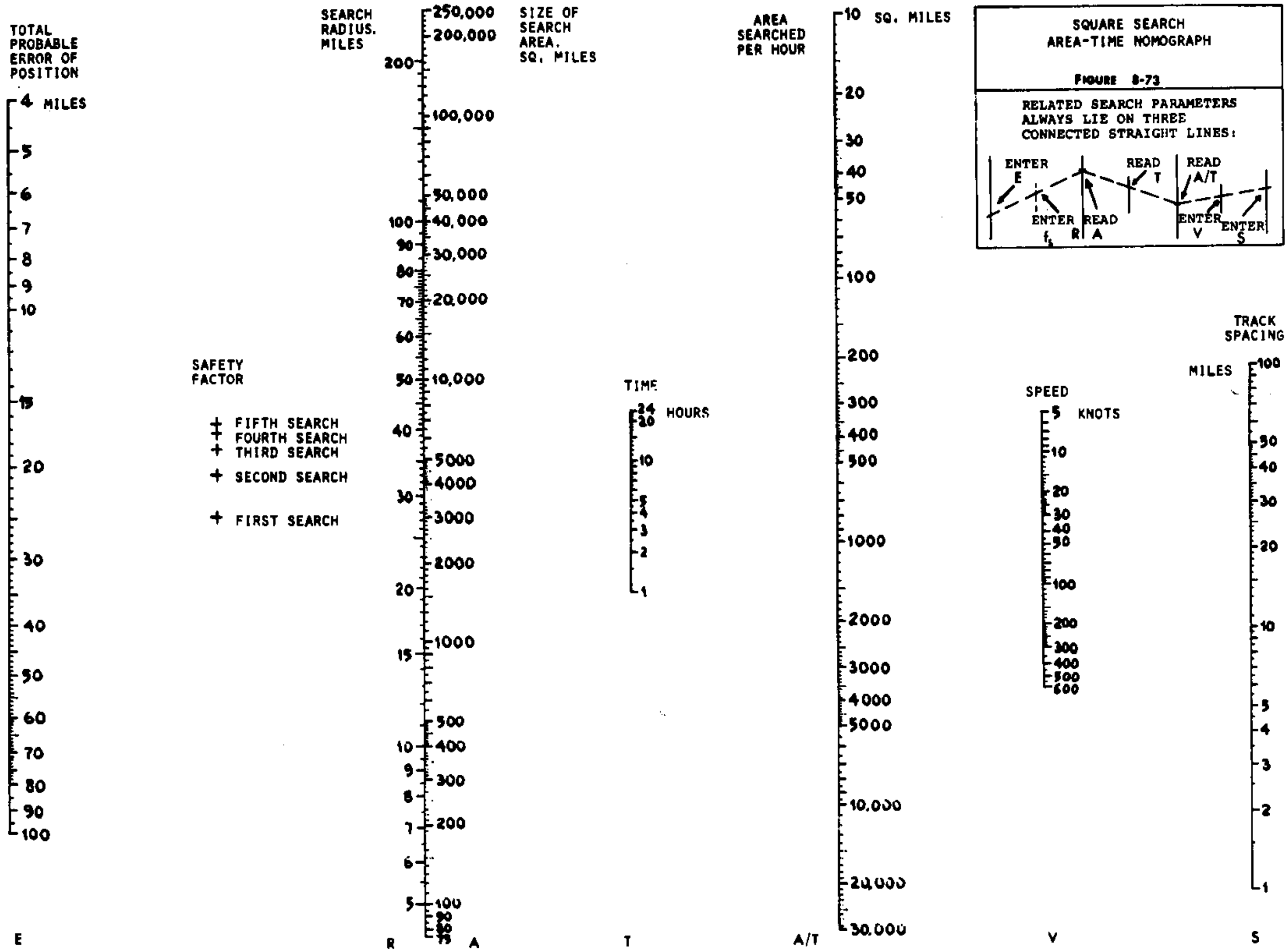
d. Rectangular Search Areas

The two nomographs for rectangular search areas are used in the same manner as that used with the square area nomograph. Assuming that you want to extend the search area around a datum point to a rectangle of arbitrary length L, figure 8–74, rectangular search area nomograph, is used to solve for the parameters of search area size based on the total probable error (E), search safety factor (f_s), search radius (R), and the search area length (L). This nomograph provides for the expansion of the width of a rectangular search area where the initial width equals 2E by using progressively larger search safety factors (f_s). It does not progressively enlarge the length of the rectangular area. This is illustrated in figure 8–76.

Figure 8–75, rectangular search time nomograph, is used to solve for the parameters of track spacing (S), SRU search speed (V), rate of search (A/T), search time (T), and search area size (A), depending upon which parameters are known, or are being held constant, during a particular solution. The SMC uses this nomograph to accomplish his necessary compromises between his optimum search plan and his attainable search plan.

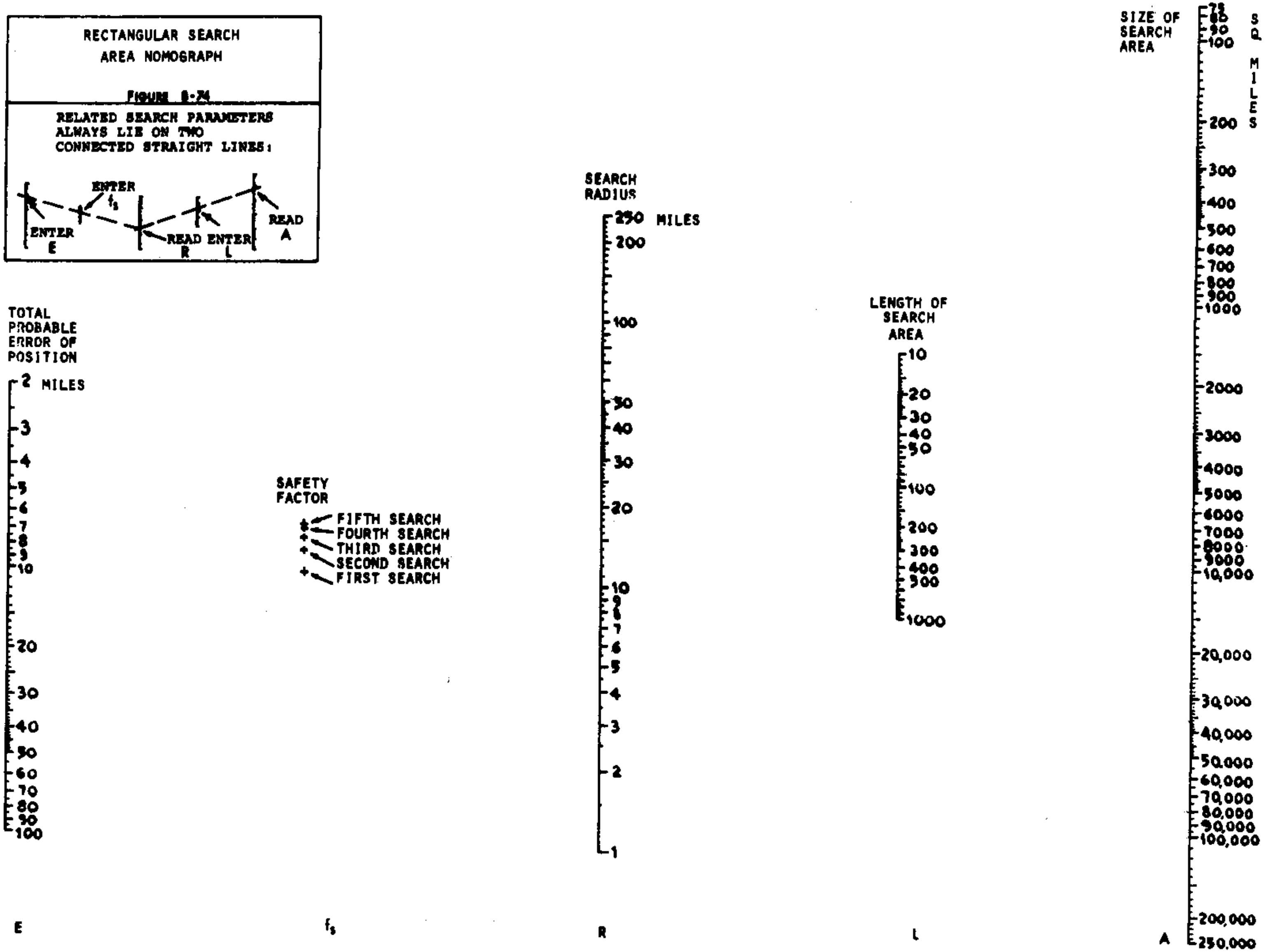
e. Circular Search Areas

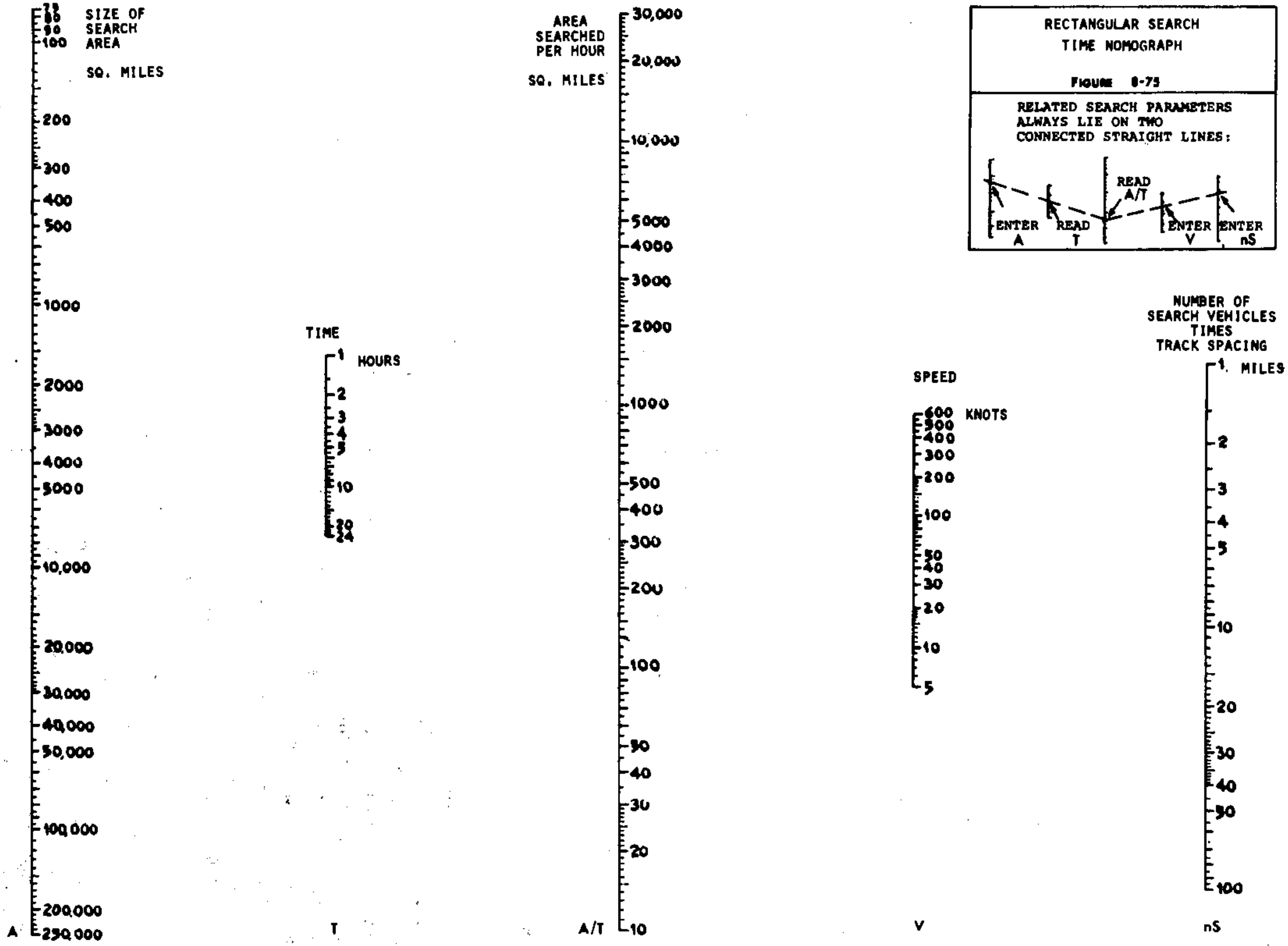
The nomographs for circular search areas are also used in a manner similar to that used with



SQUARE SEARCH
AREA-TIME NOMOGRAPH

FIGURE 8-73


RECTANGULAR SEARCH AREA NOMOGRAPH
FIGURE 8-74
RELATED SEARCH PARAMETERS ALWAYS LIE ON TWO CONNECTED STRAIGHT LINES:
ENTER E
ENTER f_s
READ R
ENTER L
READ A
TOTAL PROBABLE ERROR OF POSITION
2 MILES
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
E
SAFETY FACTOR
FIFTH SEARCH
FOURTH SEARCH
THIRD SEARCH
SECOND SEARCH
FIRST SEARCH
f_s
SEARCH RADIUS
250 MILES
200
100
50
40
30
20
10
9
8
7
6
5
4
3
2
1
R
LENGTH OF SEARCH AREA
10
20
30
40
50
100
200
300
400
500
1000
L
SIZE OF SEARCH AREA
SQ MILES
75
80
90
100
200
300
400
500
600
700
800
900
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
200,000
250,000
A



RECTANGULAR SEARCH TIME NOMOGRAPH

FIGURE 8-75

the square search area nomograph, and are designed to be self-explanatory. These two nomographs are specifically designed for use with the sector search pattern. Figure 8–77, sector search area nomograph, is used to solve for the parameters of number of sectors (N), track spacing (S), search area (A), or search radius (R), based on the total probable error (E) and search safety factor (f_s). It includes a data box which contains pattern data related to specific sector search patterns with the listed number of sectors (N) that should be used by the SMC, OSC, or SRU. Patterns with different numbers of sectors than those in the data box should not be used, as they do not have equal geometric sectors.

The values of track spacing on the S scale are for the maximum track spacing in the pattern. This maximum track spacing occurs at the outer end of each search leg, and is equal to the crossleg in length.

When aligning the straightedge between the A–R, S, and N scales, the straightedge must always cross the center of the + mark of one of the listed sectors. For example, if the SMC had a circular search area whose search radius was 20 miles, and computed a desired track spacing of 10 miles, the straightedge would fall between the + marks of the 12 and 16 sector search patterns. The SMC would then have to decide on whether to use either the 12 sector pattern or the 16 sector pattern. Since the 12 sector search pattern mark is closest to the straightedge, he would select that pattern. The SMC would realign the straightedge with the 12 sector + mark and the 20 mile search radius, and read off S=10.2 miles. He would therefore specify that a track spacing of 10.2 miles be used for this search effort.

Figure 8–78, sector search time nomograph, is used to solve for the parameters of search radius (R), search area (A), number of sectors (N), length of total search trackline (L) completed by the SRU in search time (t) number of SRU (n), or search speed (V), depending upon which parameters are known, or are being held constant, during a particular nomograph-derived solution. The SMC uses this nomograph to accomplish his necessary compromise between his optimum search plan and his attainable search plan. This nomograph assumes that the pattern is started and ended on the perimeter of the search area.

Using the progressively larger search safety factor (f_s) will provide progressively larger search areas, expanding the circular area in all directions. The search area size on the "A" scale is the size of the individual search area for each search; it is not accumulative of the preceding search areas.

f. SRU Maximum Area or Time

For convenience in determining how large an area an aircraft SRU can search, figure 8–79 provides a slightly rearranged format of the

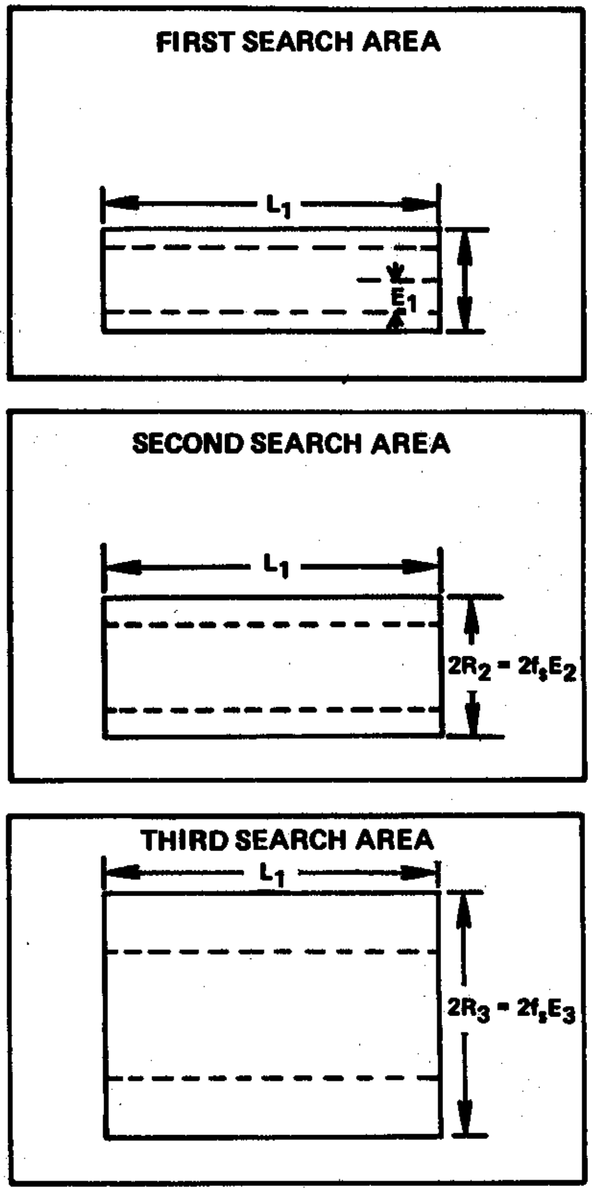


FIGURE 8–76

main parameters of previous nomographs. Its use is optional, since the same information can be extracted from the other area-time nomographs. However, the scales of figure 8–79 may prove easier to read and to extract data from. In addition, this nomograph will be used to explain the general procedure for determining the maximum search time available from aircraft SRU. The SMC must always insure that he does not assign an area too large for an SRU to complete in his available search time. This procedure is used for any mission involving aircraft search units, and is equally applicable when using the other area-time nomographs.

A number of factors will affect the maximum time an aircraft SRU can stay in the search area, and hence, will affect the maximum search area which that SRU can complete. Some of these are:

Distance between the assigned search area and the SRU's staging base;

Length and width of the search area;

Number of search pattern-required turns;

Time spent on false sightings; and

Fuel reserves.

Except for the fourth item, the above factors can be readily determined by a combination of plotting and simple nomograph solution.

The general procedure is:

1. Determine on scene search speed and search time available from the parent command or SRU commander. This time should reflect reserve requirements based upon actual and forecast weather conditions and service regulations.

2. Reduce this by 15% to allow for false sightings and other diversions.

3. Enter figure 8–79 with V, nS and T and read square miles on the A scale.

At this point the SMC might desire to make various changes or compromises, and then compare with the resultant changes in P. This nomograph (figure 8–79) is not as useful for this operation as the previous area-time nomographs. Hence, this nomograph may be bypassed if desired, by the SMC going directly to the other nomographs, if the search area shape is a square, rectangle, or circle.

If the search area size were already established, this nomograph may be used to quickly determine the time required to search it, with the number of SRUs, S, and V specified. For example, A=4,000 square miles, V=120 knots, n=2, S=3 miles. Enter figure 8–79 with these values and extract T=5.5 hours.

852 Search Planning Forms

Search planning forms and worksheets have been developed by various SAR coordinators to aid the SMC during his search planning computations. Some examples of these forms and worksheets are depicted in the figures 8–80 and 8–81. These or similar forms are recommended for use by search planners for the dual purpose of not overlooking any pertinent computation, and to help establish the logical sequence of any required computation.

860 SEARCH ACTION PLAN

After the SMC has completed his basic search planning and made the necessary compromise to reach an attainable search plan, he must convert his plan into action. The search action plan message is designed to perform this function.

The format and use of search action plan messages are discussed in chapter 4. Although the complete format of the message is not required for every mission, it can serve as a useful guide for the desirable items of information which should be given to all participating search units.

When preparing his search action plan, the SMC should consider six specific subject areas. These subject areas follow the format of the message, and are:

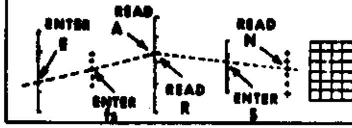
(a) Situation.
(b) Search areas.
(c) Execution of search plan.
(d) Coordination required.
(e) Communications.
(f) Required reports.

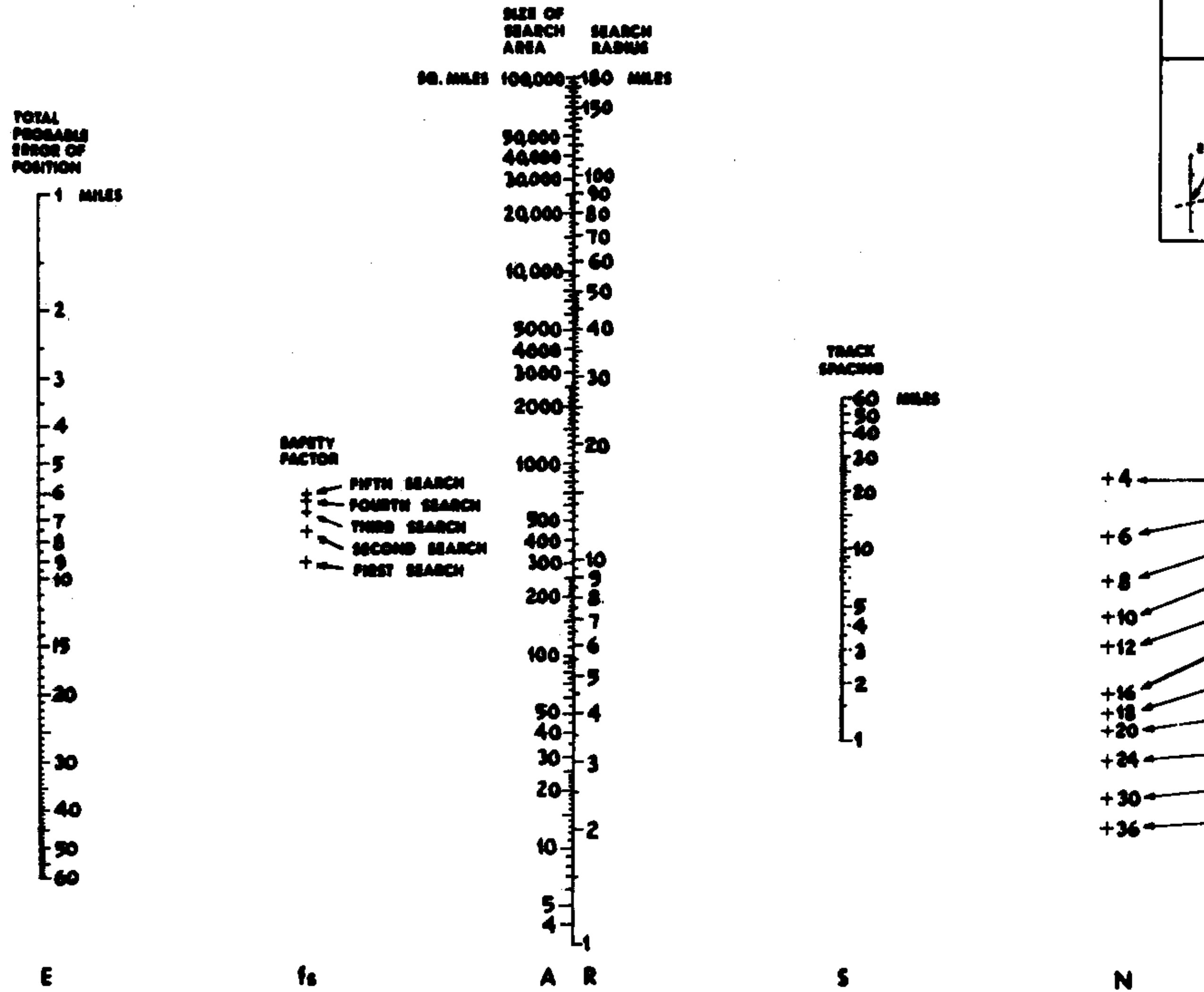
861 Situation Summary

An evaluation of the existing situation at the distress scene is made, and the pertinent facts are summarized for the message. Specifically included are the nature of the emergency, last known position, description of search targets, types of detection aids and survival equipment which survivors may have, present and forecast weather on scene, and any search units already on scene.

SECTOR SEARCH AREA NOMOGRAPH
Figure 8-77

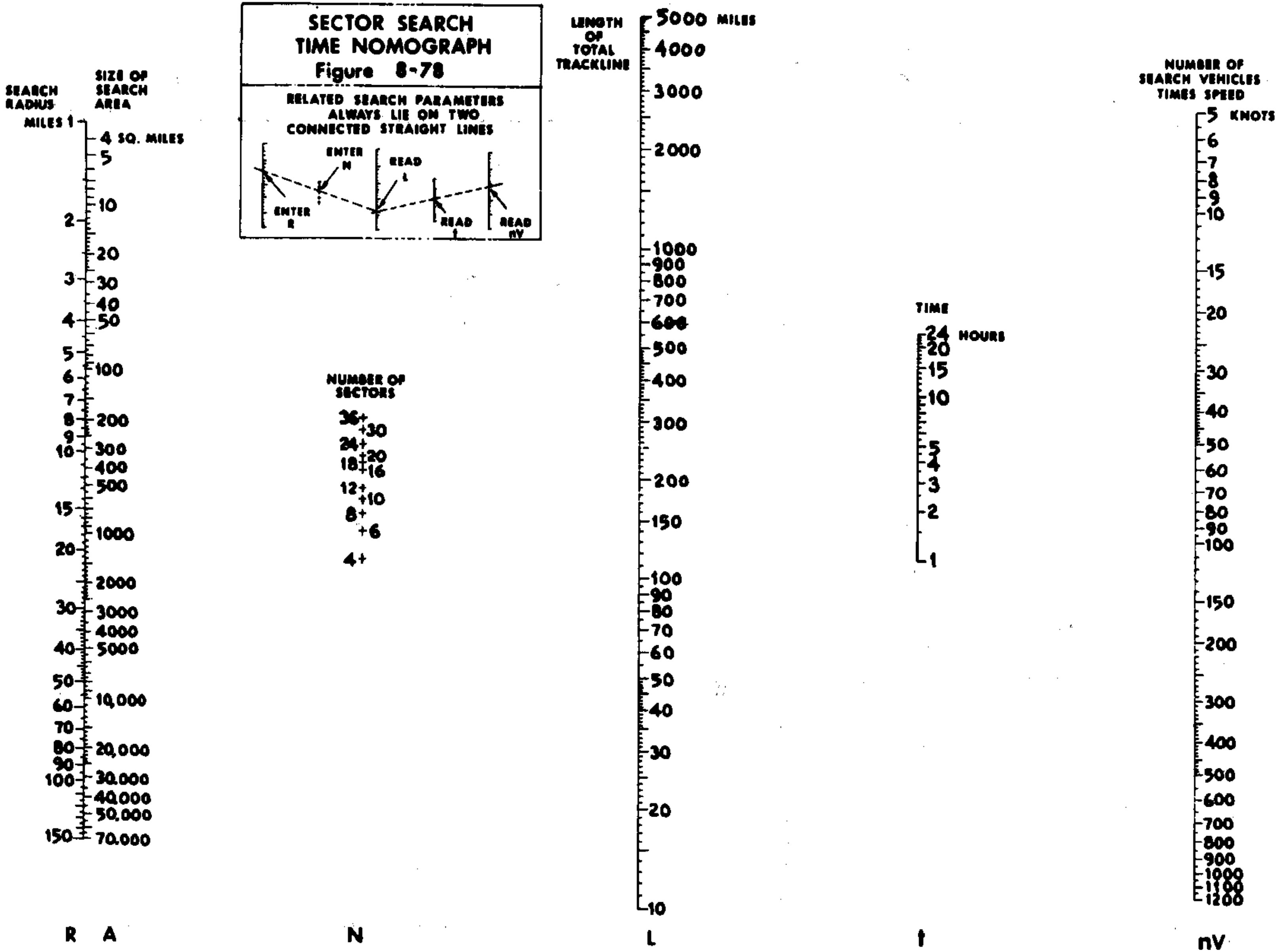
RELATED SEARCH PARAMETERS ALWAYS LIE ON TWO CONNECTED STRAIGHT LINES



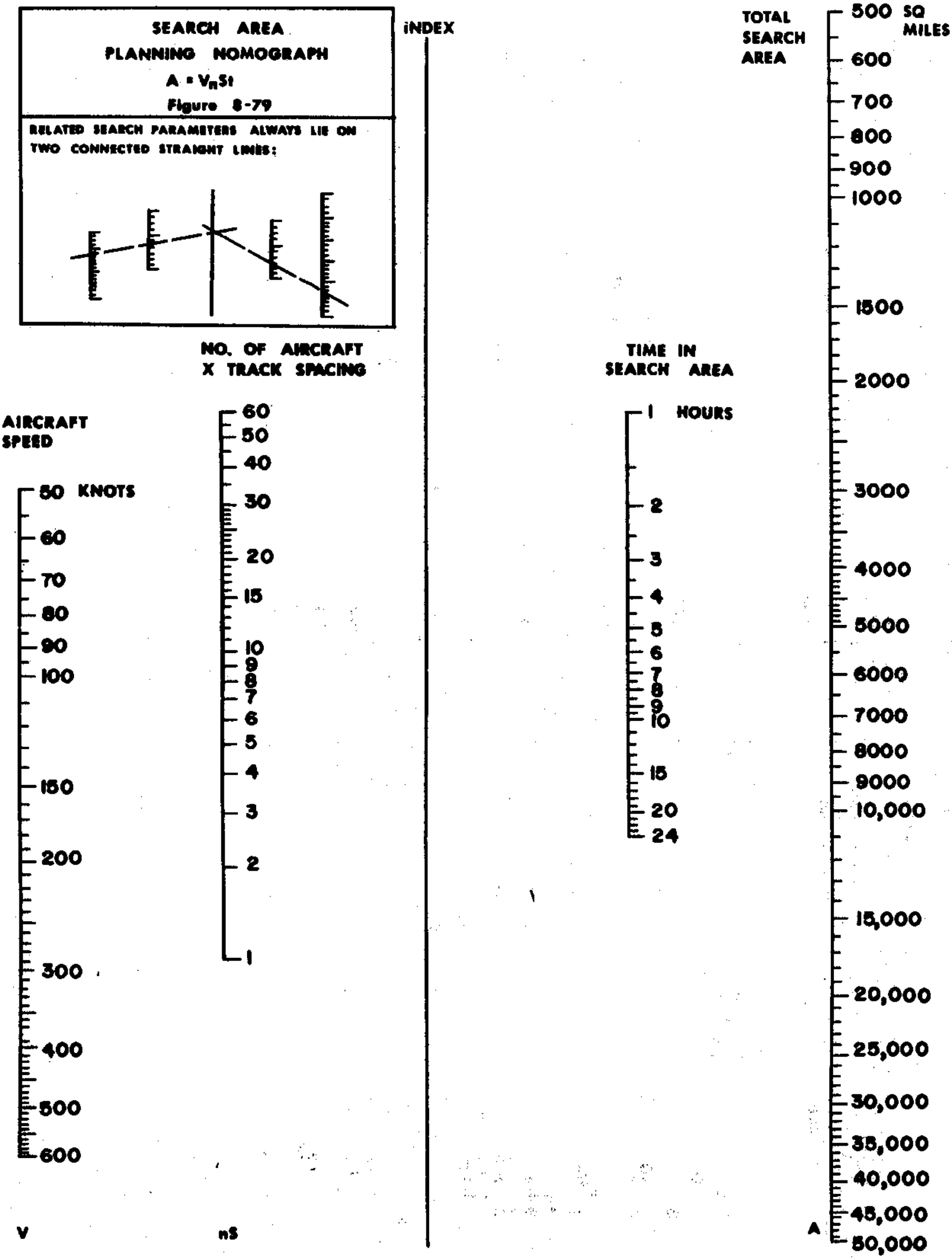


No. OF SECTORS N	No. OF LEGS	No. OF CROSS-LEGS	CENTRAL ANGLE	COURSE CHANGE ANGLE
4 *	2	1	90°	135°
6	3	2	60°	120°
8 *	4	3	45°	112½°
10 *	5	4	36°	108°
12	6	5	30°	105°
16 *	8	7	22½°	101°
18	9	8	20°	100°
20 *	10	9	18°	99°
24	12	11	15°	97½°
30	15	14	12°	96°
36	18	17	10°	95°

* AVOID WHEN USING 3 SEARCH CRAFT



SECTOR SEARCH TIME NOMOGRAPH
Figure 8-78



SEARCH AREA PLANNING NOMOGRAPH

$A = V_nSt$

Figure 8-79

862 Search Area Details

a. General

After the SMC has computed the datum and determined the overall search area, he then divides it into subareas which can be searched by individual search units during the allotted time. He summarizes the individual search areas using one of the description systems previously discussed.

b. IFF/SIF Assignments

IFF/SIF mode/codes may be assigned to individual search craft for use within their search area. Each SRU should be informed of the IFF/SIF mode/codes assigned to every other SRU. If the SRUs are equipped with IFF/SIF interrogators, they will be able to either positively identify which radar targets are SRUs, or to determine the slant range to a specific IFF/SIF signal of an SRU. See caution in paragraph 423.

IFF/SIF mode/codes should be selected from appropriate code assignment publications if this safety precaution is going to be used. The SMC or OSC should notify appropriate ATC/GCI agencies that SRUs will be assigned SAR IFF/SIF mode/codes while in the SAR

Search Planning Worksheet

1. DATUM: Determine datum for ____________ Z.
   - (a) Reported/assumed/DR position ________ Z ________ Lat. ________ Long.
   - (b) Parachute drift: Bailout/chute opens altitude ________/________ ft.
     Avg. wind at alt. ________ T ________ kts. Set ________ T ________ mi.
     Splash point ________ Lat. ________ Long.
     Survival craft drift (c, d, e)
   - (c) Sea current: Publication used ____________.
     Set ________ T ________ MPD/KTS. For ________ HR, ________ T, ________ miles.
   - (d) Wind current:
     1. Surface wind from ________ T ________ kts from ________ Z to ________ Z.
        Set ________ T ________ MPD/KTS. For ________ HR, ________ T, ________ miles.
     2. Surface wind from ________ T ________ kts from ________ Z to ________ Z.
        Set ________ T ________ MPD/KTS. For ________ HR, ________ T, ________ miles.
   - (e) Leeway:

	A.	B.
1.	Set ________ T ________ MPD/KTS.	Set ________ T ________ MPD/KTS.
	For ________ HR ________ mi.	For ________ HR ________ mi.
	D_{min} ________ T ________ mi.	D_{max} ________ T ________ mi.
2.	Set ________ T ________ MPD/KTS.	Set ________ T ________ MPD/KTS.
	For ________ HR ________ mi.	For ________ HR ________ mi.
	D_{min} ________ T ________ mi.	D_{max} ________ T ________ mi.

   - (f) Datum: ________ Lat. ________ Long.

2. SEARCH AREA:
   - (a) Drift error — $D_e=$ ____________ mi.
   - (b) Distressed craft position error — $X=$ ____________ mi.
     Search craft position error — $Y=$ ____________ mi.
   - (c) Total probable error $=\sqrt{D_e^2+X^2+Y^2}$ — $E=$ ____________ mi.
   - (d) Safety factor — $f_s=$ ____________
   - (e) Search radius $=f_s(E)$ — $R=$ ____________ mi.
     Search area size $=4R^2$ — $A=$ ____________ sq. mi.

3. AREA COVERAGE:
   - (a) Target ____________.
   - (b) Search altitude ____________ ft.
   - (c) Visibility ____________ mi.
   - (d) Sweep width ____________ mi.
   - (e) Desired P ________ % ________.
     Desired coverage factor ____________.
   - (f) Desired track spacing ____________ mi.

4. SEARCH VARIABLES:
   - (a) Time limit for search ____________ hr/days.
   - (b) Aircraft hours for search ____________ hrs.
   - (c) Number of aircraft required ____________ a/c.
   - (d) Required: P ________ %, f_s ________, W ________ mi, S ________ mi.
   - (e) Search pattern ____________.

FIGURE 8-80

Water Drift Worksheet

[Vector plotting can be conveniently accomplished on "Maneuvering Board" sheet (HO 2665A)]

Position at start of period	Period of time		Sea Current or tidal current		Local surface wind		Wind current		Leeway		Total drift, minimum		Total drift, maximum		Datum position end of period
	From	To	Set	Distance	From	Kts.	Set	Distance	Set	Distance	Set	Distance	Set	Distance	

FIGURE 8–81

area. SRUs departing the SAR area should change IFF/SIF codes and modes, as required, while returning to the staging location.

c. Air-to-Air TACAN Assignments

Air-to-Air TACAN channels are also assigned to individual search areas for use by assigned SRU. Pairing of TACAN channels must be exactly 63 channels apart for air-to-air ranging operations. For example, if the SMC desired to pair SRU No. 1 and SRU No. 2, he could assign TACAN channel 10 to SRUs No. 1 and TACAN channel 73 to SRU No. 2. During the search these two SRUs would then have the slant range between them continuously displayed on their TACAN instruments. Any pair of channels may be used for this purpose, as long as they are exactly 63 channels apart.

Suppose that the SMC had divided the overall search area into four subareas as depicted in figure 8–82, and then assigned two USN aircraft and two USCG aircraft to the individual search areas as shown. Most likely, the aircraft in areas A–1 and A–2 and those in areas A–3 and A–4 would be most concerned with approaching each other. (Even though they had an altitude separation of 500 feet.) Therefore the SMC pairs the two SRUs in A–1 and A–2 on TACAN channels 20 and 83. Similarly, the SMC pairs the A–3 and A–4 aircraft on channels 30 and 93. If by some chance the paired aircraft approach their common boundary simultaneously, they can both monitor their slant range continuously, for their pilot's peace of mind.

863 Search Plan Execution

a. General

After dividing the overall search area into individual search areas, the SMC assigns specific SRUs to each subarea, designates which search pattern is to be executed and in which direction the pattern is to creep, and assigns search altitudes for aircraft to maintain during their search. In addition, the SMC normally specifies the commence search point (CSP).

b. SRU Separation

The CSP, pattern creep, and search altitude are the primary tools the SMC uses to maintain lateral and vertical separation among the SRUs on scene. The search units may help themselves by using IFF/SIF interrogators, RADAR, air-to-air TACAN, and visual lookout; but it is the SMC's and the OSC's responsibility to provide measures for safe separation between all participating search craft. While lateral and vertical separation is important at all times, it becomes increasingly so during reduced visibility conditions.

Referring to figure 8–82 again, the SMC first specifies that all search patterns creep north. This will help insure that the aircraft in areas A–1 and A–2 will maintain a lateral separation of one search area width from the aircraft in areas A–3 and A–4. (Assuming they will begin their search at about the same time.)

Second, the SMC specifies the CSP as the southwest corner. This will help maintain a separation between the two aircraft in A–1 and A–2, as well as between the two aircraft in A–3 and A–4, by a distance equal to the individual search area length. (Again assuming that the A–1 and A–2 aircraft start search at about the same time, and that the A–3 and A–4 aircraft start search at about the same time.)

Third, the SMC specifies search altitudes of 500 feet for A–1 and A–4 aircraft, and search altitudes of 1,000 feet for A–2 and A–3 aircraft. This provides a positive vertical separation between each aircraft and the two adjacent aircraft.

Unless there is an unusually large difference in the commence search times of the two diagonally opposite aircraft, the SMC can assume that adequate lateral and vertical separation will now be maintained during this search effort. And as long as each aircraft properly navigates and executes his assigned search pattern, the SMC knows that at no time can any one search track approach another a distance less than one track spacing. This is so because each search pattern is always one-half of a track spacing inside the individual search area boundary.

Outside of the search area, lateral and vertical separation of aircraft is provided by either air traffic control (ATC) agencies under instrument flying conditions, or by the aircraft themselves under visual flying conditions. But since the control of air traffic in the search area is usually not feasible by ATC facilities due to the low search altitudes, responsibility for maintaining safe separation within the search area rests with the SMC, the OSC and the aircraft commanders.

864 On Scene Coordination

a. OSC Designation

The SMC should designate the best qualified and most capable SRU as his OSC, without regard for the comparative military seniority among the participating search units.

b. CHOP Coordination

The SMC Schedules the on scene arrival or rendezvous times for SRUs. If there are any changes of operational control (CHOP) requirements during the SRU's en route, arrival, departure or return portions of their movements, then these requirements must be coordinated with parent agencies, the SRU's, and the OSC. The SMC specifies these CHOP requirements in his search action plan message.

c. SRU Reliefs

If on scene reliefs are required to be provided by the parent agency of participating SRUs, this must be coordinated with the appropriate agency by the SMC.

d. Changing S or P During Search

The SMC accomplishes his search planning based on existing and forecast weather. If the weather on scene during the search is different from that which the SMC used, the SMC-designated track spacing will not result in the probability of detection that he planned for. To cover this common situation, the SMC should provide his OSC with guidance as to whether or not to maintain the specified track spacing in the event of on scene weather being different from that forecast. If the weather deteriorates below that forecast, the specified track spacing will result in a lower coverage factor and probability of detection, but the full search area will be completely searched. On the other hand, the SMC may desire to obtain a specified coverage factor and probability of detection. If the

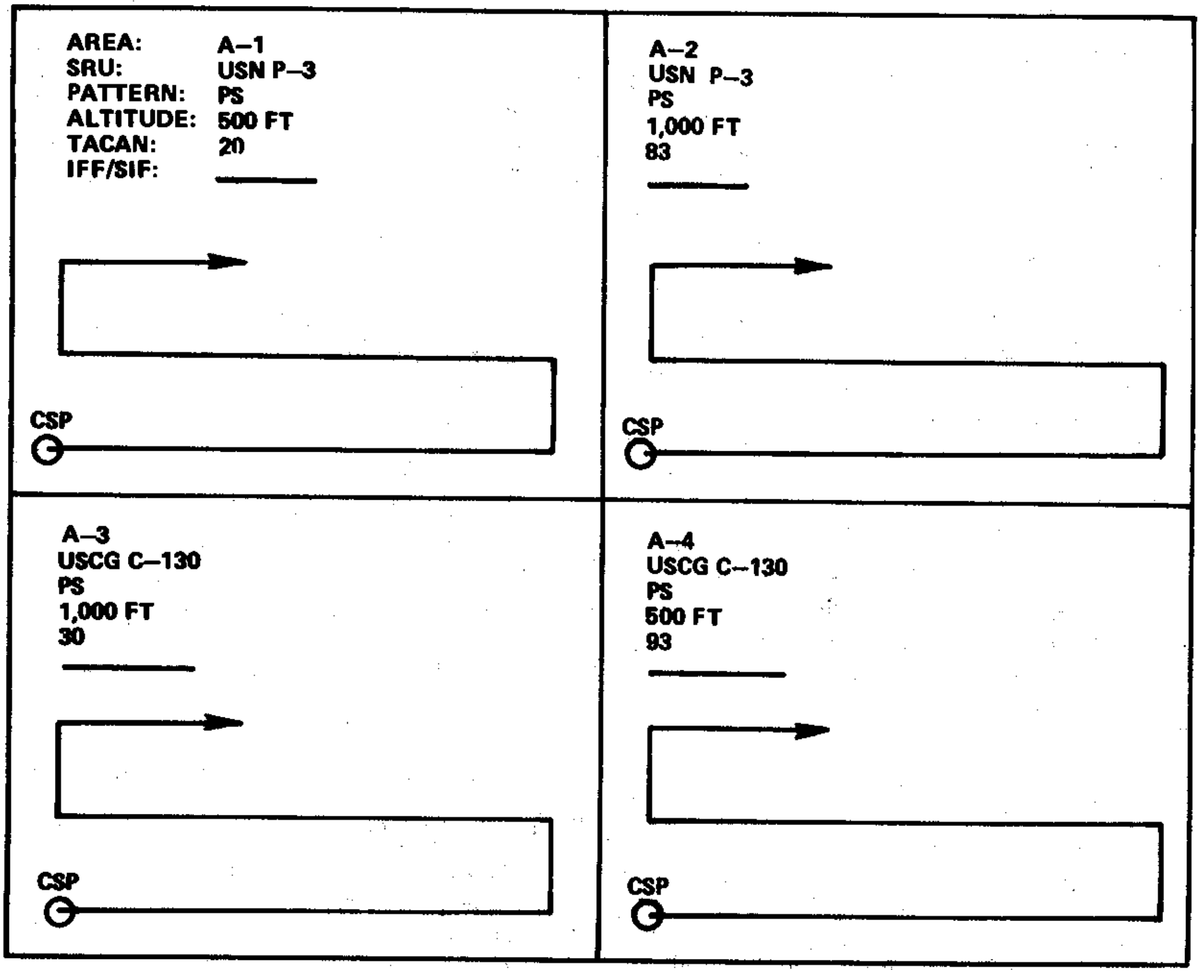


FIGURE 8–82

weather deteriorates below that forecast for the search, the track spacing will have to be reduced in order to maintain the specified coverage factor. As a result, the full search area will not be searched, but the area that is searched will have the desired probability. The SMC should therefore tell the OSC whether to maintain S or maintain C in event of changing, on scene weather conditions.

e. Non-SAR Aircraft

If the search area is protected by some form of airspace reservation (discussed in the next paragraph), the SMC must keep his OSC advised of any non-SAR aircraft which the SMC has authorized to penetrate into the airspace reservation.

865 ATC Coordination

a. IFR/VFR Criteria

The SMC must coordinate several activities with air traffic control (ATC) facilities during the course of a mission. Even when weather conditions permit flight operations under Visual Flight Rules (VFR), this coordination can be appreciable during large-scale missions. And, when the weather is such that aircraft must operate under instrument flight rules (IFR), coordination with ATC is always required.

Flight operations conducted within the domestic U.S. airspace are governed by the FAA-promulgated Federal air regulations; flight operations in international airspace (over international waters), and in certain foreign airspaces, are governed by ICAO standards, recommended practices and procedures.

Aircraft are prohibited from flying in IFR conditions in controlled airspace unless flying on a clearance obtained from ATC. In uncontrolled airspace it is usually not possible for an aircraft to obtain an IFR clearance and, as a result, aircraft are expected to operate only if VFR criteria can be maintained. Helicopters have no established minimum visibility limitations when operating at low altitudes outside of controlled airspace, but they must be able to see and avoid other aircraft and obstructions.

b. ATC Services

There are five major services provided by ATC:

1. Separation of aircraft.
2. Obstruction clearance.
3. Orderly air traffic flow.
4. Safety information.
5. SAR System alerting.

All five services are provided to aircraft on IFR flight plans within controlled airspace. Only the safety information and alerting services are available to aircraft in uncontrolled airspace, and then only if an ATC facility is aware of the aircraft's presence.

Air route traffic control centers (ARTCC) provide ATC services in domestic U.S. airspace, while oceanic area control centers (OACC) provide them in international airspaces.

c. SAR Airspace Reservations

The SAR coordinator or SMC may request ARTCC or OACC to establish temporary airspace or altitude reservations during SAR operations. These reserved airspaces have the purpose of preventing unessential, non-SAR aircraft from interfering with SAR aircraft operations, and thereby unnecessarily hazarding the aircraft in their operations. There are three general types of SAR airspace reservations: Area of temporary flight restriction, SAR operations warning areas, and SAR altitude reservations.

d. Temporary Flight Restriction

The first paragraph of part 91.91 Federal Air Regulations reads as follows: "Whenever the Administrator [Federal Aviation Administration] determines it to be necessary in order to prevent an unsafe congestion of sight-seeing aircraft above an incident or event which may generate a high degree of public interest, or to provide a safe environment for the operation of disaster relief aircraft, a notice to airmen will be issued designating an area within which temporary flight restrictions apply."

A temporary flight restriction provides the greatest amount of protection for SAR aircraft. It can only be obtained within U.S. domestic airspace. A temporary flight restriction may be imposed for forest fires, floods, earthquakes, or similar disasters. The requested area for temporary flight restrictions would normally be within 5 statute miles of the disaster site or disaster boundaries and include the airspace between the surface and 2,000 feet above the surface. The size may vary, however based on the actual need.

Part 91.91 of FAR continues:

"When a notice to airmen has been issued under this section, no person may operate an aircraft within the designated area unless—

(1) That aircraft is participating in disaster relief activities and is being operated under the direction of the agency responsible for relief activities;

(2) That aircraft is being operated to or from an airport within the area and is operated so as not to hamper or endanger relief activities;

(3) That operation is specifically authorized under an IFR–ATC clearance;

(4) VFR flight around or above the area is impracticable due to weather, terrain, or other considerations, prior notice is given to the Air Traffic Service facility specified in the notice to airmen, and en route operation through the area is conducted so as not to hamper or endanger relief activities; or,

(5) That aircraft is carrying properly accredited news representatives, or persons on official business concerning the incident or event which generated the issuance of the notice to airmen; the operation is conducted in accordance with section 91.79 of this chapter; the operation is conducted above the altitudes being used by relief aircraft unless otherwise authorized by the agency responsible for relief activities; and further, in connection with this type of operation, prior to entering the area the

operator has filed with the Air Traffic Service facility specified in the notice to airmen a flight plan that includes the following information:

(i) Aircraft identification, type, and color.

(ii) Radio communications frequencies to be used.

(iii) Proposed times of entry and exit of the designated area.

(iv) Name of news media or purpose of flight.

(v) Any other information deemed necessary by ATC."

When the area in which temporary flight restrictions apply is designated by an ARTCC upon the request of the SMC, the ARTCC issues a NOTAM and specifies the flight service station (FSS) nearest to the disaster as the coordination facility for air traffic control. If the disaster scene is of appreciable size, as would be the case of a flood or forest fire, the ARTCC will usually assign ATC coordination responsibility to the FSS nearest to the RCC or disaster control operations base. But whichever FSS is assigned as the coordinating facility, it will be responsible for coordination between the SMC and all affected aircraft in matters of aircraft movement. Should the SMC not have adequate communications with the assigned FSS, he may use his normal communications link with the ARTCC for relay.

When the size of the area in which temporary flight restrictions apply is small, and a large number of SAR aidcraft are operating within it, the SMC should not hesitate to prohibit news media aircraft from operating at altitudes at or below those which SAR operations are being conducted. Although cooperation with the news media is desireable in all SAR missions, unnecessarily hazarding the participating SRUs should never be acceptable. If at any time the SAR aircraft traffic increases, and the SMC has previously authorized entry by news media aircraft, the OSC should not hesitate to rescind this authorization. In all cases, news media aircraft should be instructed to contact the OSC prior to entry, and to remain outside the area if unable to establish communications. Violating aircraft should be immediately reported by the OSC to the FSS coordinating facility or to the SMC for relay to the ARTCC.

e. SAR Operations Warning Area

SAR operations warning areas can be obtained in either domestic U.S. airspace or in international airspace. This type of SAR airspace reservation is usually obtained in uncontrolled airspace. Restraint on airmen from entering the area is voluntary. ARTCC or OACC will not routinely issue a NOTAM for this type of reservation, and hence, the SMC should request the appropriate air traffic facility to issue a NOTAM which requests that all non-SAR aircraft remain outside of the area.

After the SMC has developed his overall search area, he should add 5 miles to the outer boundaries and pass these coordinates to the ARTCC. The SAR operations warning area will include the airspace within the expanded boundaries, and from the surface up to that designated by the SMC. Normally the SMC will not designate an upper ceiling of over 2,000 feet for overland missions, or over 6,000 feet for overwater missions. For missions in international waters, the upper ceiling should be just sufficient to reach the base of the oceanic control area (CTA). The base of the CTA for any particular ICAO region may be found in the ICAO air navigation plan for that region. CTAs are positive control areas, and only aircraft on IFR flight plans are authorized to operate within them.

During the time that the SAR operations warning area is in effect, ATC will not route any IFR traffic to within 60 miles of the boundaries laterally, or within 1,000 feet above the upper ceiling of the area. However the OSC and SRUs, must understand that there is no prohibition against non-SAR VFR traffic entering the SAR operations warning area.

f. SAR Altitude Reservation

SAR altitude reservations can be obtained in either domestic or international airspace. This type of SAR airspace reservation is usually obtained in controlled airspace, and hence provides for positive aircraft separation safety. ARTCC or OACC will not issue a NOTAM for this type of reservation.

During large-scale missions, or missions occurring some distance from adequate communications facilities, the SMC may require that the OSC aircraft establish a high-altitude orbit over the search area. The OSC will then be in an excellent position to maintain communications with all participating SRUs, at the scene, and in addition will be able to establish good communication links with shore radio stations.

The SMC selects a position over the search area which will permit the OSC to establish early radio contact with aircraft SRUs as they approach from their staging bases. The SMC then requests ARTCC or OACC to establish the altitude reservation for that position, the selected altitude, and for the desired orbit distance from the position which the OSC will be staying within. The aircraft SRU which is assigned as OSC must also duplicate the request on his flight plan when filing it prior to departure.

g. Requesting SAR Airspace Reservation

When requesting SAR airspace reservations, the SAR coordinator or SMC should provide the ARTCC or OACC with as much of the following information as possible with the original request:

1. Name and organization of the person requesting the area designation.
2. Brief description of the incident.
3. Estimated length of time that the area is to be designated.
4. Name and telephone number, or other contact method, of the SMC.
5. A clear definition of the area by reference to prominent geographic features depicted on aeronautical charts, or by geographic coordinates.
6. Nature of operations and altitudes being used by aircraft SRUs.
7. SAR aircraft staging bases, and when appropriate, whether nonparticipating aircraft should be requested to avoid these bases.
8. Approval or disapproval of aircraft carrying accredited news media representatives, or persons on official SAR business, to operate at altitudes being used by SAR aircraft.
9. When approval is given under 8 above, any special instructions such as radio call signs, frequencies of SAR aircraft, requirement to contact the OSC, specific areas to be avoided, direction of traffic flow, etc., should also be given.

In all cases where SAR airspace reservations have been established, the SMC must notify ARTCC or OACC as soon as the reservation is no longer required.

h. Aircraft SRU Call Signs

As discussed in chapter 4 aircraft of the Armed Forces, CAP, and CGAUX should use the word "rescue" in their call signs, when engaged on any SAR mission. This is of particular importance when the aircraft are operating in a SAR airspace reservation. This will identify them as being authorized to be in the area, and will avoid having violations filed upon them for unauthorized entry.

866 Communications

The SCM selects primary and secondary control channels, on scene channels, monitor channels, and press channels. He specifies any special communication procedures, radio schedules, or other communication factors which pertain to the execution of his search action plan. These elements are discussed in chapter 4.

867 Reports

The OSC must submit periodic situation reports as discussed in chapter 4. If only one SRU is involved, then the Commander of that SRU must make the required situation reports. Normally the SMC requires the SRUs' arrival times, rendezvous accomplished times, expected departure times, actual departure times, and similar information to properly schedule relief search units.

Search results from each SRU are obtained by the OSC from each search unit as it departs. The OSC then forwards this information in standard SITREP format to the SMC.

870 RESCUE PLANNING

The planning for a rescue follows the same logical sequence that is followed when planning for a search. The time required is much less since most rescues will logically follow the conclusion of a successful search and SAR units present on scene would be expected to carry out the required rescue without delay, if they were capable of doing so.

However, there are occasions when either rescue planning is the first planning event, as would be the case of the known disaster in a well-defined position, or the search units conducting the search are unable to complete a rescue after locating the search object.

Generally the rescue planning will involve diverting or dispatching helicopters, surface vessels, or boats for rescue of personnel involved in water areas such as oceans, lakes, or rivers. During an inland mission the dispatch of pararescue teams, land SRUs, or helicopters may be required after the search target has been located by fixed-wing aircraft that are unable to land in the immediate area.

a. Influencing Factors

The SMC must decide what method of rescue should be followed and what rescue facilities should be used. He should consider the following factors:

1. Action taken by the sighting facility and other facilities at the scene.

2. Location of the survivors: whether on land or water, type of terrain or closeness to shore, distance from operating bases, and distance from safe delivery point or receiving hospital for delivery of survivors after rescue.

3. Condition of survivors. If not known, it must be assumed that urgent medical attention will be required. If known, a detailed description of injuries will determine need for stretchers, blood plasma, intravenous fluids, etc.

4. Number of persons reported to be on board the distressed craft and number who appear to be at the site.

5. Available rescue facilities and their state of readiness. (If SMC has previously moved potential rescue facilities into the search area, or if he had previously upgraded their alert status, this delay can be reduced.)

6. Weather conditions and their expected effect on both rescue operations and survivor life expectancy.

7. Communications available at the scene. An orbiting radio-relay aircraft and delivery of air-droppable radio transceiver may be required.

8. Time of day.

b. Environment Evaluation

Even though the position of the distress scene is accurately known, it may be extremely difficult for a rescue unit to reach it. In inhospitable and inaccessible land areas particularly, the operation should not be undertaken without thorough planning. There are three areas that the SMC should consider before committing any rescue units, especially land or pararescue units.

1. Aerial Survey. A thorough aerial survey of the distress scene should be made for the purpose of:

(a) Identifying parts of the search object.
(b) Determining the path of the search object.
(c) Detecting deployed parachutes back along the flight path.
(d) Detecting signs of fire or explosion.
(e) Accurately determining position of the search object.
(f) Detecting signs of survivors.
(g) Detecting signs of casualties.
(h) Detecting trails or signs of departed survivors.
(i) Detecting fires, shelters, survival equipment.
(j) Detecting prepared ground-to-air signals or survivor's radio transmissions.
(k) Detecting the approach or presence of suitable rescue units in the area.
(l) Determining access routes to scene.

2. Urgency of Situation. It is not always possible to determine from an aircraft in flight whether there are survivors at the distress scene, and if so, what their condition is. Survivors may have suffered injuries which should be given immediate medical attention. Uninjured survivors may be in shock or go into shock after establishing communications with a SAR aircraft. It must be assumed that survivors are always in need of immediate medical aid.

Unless there are reliable assurances that all is well and no help is needed, provided by radio communications, by ground-to-air signals or by the presence of adequate assistance already at the scene, the situation must be considered urgent. The mere presence of persons other than the survivors at the scene is no indication that they constitute an adequate rescue unit. There may be no medical supplies, no survival equipment, or no medical skill. So without the assurances listed above, it is still necessary to proceed with the rescue operations.

3. Magnitude of Situation. The magnitude of the rescue effort required is normally fairly easy to determine if the following factors are considered:

(a) Number of persons reported aboard the distressed craft.

(b) Report or signs of bailout.

(c) Size of distressed craft, if number of persons are not reported.

(d) Probable method of evacuation.

(e) Terrain, weather (existing and forecast).

(f) Access route and distance to travel.

(g) Amount and type of survivial equipment available to survivors.

Upon determining the magnitude of the rescue efforts required, an immediate evaluation should be made of any additional forces needed.

871 Selecting Rescue Method

The selection of the rescue method is closely allied with the selection of the rescue unit. Basically the environment of the distress scene, the urgency of the mission, and the magnitude of the rescue effort required will dictate both method and facility selected. The environment surrounding the survivors will usually be the paramount influencing factor.

The selection of a specific rescue method is normally left to the discretion of the OSC or commanding officer of the SRU dispatched by the SMC. Therefore the SMC's consideration in this area is usually limited to an evaluation of whether or not a rescue method is available to and possible for the SRU he selects and dispatches.

872 Selecting Rescue Facility

The selection of rescue facilities is determined by the same considerations given to selecting search facilities with one major difference. The capabilities, possible techniques, and limitations of the SRU for conducting the rescue, rather than the search, are considered. The rescue unit's nearness to the scene, time delay in reaching the scene, and its availability are also prime considerations. If a search unit which is also capable of completing a rescue was originally available, selected, and dispatched for the search portion of the mission, this consideration factor resolves itself. For this reason the SMC should, if possible, use SAR units that can both search for and rescue survivors. In fact most of the rescue planning delays can be avoided by this procedure.

All rescue means must be evaluated for availability and suitability. Facilities or methods to be considered though not necessarily in the preferred order are:

(a) Helicopter landing.

(b) Helicopter hoist pickup.

(c) Land party penetration/rescue.

(d) Marine SAR unit rescue.

(e) Pararescue team deployment/rescue.

(f) Fixed-wing landing.

(g) Other.

873 Medical Considerations

When survivors are suspected or known to be injured, the delivery of trained medical personnel to the scene is of great importance. The seriousness and urgency of the situation usually dictates the need for medical personnel.

Medical personnel may be delivered by helicopter in both inland or maritime missions if within the helicopter's range and other capabilities. In maritime areas, a second choice would be to deliver medical personnel by marine craft. In inland areas, ground vehicles may be used to deliver medical personnel. However, both marine craft and ground vehicles are relatively slow and subject to limited access routes in coastal and inland areas.

When helicopters are not available, consideration must be given to deployment of a pararescue team. Therefore, it is desirable in many cases that a pararescue team be carried by at least one search aircraft suitable and authorized for dropping parachutists when search operations are in remote areas.

The uniqueness of trained pararescue teams gives the SMC a great advantage in being able to place a land SAR unit at the distress scene with a minimum of delay. By transporting them to the scene by aircraft and deploying them by parachute, all the time delays encountered by ground penetration are eliminated. In addition these teams are qualified for jumping into the open ocean, and have proven most effective in maritime medical missions.

874 Optimum Rescue Plan

A rescue plan is not required for most SAR missions, since it is either developed at the same time as the search plan is developed, or the rescue may logically follow a successful search without requiring specific SMC-directed rescue actions. However, when a rescue plan is required, the SMC must carefully weigh the limitations of time, terrain, and weather just as he would in developing a search plan. The availability of suitable rescue units will vary with different geographical areas, and the forces made available to the SMC for conducting the SAR mission.

The SMC develops his original rescue plan with the assumption that the most desirable rescue unit will be available for the mission. This is why it is called the optimum rescue plan. Once he completes his optimum plan, he must make every effort to obtain the services of the type of rescue unit that he most desires.

When developing his optimum rescue plan the SMC should consider six specific subject areas. These subjects areas follow the format he will use in drafting his rescue action plan message. The subject areas are: Situation, rescue area, execution of rescue plan, coordination required, communications, and required reports from on scene.

a. Rescue Situation

An evaluation of the existing situation at the distress scene is made. This involves a consideration of the type of casualty or incident, the influencing factors discussed in paragraph 870a, the urgency and magnitude of the situation, and the results of the aerial survey discussed in paragraph 870b.1.

b. Rescue Area

The SMC must consider the location of the distress scene, the type of terrain involved and the access routes that must be followed by rescue units proceeding to the scene. Access routes to inland distress scenes must be chosen that will permit the rescue unit to easily navigate by reference to prominent geographical features, roads, rivers, highway mileage markers, etc. The time that it will take a rescue unit to traverse the access route is evaluated when selecting a particular route. The SMC should choose the route which will consume the least time delay while still providing adequate safety for the rescue unit and adequate navigational references.

c. Rescue Plan Execution

Specific types of rescue units are assigned various tasks to accomplish the rescue. The rescue method is specified only if appropriate for the circumstances of the mission. Consideration is given to the need for aerial delivery of supplies and other supporting equipment or technical advice to the rescue units. The SMC may at this time begin checking with parent agencies to determine if his most desired rescue units will be available for the mission execution.

d. On Scene Coordination

The SMC should designate the best qualified on scene rescue unit or individual as OSC. The SMC should schedule the on scene arrival or rendezvous times for SRUs. If there are any changes of operational control (CHOP) requirements during the SRUs en route, arrival, departure, and return portions of its movements, they should be coordinated and specified. If on scene reliefs are required to be provided by parent agencies of the participating SAR units, the reliefs must be coordinated with the appropriate agencies. If the distress scene is protected with a temporary flight restriction, the SMC must keep his OSC advised of any non-SAR aircraft or personnel he may authorize to penetrate into the airspace or area.

e. Communications

The SMC must select primary and secondary control channels, on scene channels, communication procedures, radio schedules and other communication factors in the same manner as for a search mission.

f. Reports

The OSC must submit situation reports in the same manner as he would for a search mission. If only one SAR unit is involved then the commander of that SRU must take the required situation reports. Normally the SMC will require the SRUs' arrival times, rendezvous accomplished times, expected departure times, actual departure times, and similar reports to properly schedule relief SRUs on scene.

875 Attainable Rescue Plan

Having developed an optimum rescue plan considering the various factors in the previous paragraphs, the SMC must then coordinate with any parent agency that has suitable SRUs or facilities for executing the desired rescue plan to insure their availability. If it develops that the originally chosen SRU is not available for that mission, the SMC must then compromise between his desired, optimum rescue plan and the availability of SAR units. After this adjustment is made in his optimum rescue plan, he has a rescue plan that can be attained with the available forces and under the existing time, weather and terrain limitations that he must cope with. He then writes down the complete rescue plan and informs all participating agencies of his plan. Chapter 4 provides a sample rescue action plan message.

876 Special Environment Rescues

Certain geographical areas have such unique features of terrain, weather, or accessibility that special considerations for rescue operations are required.

a. Polar Rescue Planning

1. General. The polar environment presents a most difficult rescue situation to the rescue planner. Harsh weather, sparse population, and lack of natural food and shelter make extended survival doubtful. Extreme cold, snow, ice, and lack of bases for rescue operations further complicate the recovery of survivors.

Unless otherwise known, it must be assumed that personnel stranded in polar areas are ill-prepared for survival in terms of physical ability, equipment, and necessary skills. Rescue planning must be initiated early during the search operations stage as time is critical. Rescue efforts, once survivors are located, must be directed first toward sustaining life until recovery is complete. All SAR aircraft should carry air-droppable equipment, either polar survival kits or a substitute. Considering their capabilities, early deployment of pararescue teams should always be considered.

Once the distress site is discovered, the means of rescue must be determined. Aerial evacuation is preferable and several techniques may be used. Where rescue is effected by a land party, logistic support will usually be supplied by aerial delivery. The method of recovery will depend upon survivor location, their physical condition and the availability of necessary rescue units and equipment.

2. Sustaining Life. Immediately upon location of the distress site, provisions for continued survival should be aerially delivered by the search aircraft. This is advisable even if it appears no survivors are present. Survivors may have built snow caves or other shelter and thus may not be visible from the air. In addition, an aircraft with a pararescue team aboard, trained in polar operations, should be diverted or dispatched to the scene as soon as possibly. In any case, professionals in the field of polar survival will be needed to assist. With few exceptions a pararescue team should be considered as a primary means of polar rescue. Once survivors are located, a continuous survivor covering air patrol (SURCAP) should be maintained until recovery is effected. A SURCAP is also necessary for any land SRU dispatched. Continued and regular support of survivors is paramount. Harsh conditions in the polar areas can cause death in minutes without proper equipment and in a matter of hours even with good survival equipment.

3. Polar Rescue Methods. There are several methods of recovering survivors of polar incidents dependent upon the location, weather and physiological condition of the survivors. As stated previously a means of continuing survival must be extended to the survivors when they are located; preferably a base camp will be established. Aerial recovery from the base camp will be the primary method employed in most cases.

Aerial recovery can be effected through several methods, depending on the availability of equipment and conditions. Foremost among these methods are: (a) Helicopter recovery, and (b) fixed-wing recovery.

4. Helicopter Rescue. Helicopter recovery may be the most expeditious and effective method of recovering survivors from a polar environment. Helicopters can effect recovery operations by landing at the incident site and onloading survivors or through hovering over the incident site and hoisting survivors aboard. Factors to be considered in the use of helicopters are:

(a) Helicopter's performance capabilities, including air-to-air refueling capability.

(b) Helicopter's recovery capabilities, including recovery hoist equipment and number of survivors that can be carried.

(c) Helicopter aircrew qualifications, including training in emergency medical care for survivors.

Helicopter limitations normally will be reduced to radius of action and load-carrying capacity. Adequate planning will minimize both limitations. The radius of action of the helicopter can be extended by air refueling. When this is not possible, fuel may be cached or aerially delivered in freefall "blivit" bags or palletted fuel drums, parachute dropped by fixed-wing aircraft along the route to and from the incident site. A helicopter shuttle may be in order if the number of survivors exceeds the capacity of the helicopter. In this case, the seriously injured personnel should be evacuated first in accordance with the triage priorities. (See paragraph 981) A medical evaluation by a doctor either "onsite" or "overhead" in a SURCAP aircraft should be used when possible. Fixed-wing SURCAP escort of helicopters is desirable. The SURCAP aircraft will provide communications and navigation assistance to rotary wing aircraft.

Use of available icebreakers as a helicopter advance base should also be considered.

5. Fixed-Wing Aircraft Rescue. The second method of survivor recovery by aerial means would be by fixed-wing aircraft landing at or near the distress scene. This method should be considered when rotary-wing aircraft are neither available nor practical to effect the recovery. A great variety of fixed-wing aircraft exist that could be used. These aircraft should be selected for their load-carrying and operating capabilities to support the SAR mission; for example they must be equipped to land and takeoff from the surface at or near the incident site. In most cases, a landing/takeoff strip must be prepared by the survivors and/or the land SRU unit. Consideration of air dropping equipment to prepare the surface will be necessary. However, an evaluation of the surface conditions (ice thickness, terrain features, etc.) is essential before this method can be considered or employed.

6. Land SRU Rescue. When aerial recovery is not feasible, evacuation by surface/land methods must be employed. Survivors should not leave the incident site unless accompanied by a land party. Some method of surface travel must be provided to the land party. First choice would be snowmobiles or ski-doos, followed by dog teams and sleds and lastly snowshoes and skis. A continuous or periodic SURCAP must be provided to the land party to assure communications, navigation, and logistical assistance as required.

b. Swamp Rescue Planning

1. General. Helicopter rescue is recommended for all rescue operations in swamp areas. Access by land SRUs in any of these areas is very slow and tedious. Removal of victims is also out of the question for distances of more than a few hundred yards. Air boats and hovercraft may be used if available in inland grass swamps. Hovercraft may be used in tidal grass swamps.

2. Land SRU Rescue. When a land SAR unit must be dispatched into swamp areas, the following factors should be considered:

(a) Insect life thrives in swamp areas and generous amounts of insect repellent are necessary for individual protection. Liberal amounts of repellent should be applied to 100 percent of the team member's body, and should be applied before dressing, after dressing, and immediately prior to the swamp penetration.

(b) The subsurface bottom in cypress swamps is relatively firm. However it is pocketed with many holes which are not visible from the surface.

(c) Visibility is very limited to ground parties in tropical cypress, palmetto, and mangrove swamps for ground SAR units. Because of this inability to see more than several feet, covering aircraft are required to vector the land SRU to the distress scene.

(d) Mangrove swamps present considerable barriers to walk-in penetration, due to the external root system and entanglement of the mangrove trees.

(e) The many tidal runs existing in tidal swamps will impede walk-in progress. These tidal runs average 3 feet in depth.

(f) Both inland and tidal grass swamps have areas of silt-laden mud which may be quite deep and extend over 6 feet below the surface.

All types of swamps have been penetrated by walk-in SAR units. However the time required to reach a distress scene, as well as the difficulties that will be encountered during the penetration by lands SRUs, requires the SMC to consider all other possible methods of reaching the distress scene and subsequent evacuation before committing a land SAR unit or ground party for this type of mission.

880 DELIVERY PLANNING

881 Selecting Delivery Point

The selection of a safe delivery point is usually determined by its nearness to the distress scene and by its suitability to receive the survivors or to accept delivery of a distressed craft from the SAR System. Generally the closest safe delivery point which can be reached by the SAR unit providing the transportation is selected. In missions involving a large number of survivors, it may be necessary to establish a temporary safe delivery point for intermediate handling of survivors. This might occur in the case of a major aircraft or marine disaster a short distance offshore. Survivors might be transported to a suitable nearby landing area, where a temporary emergency care center would be established. The survivors would be processed, provided emergency care, and then would be transported to a permanently established emergency care center. By using the temporary safe delivery point, a large number of survivors can be evacuated quickly from their immediate hostile environment. In addition, secondary SAR facilities such as local police and ambulance services may be used for subsequent transfer of survivors to hospitals or regional medical care centers.

a. Selecting Emergency Care Point for Survivors

There are many first aid stations, clinics, private hospitals, city/county hospitals, and emergency medical care centers. Each of these vary in their capacity to handle survivors removed from a distress scene.

Appropriate safe delivery points for injured survivors should normally be preselected and plotted on the RCC's SAR unit response chart.

b. Selecting Safe Harbor

For missions involving emergency services to marine craft, such as towing and escort services, the normal procedure is to deliver the disabled craft to the nearest safe harbor in which emergency repairs can be made. The harbor should be of sufficient depth to receive both the SAR vessel and the disabled craft, and be sufficiently protected from the elements so that upon delivery, the SAR unit may depart without expecting any further emergency to develop. The SAR System's responsibility to vessels being towed or escorted ends when they are delivered to a safe delivery point.

If the disabled craft passes up a safe harbor while being provided escort services from the SAR System, the SAR unit providing those services should terminate its services in order not to delay resuming readiness for another mission which may be of a more bonafide emergency nature. The disabled craft should be advised of the reasons when SAR services are terminated under these circumstances.

c. Selecting Suitable Airports

Selecting a suitable airport for aircraft under escort involves a consideration of the runway length for the type of aircraft involved, approach and landing aids at the airport, and the availability of adequate crash/rescue equipment. The runway has to be long enough with a suitable surface to receive the disabled aircraft; it has to have sufficient approach and landing aids to allow the aircraft to safely make its approach and land; the weather has to be such that the disabled aircraft is capable of safely penetrating it. Normally the first suitable airport along the disabled aircraft's route, or within a reasonable distance of that route, is selected as the safe delivery point by the SMC.

When a disabled aircraft is being provided emergency services such as intercept and escort, and it passes up a safe landing airport, the SAR system responsibility terminates, and SAR forces should normally be withdrawn at that time. The disabled aircraft should be advised of the reasons when the SAR services are terminated under these circumstances.

882 Selecting Transport Facility

a. General

The selection of a suitable facility for transporting survivors from rescue units depends to a great extent on the circumstances of the case and the availability of facilities.

Speed of the vehicle and the ability to sustain the survivor's life during transport are of major import. Whenever possible, the vehicle should carry a doctor or other medically trained personnel along with equipment necessary to sustain life.

b. Helicopters

Helicopters are the ideal transport facility due to their capability to recover survivors from inaccessible or hard-to-reach sites and to deliver them directly to emergency care centers.

c. Marine Craft

High-speed boats can be particularly useful in moving survivors from rescue vessels near shore to ambulances ashore. In some cases at sea, when a rescue is made by a vessel with limited treatment facilities, it is necessary to locate another with better medical facilities in order to transfer survivors in need of treatment. Likewise, it may be more convenient to transfer survivors in need of hospitalization ashore from the rescue vessel to another vessel which is inbound.

d. Ambulances

Properly equipped ambulances are the usual choice for short-range land transport where helicopters are unavailable. Ambulances are satisfactory when traffic conditions are light and suitable roads are available between the distress scene and emergency care center. However land transportation by any type of ground vehicle is subject to traffic tieups and this factor should always be considered by the SMC.

e. Fixed-Wing Aircraft

Fixed-wing aircraft especially configured for medical evacuation are ideal for long-range transportation requirements of seriously injured survivors. This is usually a function that operates outside of the normal SAR System operations because of the delays in arrangements for fixed-wing medical evacuation as well as their availability.

Almost any fixed-wing multiengine aircraft can be satisfactorily used for transport of survivors, if survivors can be brought to the landing area of the aircraft.

f. Ground SRU

In remote areas it is quite possible that neither helicopter nor ground vehicle will be able to penetrate to the distress scene. In this event it may be required to evacuate survivors by ground teams. Local, State, county, and municipal authorities normally have jurisdiction in these circumstances and should provide appropriately trained ground parties for this mission. However, the SAR System has provided land SRUs, in the past and it is expected that this may continue where local authorities do not have the capabilities for conducting this type of medical evacuation. Only properly trained ground parties should be used to evacuate injured survivors.

g. OSC Recommendations

The OSC should make recommendations to the SMC for the type of craft desired for transporting the rescued survivors to a safe delivery point when this appears to be necessary. The SMC is responsible for dispatching suitable aircraft, vessels or other units to accomplish the purpose.

However, occasionally the recommended craft are not available and the OSC must use on scene capabilities. In a maritime mission the OSC may even be required to solicit aid from passing vessels without specific SMC direction or assistance.