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Chapter 9. OPERATIONS STAGE

900 SEARCH OPERATIONS

During search operations facilities proceed to the scene and conduct search operations until distressed persons or craft are located or the mission is terminated. Search operations begin when the first search unit is briefed and dispatched to a search area. This may occur immediately after a SAR incident is assigned an emergency phase in the initial action stage, or it may occur after the SMC has developed a search plan. Generally, its beginning depends directly upon the apparent urgency of the SAR incident reported to the SAR System. It can thus overlap both the initial action stage and the planning stage at its beginning. Search operations end when all distressed persons or distressed craft have been located, or the mission is terminated.

In a strict sense, search operations will occur even during missions in which accurate distress locations are known or reported. Effecting a rendezvous between an SRU and the distressed craft or person will require some search effort on the part of the SRU to eliminate or reduce time delays.

There are eight specific events which may occur sequentially during search operations. These events are: Search briefing; dispatch of search units; SRU en route travel; on scene search; distressed craft/persons sighting; if necessary, on scene relief; return to base; and debriefing of search crew/team.

901 Search Briefings

a. General

The search crews' active participation in a mission begins with their briefing and ends with their debriefing upon return. Sending a search crew on a mission without adequately briefing them is not only unprofessional, it is also inefficient, wasteful, and unsafe. It is the responsibility of the SMC to brief and dispatch appropriate SAR units. The SMC may conduct the briefing himself, or he may appoint a SAR briefing officer.

Chapter 6 discussed the use of, and summarized the contents of, the SAR mission briefing folder and the searchcraft briefing folder. This chapter will elaborate on the operational procedures upon which these folders are based. Preparing these folders prior to the time that the actual briefing is conducted will help insure that no information is omitted and that each search crew has a written record of its instructions. Briefing should be scheduled so that ample time is allowed before takeoff or launch. In addition to the written briefing forms, flightcrews should be provided, when possible, with written weather information, weather maps and/or cross sections, and a briefing by a qualified weather forecaster. All search crewmembers should attend the briefing, as the incentive imparted by the briefing will have a direct effect on lookout (scanner) performance.

The briefing officer must expend a substantial amount of effort and preparation prior to the actual briefing. Search crews must be provided with positive incentive, necessary details, and instilled with a strong sense of motivation by the briefing officer.

b. Search Briefing Checklist

Figure 9–1 is a summarized checklist of those items normally included in search crew briefings. It may be used as a guide by the briefing officer to insure that the search crews receive an adequate briefing, and are instilled with a high level of motivation for a successful search effort. If the search craft is on a minimum-delay launch or scramble, the briefing can be conducted over the radio, condensing this checklist as appropriate. Most of the listed items in figure 9–1 are self-explanatory; those which are not are more fully discussed in the following subparagraphs:

Search Briefing Checklist

A. Situation
1. Circumstances of distress
2. Persons on board
3. Search targets
4. Descriptions
5. Last known position
6. Survival equipment
7. Current leads
8. Estimate of the situation
9. Participating SAR agencies

B. Weather
1. At time of distress
2. Current en route
3. Current on scene
4. Forecast en route
5. Forecast on scene
6. Weather hazards

C. Search Areas
1. Previous coverage
2. Current coverage
3. Airspace reservation (type)
4. Designations
5. Size
6. Major axis
7. En route searching
8. Commence search points
9. Terrain hazards

D. Search Patterns
1. General descriptions
2. Designations
3. Creep
4. Track spacing
5. Search altitudes
6. Probability of detection
7. Accurate navigation
8. Vary P versus S
9. Speed

E. Search Assignments
1. Aircraft assignments
2. Backup assignments
3. Vessel assignments
4. Boat assignments
5. Round robin ETE
6. Desired ETA on scene
7. Initial en route course
8. On scene reliefs

F. Lookout/Scanner Techniques
1. Instructional handout
2. Training film
3. Sighting reports

G. Communications
1. On Scene Channels
2. Control Channels
3. En route Channels
4. Monitor Channels
5. Cutter Aerobeacon
6. Cutter IFF/SIF
7. Cutter TACAN
8. Aircraft IFF/SIF
9. Aircraft TACAN
10. No Tactical Calls

H. IFF/SIF Assignments[1]

I. Coordinating Instructions
1. SMC Assignment
2. OSC Assignment
3. Middleman Assignment
4. OSC and OACC Chop
5. Descents and Climbs
6. OPS Normal Reports
7. Position Reports
8. Sighting Reports
9. Sighting Procedures
10. Marking Sightings
11. Flight Plan Remarks
12. Flight Hazards

J. Information for OSC
1. IFR Round Robin Flight Plan
2. ETA on Scene
3. En route IFF/SIF Squawk
4. Beacon Tuned and Ident
5. Communications Available
6. Search TAS (ACFT) SOA (Vessel)
7. Endurance on Scene
8. Return Altitude Requested
9. Intended Departure Point
10. Clearance to CHOP

[1] See Caution—paragraph 423, National SAR Manual.

FIGURE 9-1

1. Situation Briefing. This portion of the briefing is as much motivational as it is informative. The search crews should be told of all the known, pertinent facts surrounding the circumstances of the distress. For example, search crews need to know how many people are missing—including the color and type of their clothing. If any of the missing persons have a special medical problem which may either hinder their rescue or make their rescue more urgent, the search crew must know this as well. The type of survival equipment that is available for survivors use will also determine what the search crews must look for or listen for. A thorough description of the distressed craft or other probable targets is perhaps the most important single item of the briefing. For example, if the distressed craft were a foundering vessel, the most probable objects of search will be lifeboats, rafts, debris, oil, and personnel in the water. Lifeboats may vary in size from 12 to 50 feet in length and be of any color. Rafts may be doughnut, inflatable, or box-types and of any color. As a general rule, the doughnut and box-types are the same color as the vessel. The scene of the disaster is usually marked with a considerable amount of debris when a large vessel goes down. Often, a large oil slick is present. The debris will usually be found downwind of the origin of the oil slick; the boats and rafts will also usually be downwind of the debris. Persons in the water are usually found in the area of the debris clinging to floating objects. If the vessel had been abandoned some time before sinking, lifeboats, rafts, and personnel may be found upwind of the point of foundering. Because of this, search units should search both upwind and downwind of the oil and debris area. In heavy seas, survivors may also be moved by the seas in the direction in which the seas are traveling. Because of this, the area downsea should also be checked.

When an abandoned ship is located, it may have drifted before the wind faster than survival craft. In such cases concentration of search upwind is recommended. However, a low-lying, half-sunken loaded ship may drift more slowly than a floating survival craft, even if a drogue is used. A derelict may drift at a considerable angle off the prevailing wind direction.

Small craft, such as yachts and fishing vessels, sometimes carry only a small dinghy; some have balsa or inflatable rafts; and others have only lifejackets. Dinghies may be of any color but are usually white or mahogany. Lifeboats from large vessels are normally equipped with pyrotechnic detection aids and emergency radios. Many also have power and/or sail. If more than one boat is launched, they can be expected to be grouped or tied together, if possible, making sighting easier. Boats or rafts from small craft usually have a very limited supply of visual detection aids and, in many cases, none. In the case of a search over water for survivors of an aircraft incident, scanners should be briefed to look for scattered wreckage such as oxygen bottles, floorboards, pieces of/or whole rafts, or seat cushions. In some cases, there may be nothing other than a possible oil slick. If the search is to be conducted over heavily wooded terrain, scanners should be briefed to look for broken trees or scarred trees, and bits of shiny metal or plexiglas beneath the trees, burned out areas which look fresh, parachutes or visual aids which may have been set out by the survivors.

2. Weather Briefing. Knowing the weather, from the time of distress to the present, will help the search crew appreciate the environmental hazards being faced by the survivors. Also it will add to appreciating any degradation of search effectiveness during previous searches due to poor weather in the search area. Another reason for knowing the forecast weather is that the SMC has used that forecast to develop his search action plan. If the actual weather encountered is not as forecast, the SRU should always report this to the OSC, who will in turn relay it to the SMC. Many times a rapidly changing or developing weather system will not be forecast, and the SMC will have to make major revisions to his plan. Search crews should also be warned of any weather hazards such as cyclones, waterspouts, thunderstorms, icing, or turbulence that may be encountered by them in the search area or while en route.

3. Search Area Briefing. Areas previously searched as well as the current search area are included in the briefing, together with the rationale for their selection and size. This will tend to further bring the search crews into the total SAR mission by helping them to understand the rationale used in the selection of their particular search area. If the search area is protected by some form of SAR airspace reservation, search crews must be advised of the limitations of that protection. If en route searching is being used, its purpose and advantages should be explained.

Search crews must also be warned of any known terrain hazards within their search areas—as well as the probability of unknown hazards—such as TV transmitting antennae, power/telephone lines across valleys, high bridges in river/harbor areas, high-masted ships in oceanic/coastal areas, etc.

4. Search Pattern Briefing. In addition to the details of search pattern type, direction of creep, commence search point, track spacing, search altitude and forecast probability of detection, the briefer must stress the primary importance of accurate SRU navigation. Not only does the probability of detecting the survivors depend upon accurate navigation, but also *the safe separation of participating search craft depends upon the accurate navigation of every SRU on scene.* The briefing officer should always enumerate the available navigation aids and navigation systems in the search area. When search crews are not familiar with the particular area being searched, it may even be necessary for the briefing officer to provide a written summary of the navigation aids/systems for each crew's briefing folder.

5. Search Assignment Briefing. Every participating SRU must know its assigned search area and should be briefed on exact search areas assigned to other SRUs. By having this information readily available aboard each SRU, a large amount of unnecessary on scene confusion can be eliminated. In addition, each SRU should understand the desired procedures for either relieving the preceeding SRU in his search area, and/or for checking in with the OSC upon arrival and then proceeding to his assigned search area. When time permits, the briefing officer should provide each SRU crew with en route and on scene navigational charts. The en route chart should include at least the initial courseline from its staging base plotted on the chart indicating magnetic course. The on scene chart should include courseline inbound to the commence search point, the individual search area boundaries, and the specific search pattern legs plotted for the entire search area of that SRU.

6. Communications Briefing. The SMC will specify the frequencies assigned for primary, secondary, and tertiary usage as on scene and control channels. Parent agencies will normally assign en route frequencies. Monitor channels will depend upon what type of emergency radios or emergency locator transmitters are available to the survivors. And if heavy news media coverage of the SAR mission is expected the SMC will also specify the frequencies to be used as press channels. All search crews must be briefed on the specific frequencies assigned to their mission, as well as the specific IFF/SIF modes-codes and TACAN channels for each participating SRU. Tactical call signs are not normally used in SAR missions occurring outside of a war zone. It is much less confusing if all SRUs employ plain language radio call signs, especially whenever more than one parent agency is furnishing SRUs for the mission. There are only two exceptions considered acceptable by most SAR coordinators. One is the use of the search area designator (Alfa-1; Bravo-2, etc.) as a call sign on scene for the identification of the particular SRU searching within the specific area. The other exception is the use of a collective call sign for on scene identification of the OSC, thus avoiding possible misunderstandings whenever the OSC is relieved by another SRU.

7. Coordination Briefing. This portion of the briefing will have the greatest effect on the efficiency of the search operation as it is executed on scene. Every SRU must have a rudimentary knowledge of the SAR mission organization and how it directly affects the SRU's task and on scene procedures. The SRU crew should be aware of the identity of the SMC and OSC; other SRUs on scene; and procedures being used.

8. Information for OSC Briefing. Each search craft en route to the scene should contact the OSC 15 to 30 minutes prior to its ETA on scene, and be prepared to provide the following information:

(a) ETA on scene.

(b) Current IFF/SIF transponder setting.

(c) Whether the SAR vessel's aerobeacon is tuned and identified.

(d) Limitations of communications, navigational or other operational capability.

(e) Search true airspeed or speed of advance.

(f) On scene endurance.

(g) Intended departure point and time, if not via OSC position.

(h) Type flight plan filed and departure airfield.

(i) Return altitude (or flight level) planned.

(j) Type ATC/OAC clearance obtained.

9. Lookout/Scanner Briefing. In addition to the general briefing given to all search crewmembers, the lookouts and scanners should receive a separate, supplementary briefing. This briefing should include a review of the scanning techniques discussed later in this chapter; a training film covering proper scan procedures, if available and time permits; photographs and drawings of the distressed craft and its survival rafts/boats/etc. as seen from the search altitudes being used if available; proper methods for reporting sightings using the search craft's interior communication system; and some form of instructional and motivational handout for each scanner and lookout.

c. Search Briefing Forms

Figure 9–2, is one arrangement of a search briefing form used by several SAR coordinators. This form includes the minimum, essential information on which a search crew should be briefed, and is appropriate for either a scramble launch or a fully planned, relief SRU departure. Note that this form requires an attached rough sketch showing all areas currently being searched, who is in each area, and what their IFF/SIF, air-to-air TACAN, and search altitude assignments are, if these are used. During large scale searches the SAR mission coordinator can run off several ditto copies of the attachment. It not only permits the SRU commander to doublecheck his own assignment, but it also permits him to visualize his unit's place in the overall search effort.

Figures 9–3a and 9–3b are the two sides of a special briefing form used by several maritime SAR coordinators for missions involving merchant vessels. Use of this form, and a knowledge of motor vessel (M/V) rigging, will help the SRU make rapid and accurate M/V identifications during the mission without requiring a close approach by a surface vessel or a low-level aircraft fly-by. A rough sketch of the M/V's side view is made on the reverse side of the form (fig. 9–3b). Note that this form requires an attached AMVER SURPIC listing the known merchant vessels within the search area. The SURPIC should be requested from AMVER for the approximate midtime of the SRU's on scene time. The navigator should plot these vessels on his search chart in order to aid him in readily identifying vessels sighted during the search.

Search Briefing Form

Date ________ Search craft commander ________.
Search craft type and call ________ Parent activity ________.
Search targets ________.
________.
Search area designation ________ Commence search point ________.
Search area boundaries ________.
________.
Search pattern ________ Creep ________ Track spacing ________ Miles.
Search altitude ______ ± ______ feet. Search IFF/SIF squawk [1] ________.
Search air/air TACAN channel ________ or search air/ground TACAN channel ________.
Desired ETA on scene ________ Desired ETD from scene ________ ETE ________.
En route search (IS) (IS NOT) desired.
 Desired route to search area ________.
 Desired route from search area ________.
On-scene commander (OSC) is ________.
Middleman aircraft is ________.
CGC ________ is in approximate position ________.
 With aerobeacon operation on 410 kHz identification ________;
 With IFF/SIF transponder squawking ________.
 With TACAN transmitter operating on channel ________.
CGC ________ is in approximate position ________;
 With aerobeacon operation on 522 kHz identification ________;
 With IFF/SIF transponder squawking ________;
 With TACAN transmitter operating on channel ________.

On scene channels:	Primary 282.8 MHz.	Secondary 123.1 MHz.	Tertiary 5680 kHz USB.
On scene channels:	Primary ______.	Secondary ______.	Tertiary ______.
Control channels:	Primary ______.	Secondary ______.	Tertiary ______.
En route channels:	Normal air/ground or ________.		

Monitor channels: ________ for survivor signals.

(Attached is a rough diagram of areas being searched by this launch, and showing individual search areas, IFF/SIF, Tacan and Altitude assignment)

[1] See caution para. 423, National SAR Manual

Figure 9–2

Merchant Vessel Identification Briefing Form

DESCRIPTIVE DATA: (Source: Register, AMVER, ONI, DIA.)

Name ______________________. Call sign ________. Vessel type ______________________.
LOA ____________. Beam ____________. Draft ____________. Number of decks ______________________.
Gross tonnage (total volume capacity +100) ______________________.
Net tonnage (cargo volume capacity +100) ______________________.
Deadweight tonnage (cargo weight capacity) ______________________.
Special features and alterations ______________________.
Superstructure type ______________. Stern type ______________________.
Hull raises (in thirds) ____________. Sequence of uprights ______________________.
Hull color ____________. Superstructure color ____________. Stack color ______________________.
Ship loaded or in ballast? Deck cargo ____________. Dangerous cargo ______________________.

POSITION/MOVEMENT DATA: (Source: AMVER, INDEX.)
Last position ______________ lat., ______________ long., at ______________________ GMT.
Course ______________ True, speed ______________ Knots.
Departed ______________ on date ______________ for______________________.
Last port of call was ______________________ on date ______________________.

NAVIGATION/MEDICAL/RADIO/FLAG DATA: (Source: Register, AMVER, H.O.-100.)

Direction finder:	Yes	No	Unknown
Fathometer:	Yes	No	Unknown
Gyro compass:	Yes	No	Unknown
LORAN/DECCA/CONSOLAN/ETC:	Yes	No	Unknown
Surface radar:	Yes	No	Unknown
Medical doctor on board:	Yes	No	Unknown
Standard medical chest on board:	Yes	No	Unknown
FM radio telephone, 156.8 MHz:	Yes	No	Unknown
AM radio telephone, 2181 KHz:	Yes	No	Unknown
CW radio telegraphy, high freq.:	Yes	No	Unknown
Radio watch, ITU schedule:	H24	H16	H8

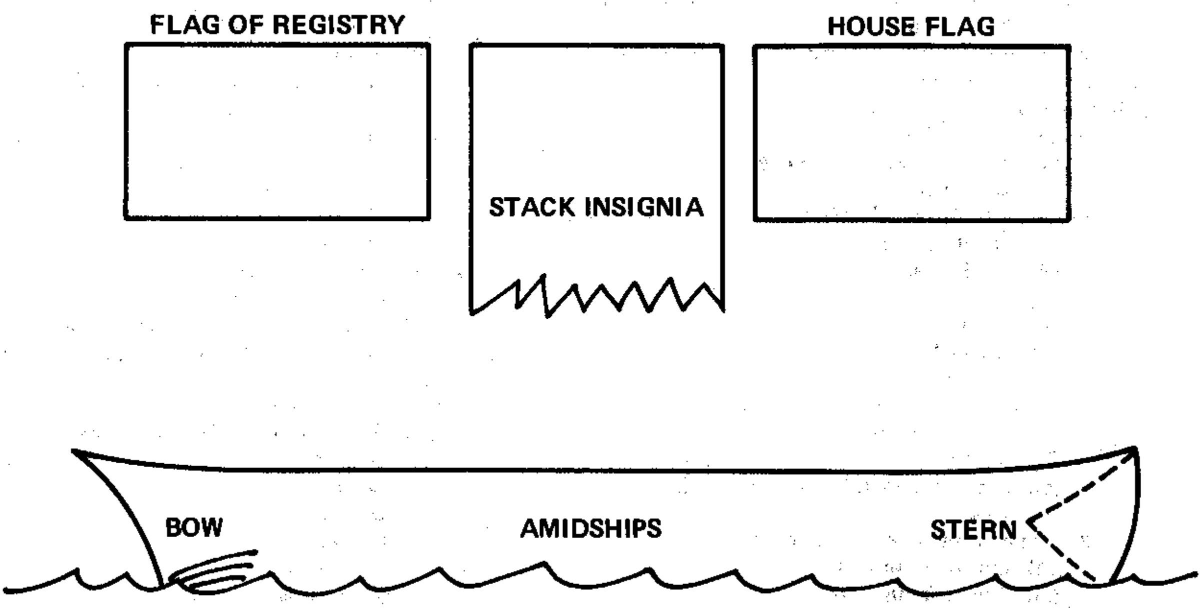
Calling freq. ______________. Working freq. ______________. Homing freq. ______________________.

OWNERSHIP/MACHINERY DATA: (Source: Register, Index.)
Owner ______________________________. Manager ______________________.
Flag of registry ______________________________. Home port ______________________.
Previous names ____.
Built in year 19___ by ____.
Engine size ______________________________. Boilers ______________________.
Propulsion type ______________________________. Number of screws ______________________.
Attached is an AMVER SUPRIC of known merchant vessels within the overall search area. Plot these on your search chart for ready reference.

FIGURE 9-3a

Merchant Vessel Identification Briefing Form

(Reverse Side)



SAMPLE RENDEVOUS MSG FM SMC TO M/V:

DH MEDICO NORFOLK CKNC 281830 GMT
BT
GOVT USCG
MASTER PODUNK/SMTA
INTEND AIRDROP OF MEDICAL SUPPLIES AT 282115 GMT STOP
REQUEST CONTINUOUS BEACON ON 522 KHZ COMMENCING AT 282015 GMT STOP AIRCRAFT CALL COAST GUARD RESCUE 1234/NC1234 WILL BE GUARDING 500 KHZ 2182 KHZ 121.5 MHZ AND 282.8 MHZ. STOP REQUEST EXISTING WEATHER/SEA CONDITIONS AND YOUR 282115 GMT DR POSITION STOP SIGNED US COAST GUARD NORFOLK UNQUOTE

FIGURE 9–3b

Figure 9–4 is an outline form for conducting the briefing of marine craft lookouts. Figure 9–5 is an outline form for conducting the briefing of aircraft scanners. Figure 9–6 is an example of one SAR coordinator's instructional/motivational handout which is given to each lookout/scanner during their briefing.

Shipboard Lookout Briefing

"If the lookout doesn't spot the survivors, nobody will"

I. Lookout Procedures:
- A. Sweep the horizon slowly.
- B. Examine the field 5° at a time.
- C. Cover assigned sector completely.
- D. Return to starting point and begin sweep again.

II. Report Sightings:
- A. First duty is to sight object and report it.
- B. Don't hold off reporting until object is identified.
- C. Insure officer of deck acknowledges report.
- D. Attempt to keep object in sight.

III. Location of Sightings:
- A. Name object (if known, say "Object").
- B. State direction—
  1. Use relative bearings in reference to bow of ship.
  2. Use 3 digits only (example—for 135° state "One Three Five.")
  3. State "Bearing." Then the 3 digits.
- C. State range—
  1. Estimated range in yards (2,000 yards = 1 mile).
  2. State "Range," then estimated distance.

(Continued)

(Continued)

D. Examples—
   1. "Liferaft, Bearing Zero Nine Zero, Range One Thousand."
   2. "Object, Bearing Three One Five, Range Five Hundred."

IV. Sighting Characteristics:
   A. Surface craft afloat—
      1. Size and distinctive markings.
      2. Location at night.
   B. Foundered distressed vessels—
      1. Objects of search:
         (A) Lifeboats.
         (B) Rafts.
         (C) Debris.
         (D) Oil slicks.
         (E) Personnel in water.
      2. Scene of disaster—large vessels:
         (A) Large amount of debris.
         (B) Oil slick.
         (C) Survivors in rafts, in lifeboats, or in water.
      3. Scene of disaster—small vessels:
         (A) Survivors in rafts.
         (B) Survivors in water.
   C. Downed aircrew—
      1. Liferafts.
      2. Personnel in water.
   D. All—
      1. Visual signals, depending on type carried.

FIGURE 9–4

Aircraft Scanners Briefing

I. Handout (Aircraft Scanner Instructions).

II. Training films:
   A. Search and rescue scanning and sighting techniques—
      TF 1–5362 (USAF).
      1962—07 minutes—color.
   B. Search and rescue visual aspects of search and signaling—
      TF 1–5054 (USAF).
      1947—17 minutes—color.
   C. Water survival communications—visual distress signals—
      TF 5595A (USAF).
      1964—17 minutes—color.

III. Briefing:
   A. Motivation—
      1. Requirement for scanners.
      2. Importance of duty.
      3. Purpose of search.
      4. Requirement for prolonged search operations.
      5. Developments in search.
      6. Orientate all statements to scanner motivation.
   B. Mission briefing—
      1. Purpose (known factors on SAR incident).
      2. Targets:
         (A) Distinctive markings and color.
         (B) Number of personnel involved.
         (C) Emergency equipment carried.
         (D) Flight information—
            (1) Length of time en route to search area.
            (2) Time on station.
            (3) Search altitude.
            (4) Weather conditions.
      3. Assigned search areas:
         (A) Pattern assigned.
         (B) Reason particular pattern assigned.
   C. Sighting characteristics (cover applicable portion)—
      1. Surface craft afloat:
         (A) Size and distinctive markings.
         (B) Location at night.
      2. Foundered vessels:
         (A) Objects of search—
            (1) Lifeboats.
            (2) Rafts.
            (3) Debris.
            (4) Oil slicks.
            (5) Personnel in water.
         (B) Scene of disaster-large vessels—
            (1) Large amount of debris.
            (2) Oil slick.
            (3) Survivors in lifeboats, in rafts, or in water.
            (4) Visual signals.
         (C) Scene of disaster-small vessels—
            (1) Survivors in small balsa or pneumatic rafts.
            (2) Survivors in water.
            (3) Limited emergency signaling equipment.
      3. Overland search objectives:
         (A) Look for—
            (1) Variations in contrast.
            (2) Odd angles of light.
            (3) Differences in texture.
            (4) Discontinuity.
            (5) Movement.
         (B) Specifically—
            (1) Broken or scarred trees.
            (2) Bits of shiny metal beneath trees.
            (3) Fresh burned out areas.
            (4) Parachutes.
            (5) Visual aids set by survivors.
      4. Survival signals—
         (A) Pyrotechnic signals (smoke or flare):
            (1) MK 13 day and night flare.
            (2) Very pistol.
            (3) Parachute.
            (4) Pen gun.
         (B) Signal mirror flashes.
         (C) Sea dye marker.
         (D) Lights.
         (E) Tracer ammo.
         (F) Others.

D. Scanning procedures—
1. Sighting ranges.
2. Eye movement patterns:
(A) Follow fixed-pattern to avoid missing areas.
(B) For waist or side position—
(1) Start under aircraft.
(2) Move out to effective field of vision.
(3) Return to starting point at same rate.
(4) Repeat.
(C) For forward position—
(1) Move right to effective field of vision.
(2) Move back to left to effective field of vision.
(3) Repeat.
3. Rate of eye movement (normal speed search aircraft):
(A) 10° eye movement per second.
(B) Pause every 3°–4° (2–3 pauses per second).
(C) Reason: Eye must be fixed or focused on object to sight it (within a 5° radius)
4. Methods of preventing fatigue and prolonging scanner endurance:
(A) Movement of head with eyes to prevent eyestrain.
(B) Areas of "No Contrast"—
(1) May cause severe eyestrain problem.
(2) Prevent by periodic focusing of eyes on nearby object (in or on aircraft or on surface).
(3) Use of sunglasses.
(C) Comfortable scanner positions.
(D) Cleanliness of windows.
(E) 30-minute rotation of positions.
(F) Relief at periodic intervals (maximum scanner endurance without rest is 2–3 hours).
(G) Use of light snacks and coffee.
(H) Intercommunication between scanners.
(I) Comfortable cabin temperatures.
(J) Correct use of visual aids.
(K) Night techniques—
(1) Lights.
(2) Dark adaptation period.

E. Sighting procedures—
1. Reporting sighting to pilot:
(A) Use clock position and estimated distance.
(B) Example: "Target, 4 o'clock, 500 yards".
2. Marking sighting locations.
3. Procedure turn technique (90°–270° method).
4. Visual Return to target:
(A) Scanner calls out clock position and estimated distance.
(B) Pilot turns aircraft in direction of sighting.
(C) Scanner continues to call out position and distance to orientate pilot.
(D) Pilot (copilot) states when he has target in sight.
(E) Do not remove your eyes from the target.

FIGURE 9–5

Aircraft Scanner Instructions

1. Purpose. The purpose of this instruction is to provide a guide for search aircraft scanners. Before all else, you should recognize the importance of your job, and endeavor to put forth your maximum effort. The success of an air search depends mainly upon the efficiency with which you as a scanner do your job. Keep in mind that your one aim and purpose is to locate the search target as soon as possible. This could mean the saving of lives, and the prevention of a large, prolonged and costly search. The primary responsibility of the regular aircraft crew is the safe operation of the aircraft, a task which at times will require their full attention leaving little or no time for actual visual search. It should be obvious that your constant surveillance is needed.

2. Scanner Organization. The aircraft commander is responsible for the organization and briefing of scanners in his aircraft. In developing his scanner organization, the aircraft commander has considered the following factors:

A. Proper assignment of scanners as to number and location.
B. Detailed emergency procedures briefing prior to takeoff.
C. Detailed search briefing prior to commencing search.
D. Correct method of scanning, day and night.
E. Prompt and accurate reporting and acknowledgment.
F. Good ability to estimate bearings and distance.
G. Proper search equipment such as binoculars, filters, sunglasses.
H. Proper use of search equipment.
I. Rotation or relief of scanners to reduce fatigue.
J. Proper scanning of sun and moon beams.
K. Night adaptation of eyes.
L. Use of off-center vision during night search.
M. Motivation of crew by keeping them advised of all developments.

3. Briefings. The aircraft commander will brief you on "Object" of the search. He will also brief you on all pertinent information regarding the search target correct emergency procedures for ditching, forced landing, and bailout. Be sure you understand them. If an emergency occurs, remain calm and respond quickly prior to search operations. Pay particular attention to to the orders of any member of the crew.

(Continued)

(Continued)

4. What To Look for. The aircraft commander will brief you on what to look for. Some things to look for which might indicate the distressed craft's position:

A. "November Charlie" flag hoist signal.
B. Any square flag and ball-shape flag hoist signal.
C. Any flame signals from a surface craft.
D. "S O S" flashing light signal.
E. Any succession of flashes from a distress mirror, flashlight, heliograph or wreckage.
F. Any red pyrotechnic light signal.
G. Any red or orange pyrotechnic smoke signal.
H. Any red rocket or star shell signal.
I. Any green sea-dye staining signal.
J. Any ejected oil staining signal.
K. Any wreckage or floating debris.
L. Any unusual object.
M. Any scarring of natural terrain.

Keep in mind that any wreckage or signals might be difficult to see, and once seen are easily lost if not kept under close observation. Whitecaps and wave motion make it particularly difficult to maintain sight of the position of wreckage or signals in the water. And obviously, an improperly checked sighting could mean the difference between life or death for the survivors. Therefore upon first sighting anything, immediately inform the aircraft commander of the first bearing and distance. He will then drop a smoke float and investigate the sighting. Do not remove your eyes from the sighting when making your report.

5. Scanning. The aircraft commander will brief you on how far out from the aircraft you scan, in addition to which sector you should scan. Use a systematic system of scanning: eyeball movement should be a repeated series of stop-focus-move; area searched should be covered by a repeated series of sweeps from below the aircraft out to the limit of track spacing and then back. The aircraft's movement will provide a proper scanning pattern. The speed of scanning will vary with search altitude. The lower the aircraft the faster the visual scan, and vice versa. As it is possible to actually see an object and yet not appreciate its presence, it is essential that you keep the object of the search continuously in mind. The aircraft commander will rotate lookouts at intervals and provide a rest period. Frequent light snacks and coffee, and a reasonable amount of intercommunication between lookouts will tend to reduce fatigue.

6. Equipment. Search aircraft windows should be cleaned inside and outside prior to departure. Sunglasses should always be used when scanning up-sun, and are recommended for continuous use during search in sunny daylight or high-glare conditions. If binoculars are provided, insure that they are clean and kept readily available. They should not be used for scanning, but rather for identifying something once it has been located by the naked eye. If possible, aircraft side windows should be opened during the search to provide better visibility and eliminate undesirable reflections. The average person requires 30 minutes for his eyes to become dark adapted. Dim red light does not appreciably affect the eyes dark adaptation. Therefore during night searches, all interior lights utilized should be red and should be dim. Keeping the lights dim will also reduce annoying reflections in the aircraft windows.

7. General. One cannot describe the personal gratification which is felt when he is instrumental in finding survivors of a disaster. So, when acting as a scanner, search as intently as you would wish someone to search for you.

FIGURE 9–6

Figure 9–7a, 9–7b, 9–7c, and 9–7d is one SAR coordinator's briefing form for a land SRU.

Land SRU/Interrogation Team—Check List

1. Briefing. Obtain all possible information before departure.

2. Preparations:

(a) If possible, use a mobile radio.
(b) Have a definite plan for transmission of position reports and other information to the mission coordinator.
(c) Determine the frequency of position reports prior to the deployment of the team.
(d) Check vehicle for: Fuel, extra fuel, flashlight, spare tire, extra water.
(e) Obtain telephone number of command post, State police, local sheriff, and participating agencies.
(f) Obtain the assistance of a local guide.
(g) Obtain the necessary road and county maps.
(h) Check weather conditions and dress accordingly.

3. Precautions:

(a) Observe State highway traffic laws.
(b) Be alert when approaching homes in isolated areas at night.
  (1) Be alert for vicious dogs.
  (2) Identify yourself by use of flashlight beamed on your person or vehicle if same bears the CAP insignia.
(c) Keep an accurate account of area searched, using landmarks, and report same to mission coordinator.

4. Possible Leads:

(a) Minute bits of wreckage.
(b) Smoke.
(c) Unusual sounds.
(d) Broken or disturbed trees or underbrush.
(e) Presence of scavengers.
(f) Drops of oil or fuel.
(g) Decomposition odors.
(h) Signs of human passage or occupancy of an area.
(i) Landslide.

(j) Horsetails (caused by wind blowing loose snow over obstruction such as an aircraft's empennage).
(k) Unexplained break in terrain contour.

5. Interrogation of Individuals:

(a) Questioning individuals who may have seen or heard the target should include:
  (1) Details of time.
  (2) Direction of the target.
  (3) Sound of an engine.
  (4) Other information.

RULE: Attempt to have individuals volunteer information. Evaluate leads as to relative merit. When information gathered does not ring true, ask verification questions.

(b) Leads requiring ground interrogation or investigation may originate form:
  (1) Individuals in the area who may have heard or seen flashes, explosions, etc.
  (2) Objects reported by search aircraft.

FIGURE 9–7a

Land SRU Briefing

1. Type, serial number, and color or distinctive marking of missing aircraft.
2. Number of personnel aboard the aircraft.
3. Probable number and condition of survivors.
4. Expected terrain and weather to be encountered.
5. Suggested ground search pattern and technique of preparation.
6. Other agencies involved in mission or requiring contact.
7. Probable air coverage.
8. Communications schedule and/or frequencies.
9. Primary and alternate method of communication.
10. Proposed resupply schedule.
11. Probable method of survivor evacuation—team recovery.
12. Other pertinent information.

FIGURE 9–7b

Team equipment for use on land rescue missions:

1. Splint sets.
2. Electric lanterns.
3. Picks.
4. Brush hooks.
5. Cooking implements.
6. Mosquito netting.
7. Insect repellent.
8. Survival manual.
9. Halazone tablets.
10. Snakebite kit.
11. Oxygen unit (if procurable).
12. Ambulance and/or radio-equipped vehicle.
13. Searchlight.
14. Machete.
15. Roadmaps and aeronautical sectional charts.
16. Food and water.
17. Cable cutters.

FIGURE 9–7c

Individual equipment for use on land rescue missions:

1. Compass.
2. Signal paulin.
3. Pair of gloves.
4. Signal mirror.
5. Water and rations for 1 day.
6. Extra socks, trousers, and shirts.
7. Insect repellent.
8. Shelter half.
9. Poncho.
10. Flashlight.
11. Mosquito net.
12. Individual first aid kit.
13. Halazone tablets.
14. Matches and waterproof case.
15. Hunting knife

FIGURE 9–7d

d. Navigator's Postbriefing Check

The navigator of an aircraft search unit should check the aircraft for the following items:

1. Clean windows.
2. Regular binoculars for checking visual sightings.
3. Gyrostabilized binoculars for searching if available.
4. Operable UHF/VHF homers or signal strength meters.
5. Operable INTERCOM for each scanner.
6. Spare Loran set; if available.
7. Air droppable equipment as anticipated to be required.
8. Hot coffee and food. (Either preheated or heatable.)
9. Comfortable seats for all crew and scanners.
10. Identification and immunization cards carried by each crewmember and scanner, in case aircraft is diverted into foreign territory.

902 Dispatch of Search Units

a. General

Operationally ready SAR units with rapid reaction times are mandatory prerequisites for a reliable level of SAR mission successes. SAR-dedicated units, equipment and personnel must be identified, available and ready around the clock. Rapid and reliable dispatching procedures must be established and maintained. Even though a rapid reaction to a distress is required, SAR personnel must be equally concerned with the safety of themselves or others in their effort to effect swift launches. Inadequate preparations or shortcuts cannot be tolerated.

Usually it is apparent which type of SRU is the best suited for a particular mission. Even though that type of SRU is available and is dispatched, the SMC must always consider the advisability of dispatching alternate, backup SAR units. For example, a helicopter recovery of a large number of survivors may be backed up on land by a land party and from the water by a rescue vessel.

During a preplanned search effort, the search crews of aircraft, boat, and land SRU are normally briefed prior to dispatching their unit. However, upon becoming aware of an urgent distress situation, the SMC may select and dispatch appropriate SAR units on a scramble basis. Under these circumstances, search briefings normally follow the SRU dispatch.

b. Dispatching Aircraft SRU

Scramble procedures must be fully coordinated with all controlling agencies; i.e., all vehicle and aircraft movement controlling agencies. Preplanned departure routes must be coordinated with air traffic control agencies, and designated mission briefing frequencies must be used for mission briefing information. Local agreements with established checklists among these various local agencies have proven to be an effective means for insuring the safe, prompt, and efficient dispatch of alert aircraft responding to a SAR mission.

c. Dispatching Vessel SRU

SAR vessels are usually dispatched first and briefed later because of their slower response times and en route speeds. During this intial dispatching period, the vessel requires only a limited amount of mission information since it will be either recalling personnel and preparing its main propulsion for underway operations, if in port, or it will be terminating its present operations and be concerned with its own navigation if underway. The essential information required initially would be:

1. Brief statement of emergency phase, type of craft involved, and nature of emergency. (For example, distress Navy P-2 ditched.)

2. A definite destination and mission. (For example, proceed to 30 N. 60 W. and assist/rendezvous/await search assignment.)

3. Brief statement of future plans. (For example, plan CRM search commencing 251200Z.)

The above information will suffice to get the vessel started toward the desired location, which is of primary concern at this time.

903 Search Unit En Route Travel

a. General

All search preparations should be completed prior to arriving in the search area. Lookouts and scanners must be assigned and positioned, and their relief and rotation schedule established. Hot drinks should be distributed, suitable clothing for protection against the elements should be issued, and other efforts made to insure that the lookouts/scanners are as comfortable as possible. Navigational charts must be layed-out and readied, including the plotting of each planned leg of the selected search pattern. Winds and weather must be closely monitored to verify correctness of forecast conditions. Smoke floats, drift signals, sea-dye markers, and similar devices are readied for instant launch from the aircraft in case of a sighting. Droppable supplies, such as the MA-1 kit, are readied for drop if conditions indicate a possibility for their need. Homing, monitor, and on scene communications channels are tuned and guarded. The "information for OSC" is passed to the OSC when establishing communications (approximately 15 to 30 minutes prior to the estimated time of arrival on scene).

b. En Route Searching

En route searching is sometimes employed by the SMC to take advantage of the time normally lost to the overall search effort for the SRUs proceeding between their staging bases and the search area. It is possible at times for the SMC to take advantage of specific routes between launch base and search area. This has the effect of increasing the effectiveness of the same number of SRUs, and can result in a larger total area being searched or in a higher probability of detection Figure 9-8 is an example of the use of en route searching to obtain

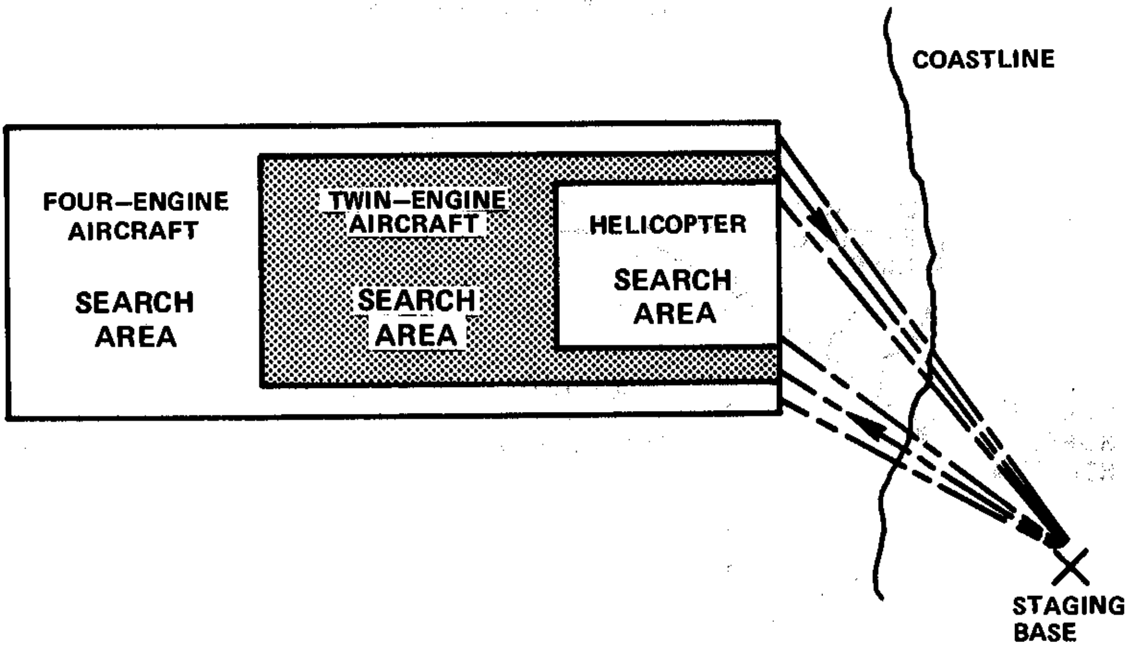


FIGURE 9–8

more effective search coverage from a mix of search aircraft.

c. En Route Bearing Coincidence

En route bearing coincidence procedures have been used successfully to locate distressed aircraft, vessels, and survivors. Direction finding capability may be used to successfully guide a SAR aircraft to a distress position. Use of the bearing coincidence method has the advantage of eliminating or nullifying the inherent errors in radio direction finding bearings and the navigational errors of the searching unit. To use this method, it is necessary for at least one station or craft to have obtained a bearing on the distressed craft. If a shore station obtained the bearing, the search craft first establishes communications with the station. The station then vectors the SRU to the same bearing as the distressed craft. The SRU attempts to intercept this bearing at a positive distance on one side or the other of the distressed craft. The SRU then turns toward the distressed craft, while the station continually provides vector information. By altering the SRU's heading in such a manner as to maintain bearing coincidence, the SRU is in effect traversing along a track which is equivalent to a line of position passing through the distressed craft's position. (See fig. 9–9.)

If two stations were able to take bearings on the distressed craft the second DF station also takes bearings on the SAR craft. When the bearings taken by both stations on the SAR craft are the same as the last bearings on the distressed craft, coincidence has been achieved and the SAR craft orbits. When only a single DF bearing is available, the search craft adjusts course as necessary to keep the bearings being taken on it by the DF station the same as the last bearing on the distressed craft. The pilot must listen for an increase in volume of the radio signals from the distressed craft as he nears the scene of the transmissions, and use radar and visual search for contact.

d. En Route From Advanced Base

Many times a large-scale search using many light aircraft will be staged from a single airport, and the entire mission will be flown under visual flying conditions. Under these circumstances, the SMC should assign en route altitudes in addition to on scene search altitudes. Many light aircraft will not be equipped with radios, yet there is a simple measure which the SMC may take to increase the safety of flight

En Route Bearing Coincidence

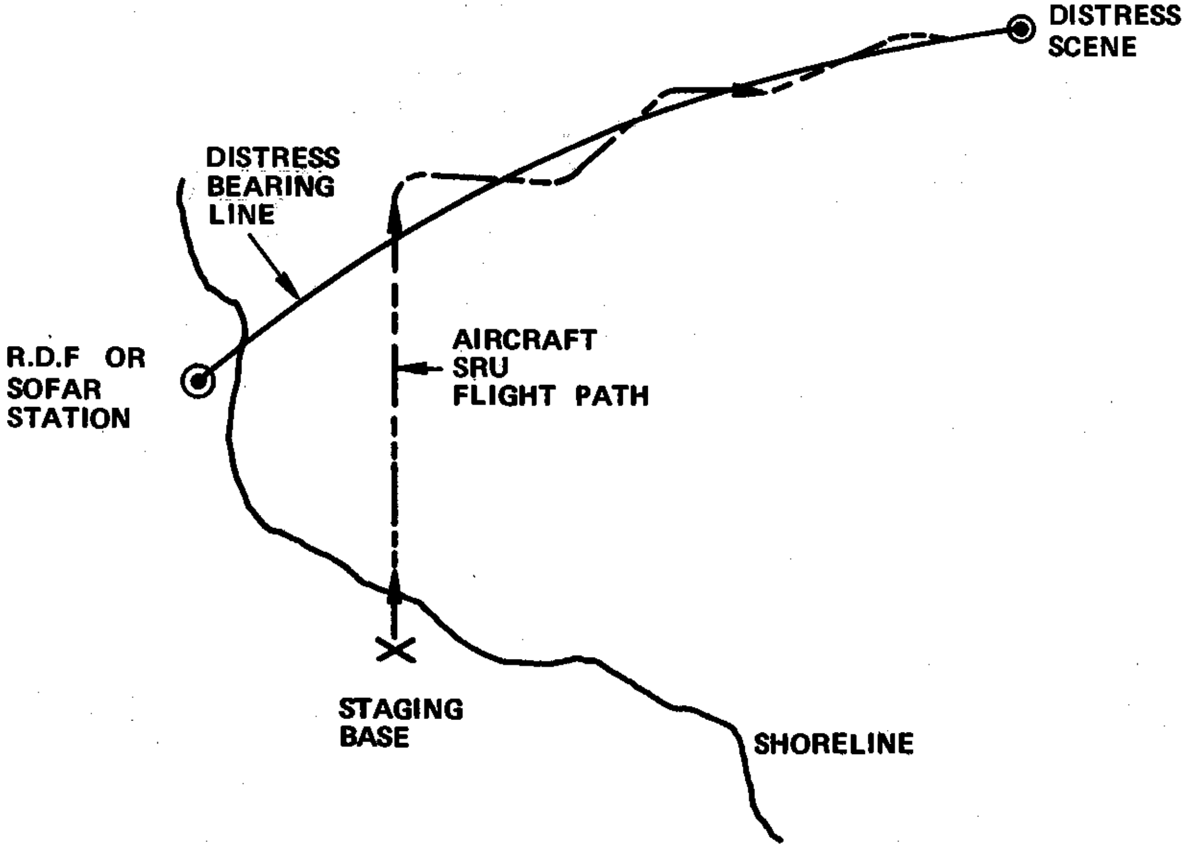


FIGURE 9-9

around the airport. This measure is to assign one altitude for flying from the base toward the search area, and another, high altitude for flying from the search area back to the base. For example, assign a 1,500 feet as the outbound altitude, and 2,000 or 2,500 feet as the inbound altitude. Thus returning aircraft will be approaching the base from a high-vantage point that permits safely observing all traffic prior to descending for landing.

904 On Scene Arrival

a. OSC Initial Briefing

After the OSC obtains the information he requires from arrving search units, he will give his initial briefing. For aircraft this is done during descent; for surface vessels during the interval when the vessel is approaching the commence search point. The OSC's initial briefing includes confirming or providing the following information with every arriving SRU:

1. New developments since latest SAR action message.
2. Search targets.
3. Search area designation.
4. Search pattern.
5. Major axis and direction of creep.
6. Track spacing.
7. Search altitude.
8. Search IFF/SIF Squawk.[1]
9. Search TACAN channel.
10. Traffic advisories.
11. OPS normal reporting times.
12. Latest on scene weather.
13. Vector to commence search point.
14. If aircraft is assigned to coordinated air/surface search.

(a) Correction to track table.

(b) Time and heading on crosslegs.

(c) Inbound and outbound headings on searchlegs.

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[1] See caution par. 423.

b. Without Airspace Reservation

If no airspace reservations are provided, SAR aircraft are responsible for complying with all FAA and ICAO requirements. When IFR conditions exist en route to the search area, each SAR aircraft must file and operate under an ATC-approved instrument flight plan en route to the search area. Upon arriving over its assigned search area, each SAR aircraft must then obtain ATC clearance prior to leaving its en route altitude and descending to its search altitude. SAR aircraft assigned to visual searches must be able to comply with VFR criteria within their search area. If unable to maintain this VFR criteria, SAR aircraft should discontinue search and obtain an ATC-approved instrument flight plan back to its staging base. If however, VFR conditions exist within the search area, the SAR aircraft should complete its assigned search pattern; then obtain ATC clearance before reentering a controlled airspace for return to its base under instrument flight rules.

c. With Airspace Reservation

During large-scale searches, the SMC normally obtains a SAR airspace reservation from the appropriate ARTCC or OACC. Using a SAR airspace reservation will facilitate air traffic safety within the search area. When ATC facilities are unable to provide ATC services to search aircraft within the airspace reservation, the SMC and OSC will normally furnish safety and alerting services, with all aircraft maintaining their own separation under visual flight rules. When IFR conditions exist in the upper portions of the SAR airspace reservation, but VFR conditions exist at the assigned search altitudes, the OSC may provide air traffic control service if qualified personnel are available, or air traffic advisory service if qualified personnel are not available for the descent to search altitude. When IFR conditions exist throughout the SAR airspace reservation, aircraft shall not be assigned to visual search missions.

Due to lack of adequate air traffic control facilities and trained controllers, the control of aircraft in the SAR area must often be advisory rather than directive. Unless the on scene commander has a qualified and experienced air controller available to handle air traffic, technical air safety decisions must be made by the aircraft commander concerned. In certain multi-aircraft situations, in order to avoid giving the responsibility for traffic separation to a surface unit, the SMC should designate an aircraft SRU as OSC for aircraft and assign this responsibility to him. In such situations the airborne OSC will often be directed to cruise at high altitude in order to better control search aircraft and serve as a communications link with the SAR coordinator.

Under IFR conditions within the upper part of the SAR airspace reservation, the following minimum aircraft separation should be used.

1. Horizontal separation between aircraft at the same altitude—15 miles if both aircraft have been positively identified by radar and are in radio contact with each other or the controlling facility; otherwise they must be separated by 30 minutes of flying time; or

2. Vertical separation—1,000 feet, regardless of the horizontal separation. This separation is maintained during the time the aircraft are arriving or departing the search area, since the actual search is intended to be conducted under VFR conditions. The purpose of the OSC's traffic control or traffic advisories may be considered as twofold: first, to safely transition arriving aircraft from IFR en route conditions to VFR search conditions; and second, to safely transfer departing aircraft from VFR search conditions into positive ARTCC or OACC control.

d. Aircraft Altimetry

An aircraft's pressure altimeter is an aneroid barometer grauated in units of height instead of units of pressure. It indicates the height of an aircraft above a reference pressure level which is set in the altimeter. If sea level barometric pressure is set in the altimeter it will indicate the height in feet above sea level.

"Altitude" is used in domestic airspace (Continental United States and offshore to 100 to 150 miles) to assure obstruction clearance and separation of aircraft. Assigned altitude will not provide separation between aircraft unless all adjacent aircraft have the same altimeter setting. Altimeter settings are obtained from ground stations.

"Flight level" is the height of an aircraft in hundreds of feet with its altimeter set at standard atmospheric pressure (29.92 in. hg.). It is used over ocean areas where sea level barometric pressure is not readily available. An altimeter indication of 9,000 feet would be read as flight level 90. Flight levels provide vertical separation of aircraft over oceanic areas since the common altimeter setting of 29.92 is being used.

If a surface SRU is on scene in an ocean area when aircraft SRUs arrive, the surface SRUs can aid the aircraft by providing them with an altimeter setting; i.e., the actual sea level pressure. This will assist them in transitioning from using their pressure altimeter for maintaining flight level en route to maintaining altitude in the search area.

A caution which must be observed is that large bodies of water other than oceans are not always at sea level. For example, the Great Lakes of North America are about 600 feet above mean sea level.

e. Aircraft Holding Procedures

When a SAR vessel with an aeroradio beacon is on scene, arriving aircraft may establish a standard holding pattern on the ship's beacon using their inbound course to orient the holding pattern. Holding is a maneuver which keeps an aircraft within a specific airspace. A holding fix (ship's beacon) is a navigation aid used as a reference point in establishing and maintaining the position of an aircraft. The holding procedure begins as the aircraft passes over the fix. It then executes a 180° standard rate turn to the right, and the pilot adjusts his outbound leg for wind to achieve a 1-minute inbound leg.

f. Aircraft Descent via Ship's Radiobeacon

If instrument conditions exist between en route flight level and search altitude, the pilot of an arriving aircraft may make an instrument descent on the radiobeacon of a surface SRU already on scene (usually that of the OSC). The OSC should inform the pilot about all aircraft already in the area; their position, altitude, and status (holding, searching, etc.). Unless the shipborne OSC has a qualified and proficient air traffic controller on board, the technical air safety decisions regarding the instrument descent should be assigned to the pilot while the OSC provides information of an advisory nature. If the shipborne OSC does have a qualified and proficient air traffic controller on board, then he can provide full air traffic control for arriving aircraft during instrument descents. It will be normal for the aircraft to be under the air traffic control of an ocean air traffic control center during the en route phase of the flight but not after he leaves controlled airspace.

If aircraft arrive one at a time, the procedure is fairly simple. However, if several aircraft arrive at approximately the same time and the OSC cannot exercise positive control, it is imperative that he keep each arriving aircraft advised concerning the others and that the pilots communicate with one another and coordinate their separation. If the aircraft hold on the ship's radiobeacon, none of them will be able to descend safely until those at the lower altitudes have descended and departed for their search areas.

g. Aircraft Descent Procedures via Commence Search Point

Occasionally when several individual search areas are involved and a large total area is being searched, all search aircraft will file for their commence search point or the center point of their assigned search areas instead of the shipborne OSC's position. (The SMC should specify which point to file for.)

Upon arriving on scene, search aircraft should orbit position and contact the OSC for information on other aircraft. If altitudes below are clear, the aircraft should make an orbiting descent to search altitudes, keeping the OSC advised of progress.

h. Aircraft Descent Monitoring

The OSC should use some type of checklist which will visually depict the progress of arriving or departing aircraft as they move up or down in altitude; or in-and-out of their assigned search areas if using the commence search point or center point for climbs and descents.

i. Canceling Air Search

If the visibility in the search area has deteriorated to the point where safety of flight would be endangered, the OSC should direct the arriving aircraft not to descend but to obtain ATC clearance back to base.

j. MARSA and Safety of Flight

MARSA stands for Military Assumes Responsibility for Separation of Aircraft. When the SMC and OSC direct search aircraft to conduct their search at a specific altitude, they must insure that search aircraft do not interfere with one another. The SMC uses search altitudes, commence search points, and direction of creep to provide aircraft separation during VFR searches. See paragraph 862. In addition, the OSC or pilots provide vertical separation during descent and ascent. Participating search aircraft file their flight plans with the phrase "MARSA and safety of flight in search area" noted in the remarks section of their flight plan. The safety of flight is provided by requiring aircraft SRUs to make regular "Operations Normal" reports to the OSC. (See par. 905e).

905 On Scene Search

a. General

After the SRU arrives in its assigned search area, it commences executing its search pattern in accordance with the SMC's search action plan. If the mission has developed so rapidly that the SMC has not had the time to develop or issue a complete search action plan, the OSC and/or the SRU will have to accomplish this. However after the search plan has been decided upon, only the OSC may alter it on scene, and the OSC is responsible for advising the SMC of all changes made to the plan.

Specific search techniques used by various types of SRUs are discussed in later paragraphs. However, there are certain procedures, such as marking datum and reporting on scene weather soon after arrival, which are common to all types of SRUs. Some of these are discussed here.

b. Marking Datum

The first SRU to arrive on scene for a search effort involving an established datum should mark the datum if possible. Over a desert or water area, this may be done by air dropping a fluorescent grenade marker or a smoke/drift signal for a daylight visual mark. At night a strobe light or incandescent light beacon may be used for a visual mark. But the best choice for datum marking is one of the various electronic beacons which have been especially designed for this purpose. These beacons can be freefall airdropped over water, will emit their signal for periods of up to several days, and transmit radio, TACAN, radar, or similar emissions. After a water datum has been marked, the direction and speed of the marker's drift should be closely monitored and reported to the OSC and SMC as soon as it can be determined. The marker's position is then reported at least every 4 hours while SRUs are on scene. (The SMC uses this information to recalculate datum for the search in progress and subsequent searches if required.)

c. SRU Arrival Weather Report

As soon as each arriving SRU is settled down on its first search leg, it should transmit its on-scene weather to the OSC. The OSC then consolidates the various SRU weather reports and transmits this information on to the SMC. The datum upon which the current search areas have been based must always be recalculated after the actual weather on scene becomes known. Even though the forecast winds onscene may have been only 40° different in direction and 10 knots different in speed, this may be sufficient to cause the true datum to be outside of the originally planned first search area. From the search planning viewpoint, the most important weather phenomena are winds, water currents, visibility, and cloud coverage. These must be observed by the SRU as accurately as possible, and included with the other standard items of a weather report (cloud ceilings, temperatures, obscurations, barometric pressures, swell systems, etc.).

d. Estimating Winds and Seas

Surface wind direction can be easily determined if smoke is present. However, do not use smoke signals or smoke grenades in areas covered with fuel or combustible vegetation because of fire hazard. Wind direction may also be estimated by observing wind effects on land surfaces and water surfaces. On water surfaces; wavelets and whitecaps appear to break into the wind; wavelet systems move downwind; windstreaks and foamstreaks aline themselves precisely along the wind direction. On land surfaces; flags, clothes hanging on wash lines, tree limbs, dust, snow, etc., all bend or aline themselves with the surface wind direction. Exposed personnel on the earth's surface can determine the wind direction by facing into the wind and turning the head slightly until the wind sound and wind feel is equal on both cheeks and both ears.

Search aircraft should not assume that the wind aloft at its search altitude will be the same as the surface wind. If the navigator of an aircraft searching at 1,500 feet above the surface in the Northern Hemisphere had determined that the wind affecting his aircraft's track were 020/30, then the surface wind would typically be closer to 000/20. As a general rule, winds aloft at heights of 2,000 feet and above the surface will be alined with the isobars depicted on the weather charts; surface winds will be approximately 20° to 30° off the isobar alinement, pointing toward the lower pressure side. (In the Northern Hemisphere, winds flow clockwise around a high-pressure area and counterclockwise around a low-pressure area.)

Water currents can sometimes be estimated by observing their color, kelp streaks, mud and silt streaks, or by measuring their salinity and temperature. Because of the constant circulation of the world's oceans, cold green arctic water penetrates in places almost to the tropics, while warm blue highly saline tropical water almost reaches arctic latitudes. The major currents are normally well-defined and their boundary lines easily detected by just the color or temperature changes. For example the boundary between the Labrador Current and the Gulf Stream extends for hundreds of miles, is easily seen by the spectacular green/blue color contrast, or easily noted by the abrupt temperature change of as much as 30° F. If a current probe is available to the SRU, accurate surface currents can be obtained.

e. Operations Normal Reports

During the time that the SRUs are engaged in their on scene search efforts, the OSC will normally assume the communications guard for each SRU. Hence there is no need for any SRU to guard any frequencies other than the specified on scene channels and monitor channels. Nor should the OSC assume the needless task of relaying any position reports, operations normal reports, or progress reports between an SRU and its parent agency. This task belongs to the SMC in that he alone is responsible for keeping all parent agencies and other concerned commands abreast of all mission developments.

When arriving search aircraft CHOP to the OSC, he accepts responsibility for providing flight following service. In order to fulfill this safety responsibility, the OSC must establish radio contact with each SRU at least every 30 minutes for multiengine aircraft and every 15 minutes for single engine aircraft. Therefore the OSC will assign each SRU "OPS normal" reporting time-slots. If an SRU is unable to make its OPS normal report direct to the OSC over one of the on scene channels, it should relay through any other search craft.

Position reports are not required from individual search units as long as they are within their assigned search areas.

f. Use of Flares

Flares should be dropped or fired in such a way that the flare, its parts, or any glowing particles will not fall on or near any air or surface craft, particularly tank vessels.

906 Locating/Sighting of Distress

a. General

During many searches, sightings are made only to lose the target while attempting to identify it. This usually occurs when sightings are made by untrained personnel or by a crew which does not have a definite plan to execute when a sighting is made. When such a mishap occurs, valuable time is consumed trying to relocate the object sighted. If the crew cannot relocate the object, they leave the area and resume searching, wondering if they are seeing things or if they might have actually missed locating the search object. Therefore the commander of each search unit must insure that each member of his crew knows exactly what procedure will be followed when checking out a sighting.

b. Sighting Investigation by Single Aircraft

Immediately upon making a sighting, a smoke and illumination signal or sea marker dye should be dropped to mark the approximate location of the sighting. In aircraft which are not equipped with quick jettisonable smoke and illumination signals or sea marker dye, it may be advisable to brief personnel stationed in the area nearest the hatch or door through which the equipment will be jettisoned to have this equipment readily available for jettison on a predetermined signal.

Following the drop of a signal or marker the survivor relocation pattern discussed in paragraph 906j may be used or a descending procedure turn can be made to bring the aircraft back over the sighting area. A procedure turn is effective and will, if properly executed, position the aircraft back over the sighting area in a most efficient manner. This method is also effective if smoke and illumination signals fail to function properly. Do not use smoke and illumination signals if there is a danger of igniting fuel or oil on the water.

The procedure turn most recommended is the "90–270" method. (Fig. 9–10.) From base course, the aircraft makes a standard rate (3° per second) turn to the right. Reversing course after 90° of turn (shift controls after 80°), a turn of 270° to the left is made, rolling out on the reciprocal of base course. Surface units may use the "Williamson Turn" (60°–240°) as they do for a man overboard operation.

Procedure Turn for Investigating Sighting

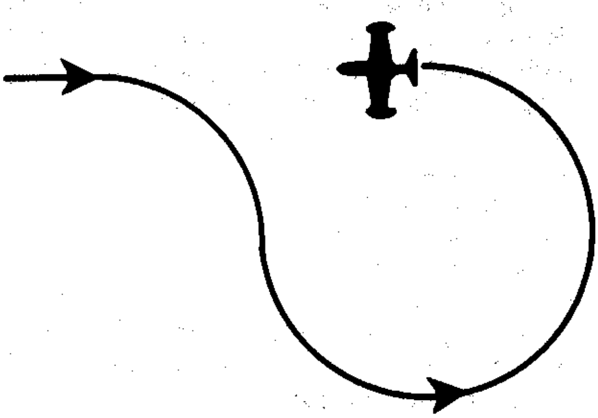


FIGURE 9–10

An alternative method may be more applicable to aircraft not equipped with automatic smoke signal launchers. Immediately upon sighting an object, the observer will call out the clock position and estimated distance (such as "Target—4 o'clock, 500 yards"). The pilot immediately turns the aircraft in the direction of the sighting. The observer will continue to call out the target position and distance to orient the pilot. As the turn progresses, the pilot or copilot will state he has the target in sight. In case of a target spotted on the copilot's side of the aircraft, it is advantageous for the copilot to take over the controls when he "picks up" the target. An exception to this procedure is when the target passes almost underneath the aircraft. In this case, the procedure turn method is best even if pyrotechnics cannot be launched.

c. Sighting Investigation by Multi-aircraft

If several aircraft are engaged in a multi-unit search pattern, and some definite procedure is not used when one aircraft pulls out of formation to investigate a target, the probability of detection may be compromised if the search has to be resumed. In multi-unit searches, the aircraft which do not engage in investigation should execute a holding pattern to retain position for resumption of search. Such pattern should have due regard for flight safety considerations depending on the number of aircraft involved and the spacing of the aircraft. If a coordinated air-surface pattern is in progress when a target is sighted, the ship should be maneuvered in such a manner so that, in the event the target investigated is not the search object, the search may be resumed as close to the breakoff point as possible.

The following detailed procedure has been successfully used during several multi-unit searches. When one SRU reports a sighting to the OSC, that SRU delays breaking formation to investigate. The OSC then makes the following broadcast over all on scene channels simultaneously, "All search units standby to execute investigation holding—(OSC pauses a few seconds)—Execute." The OSC begins timing on his stopwatch; the SRU which made the original sighting report now investigates the sighting independently; while all other non-investigating aircraft commence a 1-minute holding pattern, making their initial turn away from the investigating aircraft; and all other non-investigating boats and vessels will stop engines, coasting to a stop on their last heading. Upon completion of the investigation, the OSC will set a time, at least 3 minutes in the future, for all aircraft to depart their original holding point and resume search where it was suspended. Aircraft would be employing a standard aircraft maneuver which should present no problem in resuming search on time. A slight adjustment may be required to resume the original formation due to wind drift. The vessel which stops engines will continue to advance until dead in the water. Upon restarting engines to resume search, this advance should cancel the loss of advance required during acceleration to the original search speed. (Any vessel which cannot readily stop engines will be required to preestablish a pattern similar to an aircraft holding pattern which will permit recrossing the original search suspension position at the time set by the OSC.)

d. Survivor Sighting Procedures

Over water search craft should keep a smoke and illumination signal or sea-dye marker ready for immediate jettisoning. When any sighting is made, a signal or marker should be dropped immediately. This will serve the dual purpose of providing a reference point from which to resight lost objects, and for providing a search continuation point should the sighting prove to be a false alarm. If survivors are sighted or the distress scene located, observe the following procedures.

1. Keep survivors, or distressed craft, in sight at all times. (Assign a specific lookout to this task.)

2. Mark the position. (Use smoke and illumination signal, sea-dye marker, floating lantern, search datum marker beacon, crash position locater beacon, or any other method of marking available.)

3. If the SRU is an aircraft and circumstances are such that the pilot needs to mark the distress position by radar, he should obtain an identifying IFF/SIF Mode/Code from the appropriate radar control facility. With no communications, and as a last resort, the pilot may switch IFF/SIF to emergency, mode 1-on, mode 2-on, and mode 3-code 7700.

4. Airdrop appropriate, available emergency equipment.

5. Make survivor sighting report to OSC.

6. Direct potential rescue vessels and other aircraft to the scene by all available radio, electronic, and visual signals.

7. Effect rescue if capable.

8. Remain on scene as long as fuel endurance permits, or until relieved by the OSC, whichever occurs first.

9. Inform survivors they have been sighted by any of the following means:

(a) Via emergency radio.

(b) Aircraft fly low over survivors with landing lights on.

(c) Fire two green star shells a few seconds apart.

(d) Aircraft, drop two orange smoke signals a few seconds apart.

(e) Ship, make two distinct puffs of stack smoke, 1 minute apart.

(f) Make two white flashes with signal lamp.

10. Determine the position as accurately as possible using every available navigation aid, net, or system.

11. Vessel plot the estimated range and bearing of each survivor sighted, as well as each rescue boat launched, on the dead reckoning tracer (DRT) if equipped with DRT.

12. Illuminate the scene, if sightings made at night. Vessels may use star shells, mortar flares, or searchlights to illuminate survivors position and aid their recovery at night. Fixed-wing aircraft can drop parachute flares from an altitude as specified for the type of parachute flare being used.

13. If a second aircraft is on scene, the first aircraft should maintain visual contact with the survivors while the second aircraft climbs to high altitude, makes the sighting report, and orbits the position so as to be detected by other craft or shore stations using their radar, DF, ECM, or similar capabilities. The second aircraft is then used to attempt contact with and guide passing vessels, boats, and helicopters to the distress scene. This is attempted even though the SRU knows that the SMC may have dispatched other rescue craft. The first available means to recover survivors should always be used.

14. Aircraft photograph wreckage or distress scene from normal search heights and directions, from a low level, and from angles taking in prominent landmarks.

e. Survivor Sighted Report

When survivors are sighted, the OSC should be advised as soon as possible. Include the following items if known:

1. Position. (By latitude and longitude plus a bearing and distance if available.)

2. Survivor identity. (Individual identity and parent activity.)

3. Physical condition of survivors.

4. Wind, weather, and sea conditions.

5. SRU fuel remaining, in hours.

6. Type of emergency equipment being used by survivors.

7. Type of emergency equipment needed by survivors.

8. Type of emergency equipment airdropped by aircraft to survivors.

The above listing should be considered as a minimum listing that the SRU should report to the OSC. Passing this information in one message report will save much time that otherwise would be wasted with a series of questions and answers. Note that the position is desired using two different methods if possible. This provides a backup to insure there is no inaccuracy or error in dispatching rescue units to the survivors' position. Normally the bearing/distance is measured from the OSC's aero beacon, TACAN, radarbeacon, or IFF/SIF equipment.

f. Survivor's Signals Report

If an SRU hears or detects a possible emergency signal or possible survivor transmission on any of the monitor channels or other detection equipment of the SRU, the OSC should be advised as rapidly as possible, including the following items if known.

1. SRU position. (By latitude and longitude plus bearing and distance.)

2. Detailed description of signal or transmission heard.

3. Exact times signal commenced and terminated.

4. DF/ECM bearing of signal from SRU position.

5. Frequency that signal was being transmitted upon.

6. Signal strength.

7. Actions taken by SRU. (Homing in or continuing search pattern.)

8. SRU evaluation of signal.

g. Vessel Debris Sighted Report

If an SRU sights empty lifeboats, liferafts, debris, oil slicks, sea-dye marker, flares, smoke, or any unusual object, it should advise the OSC as soon as possible, including the following items:

1. Position. (By latitude and longitude plus a bearing and distance.)

2. Detailed description of sighted object.

3. Concentration of objects, if several sighted.

4. Wind, weather, and sea conditions.

5. SRU evaluation of object.

h. Aircraft Crash Sighted Report

If an SRU sights the scene of an aircraft crash, the OSC shall be advised as soon as possible. The following items should be reported if known.

1. Position. (By latitude and longitude, plus a bearing and distance if available.)

2. Orientation of direction of aircraft impact, scattered wreckage, or parachutes along track.

3. Condition of wreckage. (Signs of fire, explosion, controlled or uncontrolled impact, survivability.)

4. Presence or absence of survivors.

5. If survivors absent, indications of direction in which they may have departed.

6. Presence or absence of ground-to-air signals on terrain.

7. Survivor identity. (Individual identity and parent activity.)

8. Physical condition of survivors, appraisal of required medical aid, and number of casualties.

9. Wind, weather, and sea conditions.

10. SRU fuel remaining, in hours.

11. Type of emergency equipment being used by survivors.

12. Type of emergency equipment needed by survivors.

13. Type of emergency equipment airdropped to survivors.

14. Locations of open stretches of land, lakes, or rivers suitable for use as access routes by aircraft, pararescuemen, boats, vessels, or ground teams.

15. Whether the downed aircraft has any weapons or ordnance on board that might require special handling by qualified explosive handling personnel.

16. Any other actions taken at the scene.

i. Establishing Survivor Contact

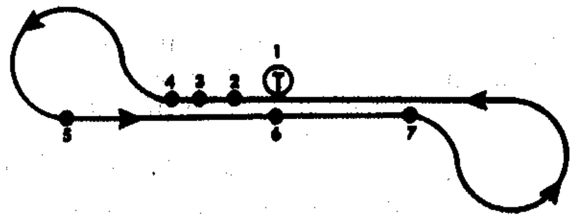
When survivors are located by aircraft SRUs and their immediate rescue is not probable, every effort must be made to establish a communications channel with them. The most suitable method is for the aircraft to airdrop a small, portable radio transceiver to the survivors. Direct two-way voice communications will then be possible between the aircraft and the survivors, and all of the details of the survivor sighted report can be easily obtained. A moderately suitable communication method is to employ the aircraft's loudhailer, public-address system—if so equipped. One-way voice communications are thus possible from the aircraft to the survivors, with the survivor's replies having to be made using one of the surface to air signal codes illustrated in appendix C. The least suitable communication method is for the aircraft to use a message block to airdrop its message to the survivors.

j. Relocating Survivors

The following procedure has proven effective in maintaining contact or relocating survivors in the water. (See fig. 9–11.) The aircraft should be in the basic search configuration, and the lookout briefed to drop a smoke and illumination signal (approx. 15 minutes duration) immediately if any crewmembers reports a sighting. (If signal ejectors are installed, one signal should be released by the pilot.) After release of a signal, the pilot notes and maintains heading, altitude, and airspeed. (Both pilots will note the time.) Fifteen seconds after the first signal is dropped, a second is dropped, and the pilot makes a procedure turn to the right, adjusting the final portions of the turn to roll out on a heading that will allow the aircraft to line up with and fly directly over the two signals. When over the first signal dropped, drop a smoke and illumination signal (approx. 45 minutes duration). This signal should land very close to the target position. If a delay of "X" seconds was involved from sighting until the first 15-minute signal ejection, delay an equal amount after passing back over the signal before ejecting the 45 minute signal. If the target is not resighted at this time, continue heading for 30 seconds and drop another 15 minute signal. Then, make parallel sweeps to the line of markers until the target is located.

If the survivors at sea are visually lost just at dusk, or if survivors have not been located but their position is fairly well established, two float lights should be dropped to outline the limits of the search area, the most probable position of survivors being halfway between the lights. An appropriate flare search pattern can then be executed between the two lights.

Standard Pattern for Relocating Survivors



1. Initial sighting—Drop smoke and illumination signal (15 minutes).
2. Maintain heading, altitude, airspeed for 15 seconds.
3. Drop 15 minute signal.
4. Make procedure turn to the right.
5. Make final turn to fly reciprocal track over markers.
6. When over market No. 1, drop smoke and illumination signal (approx. 45 minutes duration).
7. If target is not resighted, maintain heading for 30 seconds and drop a 15 minute signal. Continue search utilizing the line of markers for reference.

FIGURE 9–11

k. Diverting Vessels to Distress Scene

Navigators of search craft should always plot the position, course, and speed of all vessels sighted during the search in addition to the vessels listed in the AMVER surface picture message provided by the briefing officer. Thus, if survivors are sighted, or the distress scene is located, the nearest surface craft can be quickly determined. Any of the following methods may be utilized to divert a vessel to the distress scene:

1. Transmit a radio message to the vessel, giving position of survivors, and request that the vessel divert to assist. (If unsure of frequency guarded by the vessel, try to contact it on 500 kHz first. If unsuccessful, try 2182 kHz.)

2. Transmit a homing signal on 522 kHz, 410 kHz, 500 kHz, or any other low frequency to permit the vessel to obtain a DF bearing.

3. Request the vessel to transmit a homing signal on 522 kHz, 410 kHz, 2182 kHz, or any other LF/MF/HF frequency to permit aircraft to obtain a DF bearing.

4. Transmit flashing light message to the vessel, giving position of survivors, and request it divert to assist.

5. Airdrop message block to vessel, giving position of survivors, and request it divert to assist.

6. Fire appropriate pyrotechnic flare signal. (See emergency visual signals table in appendix C.)

7. Circle the vessel at least once at low altitude, then fly across the bow of the vessel, and at the same time rocking wings, opening and closing throttles, or changing propeller pitch. Then fly in the direction of the distress scene. Repeat this procedure until the vessel follows, or until it indicates that it is unable to comply by hoisting the international flag "November" (a blue and white checkered flag), or signals the Morse code procedural signal "N" (— •) by signaling lamp.

8. Request that the OSC establish radio contact and divert the vessel.

907 On Scene Relief and Departure

a. General

The SMC is responsible for obtaining, briefing, and dispatching relief SRUs and relief OSCs as required to carry out the search action plan. As the relief SRUs arrive on scene, each one is given his initial briefing by the OSC, and his initial movements are closely monitored by the OSC until the SRU is in his assigned search area. The SRU which is being relieved or has finished his assigned search gives his search results report to the OSC, and his departure movements are closely monitored by the OSC until the SRU is out of both his assigned search area and the SAR airspace reservation.

An OSC relief requires a direct briefing of the relief OSC by the OSC being relieved. An OSC relief involves passing not only that information normally given to each arriving SRU, but it also involves passing information about every SRU which is currently within the total search area or SAR airspace reservation.

One additional point should be made. Every participating SRU should realize—and be prepared for—the possibility that it may be assigned the OSC responsibility without much warning. Occasionally the aircraft or vessel which has been assigned as OSC will experience some form of mechanical or electronic malfunction which will prevent it from effectively carrying out the duties of an OSC. One of tho SRUs already on scene is usually selected to make an immediate relief. Therefore every OSC and primary SRU must be knowledgeable of, and capable of, carrying out the duties of both the OSC and the SRU.

b. Aircraft Departure via Ship's Radiobeacon

When aircraft desire to climb out of the search area airspace via a ship's radiobeacon (usually that of a surface OSC) they should normally be authorized to proceed to the ship's beacon one at a time giving each aircraft sufficient time to climb out and get clearance from the air traffic control center for its return flight. If the ship has a qualified air traffic controller aboard, actual control procedures may be used for the climb out.

c. Aircraft Departure via Assigned Search Area

Sometimes when several individual search areas are involved, aircraft are authorized to climb out of the search area airspace within the lateral boundaries of their assigned search area, obtaining clearance from the air traffic control center for the return flight.

d. Vessel Departure

Search vessel departures are controlled and coordinated by the OSC. Normally surface vessels are cleared to depart the search area from their present position. Occasionally they may be requested to conduct additional en route searching for a specified distance.

e. On Scene Commander Departure

When the designated OSC must depart the scene, without a relief scheduled for him by the SMC, the OSC will have to assign the OSC to that SRU which can best accomplish the OSC duties.

908 Return to Base and Debriefing

After the SRU is released from the search by the OSC, the SRU is under the operational control of his parent agency once again. However, the SAR mission duties of that SRU are not yet ended. The crew must be debriefed by the SMC or his representative in order to insure that no piece of seemingly insignificant information is overlooked (as the mission progresses it may become all-important); the search crew's effectiveness during its search is

Search Craft Debriefing Form

Date ________________. Search craft commander ________________________________.
Craft type and call ________________. Parent activity ________________________________.
Total time of mission ________________. Total time on scene________________________________.
Search area assigned ____.
Area actually searched ____.
Areas re-searched ____.
Was track spacing offset: (yes) (no). Was creep reoriented: (yes) (no).
Search altitude used ______ feet. Track spacing used ______ miles.
On-scene weather: Ceiling ______ feet. Visibility ______ miles.
Wind ________________. Sea ________________. Turbulence ________________.
Sweep width used ________________________ for a search target of ________________.
Coverage factor:
    Visual search for a target of ________________________ was ________________.
    Radar search for a target of ________________________ was ________________.
    Electronic search for a target of ________________________ was ________________.
    Sonar search for a target of ________________________ was ________________.
Sightings (posit/description/evaluation): ____
____
____.
Signals on monitor channels (posit/description/times/bearing/eval): ________________________
____.
Aircraft equipment expended ____.
Primary navigation method used ____.
Lookout organization:
    Number of lookouts ________________. Rotated: (yes) (no). How often ________________.
    Relief period: (yes) (no). How long ________________________. Air/sea sick. (yes) (no)
    Sunglasses (yes) (no). Binoculars: (yes) (no). Windows opened: (yes) (no)
Search craft commander's comments on adequacy of the following areas:

Own search craft equipment:
    Communications ________________________.
    Radar ________________________.
    IFF/SIF ________________________.
    TACAN ________________________.
    Loran ________________________.
    ADF/MDF ________________________.
    Doppler ________________________.

On scene commander's equipment:
    Communications ________________________.
    Radar ________________________.
    IFF/SIF ________________________.
    TACAN ________________________.
    Aerobeacon________________________.
    ADF/MDF ________________________.

On scene commander's performance:
    SAR knowledge ____.
    Initial briefing ____.
    Arrival and departure procedures ____.
    Handling of aircraft ____.
    Weaknesses noted ____.
Search briefing officer's performance:
    SAR knowledge ____.
    Complete briefing folders prepared ____.
    Thoroughness of briefing ____.
    Was preplanned search practicable ____.
    Weaknesses noted ____.
Search craft commander's recommendations: ____
____.
Debriefing officer's recommendations: ____
____
____

FIGURE 9–12

given an honest evaluation; and to provide a feedback evaluation of the effectiveness of the OSC's performance, and the search briefing officer's performance. Usually a searchcraft debriefing form, similar to figure 9–12, is included in each SRU's briefing pamphlet. This practice permits the returning search crew to provide the best information while everything is still fresh in their minds, as well as reducing the time devoted to debriefing after returning to their base.

The proper debriefing of search crews is as important as the briefing. A careful interrogation and evaluation of probability by the debriefing activity and search crew is necessary; crews inexperienced in search and rescue often grossly overestimate the effectiveness of search and the resultant probability. Areas covered during search are recorded on overlays on the master plot in the rescue coordination center, together with probability, date, name of search unit, and other notations, as appropriate. The use of written debriefing forms will help insure that all information is obtained and a record is available.

909 Terminating the Search

If, at the completion of the planned search effort, contact has not been made, the planner must decide if further search is justified. It is quite possible that adverse weather may have reduced the probability of detection of an unacceptable level. In such a case, the area must be given an additional search or searches until the probability has been raised to the planned level.

Once probability has reached the point at which the planner can, with reasonable confidence, feel that the target could not have gone undetected in the area, consideration must be given to whether or not further effort is called for. This often becomes a subjective matter involving humanitarian and other considerations and must be determined on the merits of each case. While no one wishes to close a case with people missing, there is a limit to the length of time and effort that can be devoted to each search. It should also be realized that in some cases, no one survives the distress incident.

When terminating an operation, either because survivors have been found and rescued or because a determination is made that further search would not be justified, the SMC shall notify the operating agency of the distressed craft and all participating agencies and facilities of the termination and the reason therefore.

910 Scanning Techniques

a. General

In the vast majority of search missions, all of the efforts expended by the SMC, OSC, and SRU crews are directed toward one critical purpose: to place many lookouts and scanners efficiently throughout the search area. In a very real sense, the participating aircraft, vessels, and boats may be considered as nothing more than convenient platforms for the scanners to ride upon while looking for the distressed craft or survivors. Not until the scanner has successfully completed his task will the SAR System be able to focus its capabilities toward the saying of life, alleviation of suffering, or protection of property. The scanner is the essential cog in the entire SAR System machinery. Therefore every SRU crewmember should be thoroughly knowledgeable in scanning techniques.

911 Scanner/Lookout Effectiveness

The effectiveness of lookouts and scanners depends upon their number, their state of training, the suitability of lookout positions, speed of craft, duration of the search, fatigue, and incentive.

The greater the number of lookouts, the greater will be the probability of detection. Care must be taken not to place all available crewmembers on lookout stations at one time on long flights, for fatigue will soon nullify the advantage gained from increased numbers. Use of the maximum number of lookouts is desired, but some personnel should be retained as reliefs when possible.

The state of training of the lookouts is an important factor in their efficiency. Tests have shown that a trained lookout is less subject to fatigue. Familiarity with the appearance of a visual target influences the chance of detection. If a lookout has never seen a raft on the water from an altitude of 800 feet or has never seen a man in the water supported by a lifebelt, he is at a disadvantage in searching. Practice is an important factor.

The suitability of lookout positions affects the lookout's efficiency. The glass or plastic windows through which a lookout views the surface should be clean and free from scratches. Efforts to see through a dirty, scratched window brings frustration, annoyance, and early fatigue. A slight film of oil or dirt may cause the loss of 50 percent of the light passing through a plastic window. Lights inside the aircraft should be kept very dim, as they produce annoying reflections in the windows. If an attempt is made to look through a windshield which is illuminated by reflected light, the probability of seeing anything is very remote. Aircraft flying very low tend to pick up salt on the windshields from the wind-driven spray; seaplanes will have salt spray on the windshields accumulated during takeoff. Preflight cleaning will help keep the view clear. They should be used to clean the windshield when passing through showers, or windshield anti-icer alcohol may be used. Whenever possible, side windows should be opened during flight for better visibility. Lookout positions should be as comfortable as possible, and seats should be provided.

On the average, the best lookout positions are occupied by the pilot, copilot, and bow lookout. If no bow station is available, the burden of lookout is placed on the pilots. This is an unsatisfactory situation as one of the pilots is flying the aircraft and his eyes are in the cockpit much of the time. As a result, many blank spots are left. If only for this reason, the aircraft should be flown on automatic pilot allowing the pilots to concentrate more on scanning outside. Even with the aircraft on automatic pilot, some concentration inside is required of the pilot flying the aircraft. The scanners should be directed to favor the side of the pilot doing the flying.

The speed of the aircraft affects the efficiency of the scanners by reducing the time in which they can scan a given sector of the surface. In searching, the slower the speed of the aircraft, the greater is the probability of visual detection.

A flight of long duration will always cause scanner fatigue. Fatigue occurs more rapidly under adverse flight conditions with low visibility and turbulence. If conditions are favorable and the scanners are trained, good visual efficiency can be maintained for 2 to 3 hours. After this length of time, it drops rapidly. Changing positions at intervals of 30 minutes to an hour will help postpone fatigue. Shift of position from the port to the starboard side of the aircraft will tend to relieve fatigue from the aftereffects of the movement of the view across the field of vision. If relief is available, lookouts should be relieved at periodic intervals. While frequent rotation of lookouts is desirable, this practice should be carried out with some caution at night. Approximately 30 minutes is required for the eyes to become dark adapted. Personnel should not be rotated directly from lighted parts of the aircraft to lookout positions, if this can be prevented. Even with shifts of position and reliefs, fatigue on long flights is inevitable and can only be postponed. Frequent light snacks and coffee, together with a reasonable amount of intercommunication between observers, tend to reduce fatigue.

Unstabilized binoculars rapidly bring on eye fatigue in aircraft and should be used only to check sightings made by the naked eye. On the steadier and slower platform provided by a surface vessel, binoculars are useful aids and should be used for scanning.

When possible, lookouts should be posted so as to maintain a 360° scan. Survivors may not be able to set off their visual signals until after the SRU has passed them.

Motivation is a highly important factor that will affect the entire performance of a search crew. During the early stages of a search, motivation is high. Only after fatigue sets in and hope of locating survivors fades does maintenance of a high motivation become a problem. Without strong motivation, lookouts merely "go through the motions" of scanning. Motivation starts at briefing, and maintenance of high motivation is the responsibility of the unit commander. Each man of the crew must be made to realize that he is an important member of the team by keeping him informed of what is going on. This will include the purpose of the search, targets to be expected, reason for search of the particular area assigned, developments in the search, etc.

912 Day Scanning

A routine scanning pattern should be used when searching. The eyes should move and pause for each 3° or 4° of lateral and/or vertical distance at a rate which will cover about 10° per second. The aircraft movement causes the field of view to be moved along, making the aforementioned scanning pattern most applicable to the nose and pilot positions in the aircraft. In the waist, eye movement should be away from the aircraft to the effective visibility and then back toward the aircraft to a point as near under the aircraft as can be comfortably seen. A scanner looking for a survivor is performing a task in a manner which is similar to that of a proofreader. The proofreader hunts from top to bottom and from left to right; the lookout scans from left to right and back again or from top to bottom and from bottom to top. A sighting is most likely to occur in an area limited by a 5° radius in all directions from the fixation point at which the eyes are focused. Therefore, the good observer or lookout does not jump his eyes too far between fixations and he pauses only briefly between fixations during daylight search. If the search is being made at night with the expectations of finding light signals or flares, the eyes need not pause so frequently in sweeping the visual field either to right or left or up and down. A good scanner adopts a routine which covers a sector systematically and brings every portion of the sector into view in the central part of their visual field at intervals of a few seconds; i.e., the observer takes a look at the extreme right hand of his sector about every three or four focus points which, if plotted, would represent a series of diagonal lines making the pattern like course saw teeth.

When searching in areas of little or no contrast; i.e., over large expanses of water, desert, or snow, a lookout's eyes have a tendency, after prolonged scanning, to focus short of the surface being searched. The scanner may not realize this when it occurs and as a result could possibly miss the search target. To preclude or remedy this situation, the lookout should periodically focus his eyes on some specific object in the "no contrast" area which may appear, such as whitecaps, trees, debris, etc. A second method is to focus his eyes on a nearby object within the aircraft or an exterior part of the aircraft (wingtip, etc.). It may require only a second to break this "inward" focus and when the eyes are returned to scanning, they will focus properly.

913 Night Scanning

The eyes require about 30 minutes of dark adaption before becoming efficient for any duties which will require their use during low levels of illumination. In most cases during search missions, a period of flight will usually occur before any search activity. This period should be used for dark adaption by insuring that the interior of the aircraft is very dimly lighted, preferably with red light.

Scanning during night time can be accomplished by using any systematic geometrical pattern provided the area is scanned frequently and thoroughly. The pattern used during scanning should be planned to make the best use of off-center vision. Periodically, the lookout should close his eyes for a period of 5 seconds to allow them to rest. When binoculars are used for scanning at night, the principle of off-center vision applies. Binoculars should be held straight forward and the eyes turned off-center toward the perimeter of the field. It will require practice to learn to do this effectively, but the final results obtained will more than justify the effort.

Some people see a lot better in the dark than others. In fact, those of us with the best night vision can see 10 times better at night than those of us with the poorest night vision. With training and practice and some understanding of the basics, however, most people can double their night vision efficiency.

Any discussion of night vision must begin with the rods and cones. At the back of the eye, we have a photosensitive layer called the retina. This is where the optic nerve connecting with the brain terminates in tiny light-sensitive structures called, because of their shapes "rods" and "cones."

In simplified terms, here is how it all works: each individual rod or cone registers an amount of light by means of chemicals which trigger impulses transmitted by the optic nerve to the brain. The brain then puts together an image from thousands of rod and cone reports and we "see."

Cones register movement, detail and color. Rods detect movement, pick up shapes in shades of gray and black and register the light of all colors except deep red. You can test the rods' inability to register color by placing a small brightly colored object where you can just see it out of the corner of your eyes. You will find you can make out its shape but you can't be positive of its color unless you turn your head and bring your cone vision to bear on it.

Cones cannot register any light dimmer than moonlight; rods are sensitive to light 1/100 as bright as starlight. At night you can see runway markers and signal flares in color because their brightness or intensity is above the vision threshold of your cones.

Distribution of rods and cones in the retina accounts for a number of facts of vision. The center of the retina is densely packed with cones but there are no rods in this area. Toward the periphery of the retina cones become less numerous and gradually are replaced by rods entirely. This distribution explains our ability to see color and detail in the daytime when the cones in our central vision can function. It also explains our inability to see an object if we look directly at it at night when the cones are inoperative. (No rods in the center, remember?) At night in order to see an object we must look to one side of it for it to register. This is known as "off-center vision."

Rods register objects at night by contrast, that is whether they are lighter or darker than their surroundings. For this reason at night other aircraft can be seen better if they are above you and silhouetted against the sky. Aircraft flying below over dark land are less visible. Planes passing over white clouds below are more visible.

The sensitivity of rods fluctuates. During prolonged visual search at night rods can become temporarily fatigued for a few seconds to a minute or more. The result—the object you are looking at "disappears" momentarily until the rods regain their sensitivity and you see again.

There are no rods or cones in the area directly over the optic disc where the optic nerve fibers and central retinal blood vessels pass into the eyeball. This creates a blind spot in the field of vision of each eye (see fig. 9–13). This, plus the fact that the eye does not "see" well during movement of an image across the retina, makes systematic scanning necessary. Maximum effectiveness in scanning is achieved by a series of short regularly spaced eye movements (fig. 9–14). Because of the absence of central vision at night, the scanner has to resist the impulse to look directly at an object located by his scan. He must, instead, use his off-center vision. This may require some practice.

Without going into the complicated physiology of the subject, let's briefly consider light adaptation and dark adaptation. Slight changes in the concentrations of the photosensitive chemicals in the rods and cones can greatly alter their sensitivity. Bright light reduces concentrations of photochemicals in both rods and cones. This process is reversible. If you remain in darkness for a long period of time, the photochemicals build up until it takes only a tiny amount of light to excite the visual receptors. This build up is dark adaptation. The cones, however, can

BLIND SPOT SELF–TEST

COVER YOUR RIGHT EYE AND FOCUS YOUR LEFT EYE ON THE CROSS. MOVE THE DIAGRAM TOWARD YOU UNTIL THE DOT DISAPPEARS. TO TRY THIS ON YOUR RIGHT EYE, TURN THE DIAGRAM UPSIDE DOWN.

Figure 9–13

never achieve anything near the sensitivity of the rods to dim light.

Dark adaptation is best performed in total darkness. However, because rods are not sensitive to red light, if you wear light-tight red goggles, you can become dark adapted in a lighted room while you read, talk or attend a briefing. At first your cones adapt much more rapidly than your rods and your sensitivity to light increases tenfold in the first few minutes after you enter darkness or put on red goggles. After a short time the cones stop adapting but the rods continue. At the end of 20 minutes, your rods will have become 6,000 times as sensitive as before and in a 30-minute period, 10,000 times as sensitive.

An important fact to keep in mind is that continuous exposure to intense sunlight for several hours can cause your dark adaptation threshold to rise. This effect is cumulative and takes several hours to wear off. For this reason, if you have a night flight scheduled, it is most important to wear dark glasses when at work or play in brilliant sunlight.

The dark-adapted eye briefly exposed to bright light is only temporarily impaired and can resynthesize its photochemicals in a short period. The extent of impairment depends on the intensity and duration of the light exposure. If possible, avoid looking at the exhausts of other aircraft. Inside your own cockpit, use the lowest lighting possible. You should be so thoroughly familiar with the location of your controls that you don't need a great deal of light.

Dark adaptation is a separate process in each eye. By closing one eye during exposure to light you can protect half your night vision.

The retina of the eye is more sensitive to lack of oxygen than any other part of the body. In addition, blood circulation in the rod area is less efficient than in the center, the cone section. Because of this, hypoxia, smoking, alcohol, and positive G forces all affect night vision.

A minor degree of hypoxia which would not effect your vision in the daytime can diminish it considerably at night. There is a 20 percent loss of night vision at 10,000 feet if oxygen is not used.

SCANNING TECHNIQUE

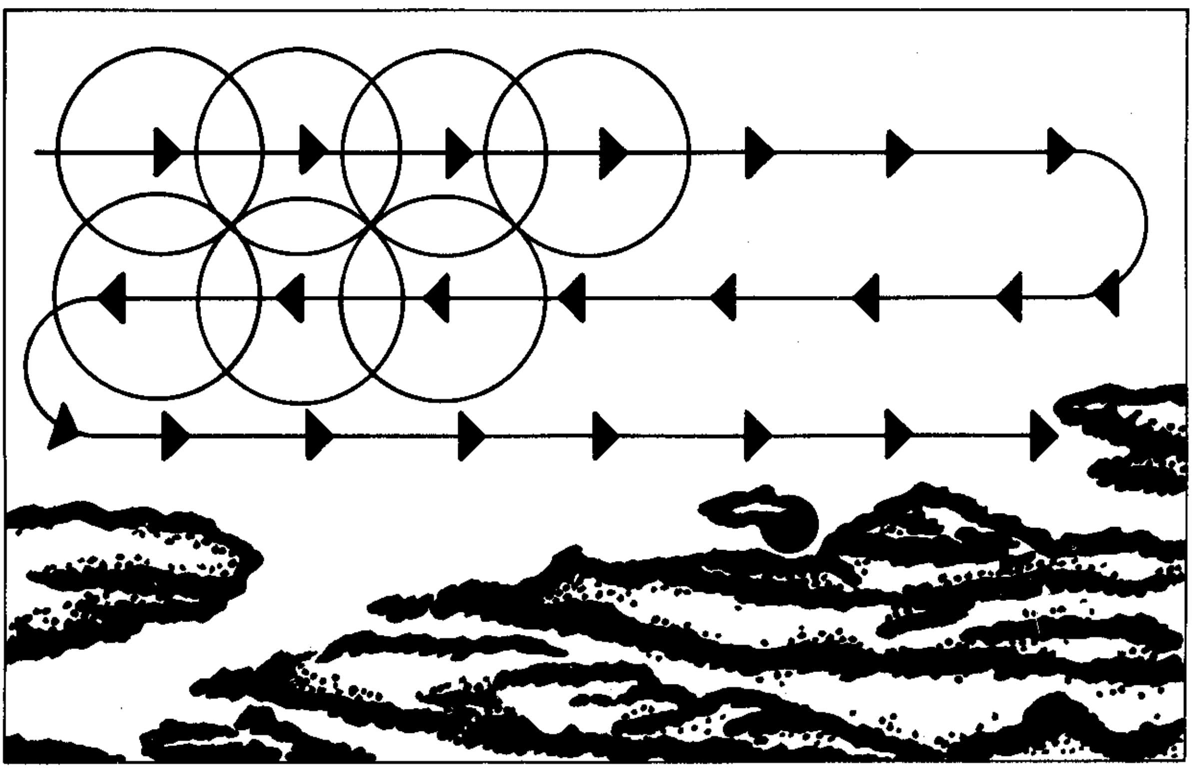


FIGURE 9–14

Smoking reduces the amount of oxygen available to the eyes because blood cells take up carbon monoxide much more readily than oxygen. More carbon monoxide in your blood stream means less oxygen for your rods with resulting diminished night vision. Chain smoking three cigarettes produces a CO blood saturation of 5 percent, the equivalent of raising your physiological altitude to 8,000 feet.

Alcohol produces a similar effect by making the body tissues less receptive to oxygen in the blood. One authority reports that a study has shown that after ingestion of 180 cu. cm. of alcohol the sensitivity of the eye was so impaired that a light had to be doubled in brightness for it to be seen.

Positive G forces cause tunnel vision which is simply the result of loss of peripheral vision. This, too, is a circulatory effect. The heart just can't pump enough oxygen-carrying blood to the eye and brain to maintain business as usual.

No discussion of night vision is complete without mention of autokinesis. Autokinesis is a visual illusion in which a single small stationary point of light, against a uniformly dark background and in the absense of all visual cues, appears to move aimlessly. The effects of autokinesis can be minimized, in night formation for instance, by not looking steadily at any point of light, by having as many other visible objects in view as possible and by being very suspicious of sudden irrational light movements.

Another common illusion at night occurs when an approaching or receding light seems to expand or contract at a fixed distance. Here again, shift your gaze.

Dirt, grease, and scratches on your aircraft canopy or windscreen breakup and refract light and make it more difficult for you to see. Obviously, clean unscarred window surfaces and canopies will help your night vision.

And finally, personal physical fitness improves all systems, night vision included.

920 SEARCH BY AIRCRAFT

Aircraft are generally the best search craft available to a SAR mission coordinator. However several advantages of a search aircraft can be greatly nullified if the aircraft crew is not functioning properly.

Even in the most favorable circumstances a search operation will demand the constant vigilance of a pilot, not only in the handling of the aircraft and the execution of the search pattern, but also in the conduct of the search itself. When adverse weather is the cause, or a contributory cause, of an aircraft accident, the first search operations may have to be flown in marginal weather conditions. It is, therefore, imperative that the pilots used are properly qualified to operate in these conditions with the aircraft used and are fully conversant with the related inflight procedures.

921 Overwater Search

a. Markers for Sightings

Smoke signals or dye markers should be ready for instant release if objects are sighted. If all the aircraft hatches are closed, a delay may result if markers must be dropped by hand. Markers or smoke signals should, therefore, be carried in the flare or smoke float release tubes to permit their being remotely released by the pilot from the cockpit. As these signals sometimes fail, it is advisable to drop two when an object is sighted.

An electronic datum marker buoy should be made ready for dropping at the position of the survivors when sighted, if any possibility exists that visual contact might be lost. Such possibilities include decreasing visibility due to weather or darkness, and departure from the scene for any reason before being relieved by another unit.

An inexpensive but very adequate daylight, visual marker can be fabricated by attaching a lifejacket sea-dye marker to a balsa wood message block.

Caution: in the event that survivors are located in the close vicinity of fuel/oil slicks, non-pyrotechnic marker devices shall be utilized to mark the location to prevent possible ignition of the fuel/oil.

b. Use of Autopilot

During searches, the aircraft should be flown on automatic pilot when possible. This will allow the pilots to maintain a better lookout and keep the aircraft closer to the proper heading.

c. Navigator Duties

The navigator's primary responsibility is to keep the aircraft's track as close as possible to the preplanned search pattern legs. In addition to the arrival duties of determining aircraft drift, wind aloft at search altitude, and compass deviation, the navigator should establish an hourly routine to insure that important navigational duties are not overlooked. The navigator of a SAR aircraft is expected to obtain fixes at least every 5 to 10 minutes to insure that any DR errors will be of negligible concern to the SMC and OSC. If the navigator must accept an unreasonably long time between fixes (say 30 minutes), the OSC and SMC should be informed of this in order to allow for the SRU's DR error when computing the radius of the search area. Whenever doppler navigation equipment is on board and is functioning properly, 20 minute intervals between fixes may be used.

The navigator should plot the positions of all surface vessels sighted in the area, together with their course and speed. When possible, the identification of the vessels should also be entered. If survivors are later sighterd, the location of surface units in the area will be available if their diversion is desired.

Larger radar targets are often detected far outside visual range. If each target is investigated when contact is first made, considerable time may be lost. If a target is detected at a distance from the track of the aircraft, it should be plotted by the navigator. If the plotted position shows that it is considerably closer to the next search leg than the present leg, it should be identified on the next search leg. Small objects should be investigated when contact is first made as the distance is usually short, and they may be difficult to detect again.

Because of the low-search altitudes, and at times, distances involved, electronic navigation aids may be unreliable or nonreceivable during overwater search missions. Under these circumstances and with lack of geographical fixes, the accuracy of search patterns flown is directly proportional to:

1. The accuracy of the pilot's ability to maintain desired heading and airspeed.

2. The accuracy of the navigator's dead reckoning,

3. The ability of the navigator to obtain winds by direct observation of the sea.

d. Crosslegs

Searching with close track spacing requires very accurate and careful navigation. The execution of the crosslegs is especially critical. The distance that an aircraft moves on a crossleg is composed of the distance flown on the straightaway of the crossleg, plus the turning diameter of the aircraft (see fig. 9–15). As a general rule, to take into account the time factor for the turn diameter, all turns are started 15 seconds prior to the computed time for the end of the leg.

The following table gives the approximate no-wind turning diameter of an aircraft at various speeds in a standard rate turn; i.e., 3°/ second. The general formula is

$$\frac{TAS+10}{100}=TD.$$

Speed in knots:	*Diameter of turn in nautical miles*
110	1.2
120	1.3
130	1.4
140	1.5
150	1.6
160	1.7
170	1.8
180	1.9

The Crossleg

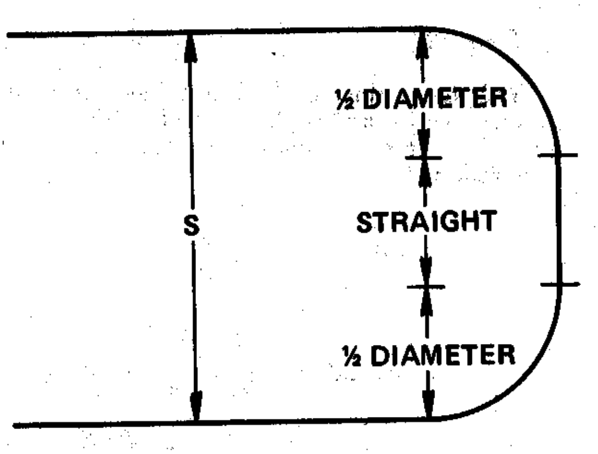


FIGURE 9–15

However, any wind component parallel to the crossleg will exert an influence on the turn. Figure 9–16 depicts time on the straightaway of the crossleg as a function of track spacing and wind component parallel to the crossleg.

The crossleg wind component is that component of wind which is parallel to the straightaway of the crossleg. In figure 9–16 two figures are shown for each value of the wind component and track spacing. The figure to the left of the slant line is the time required to fly the straightaway with a tailwind component. The one to the right is that required with a headwind component. For example, an aircraft is searching east and west legs at TAS of 150 knots with track spacing of 4 miles. The wind is from 060° at 40 knots. The component of wind parallel to the crossleg is thus 20 knots on the nose. Entering the table with 20 knots headwind component and 4-mile track spacing, the time required in the straightaway of the crossleg is 1 minute plus 16 seconds. This value is good for the entire search unless the wind or track spacing changes. To construct a table for speeds other than 150 knots, proceed as follows:

Time to Complete Crossleg at TAS of 150 Knots

Track spacing	Crossleg wind component				
	0	10	20	30	40
2	10	6/15	3/21	0/27	0/35
3	34	28/41	23/48	18/57	14/1–08
4	58	51/1–06	44/1–16	38/1–27	33/1–41
5	1–22	1–13/1–32	1–05/1–44	58/1–57	52/2–14
6	1–46	1–36/1–58	1–26/2–11	1–18/2–27	1–11/2–46
7	2–10	1–58/2–23	1–48/2–39	1–38/2–57	1–30/3–19
8	2–34	2–21/2–49	2–09/3–07	1–58/3–27	1–49/3–52
9	2–58	2–43/3–15	2–30/3–35	2–18/3–57	2–08/4–24
10	3–22	3–06/3–41	2–51/4–02	2–38/4–27	2–27/4–57

FIGURE 9–16

$X+TD=S$, where S is track spacing, X is straightaway of the crossleg and TD is turn diameter of the aircraft. TD is equal to the speed of the aircraft plus 10 knots, divided by 100. For example, at 180 knots, TD is equal to $\frac{180+10}{100}=1.9$ miles.

$$X=S-TD$$

With the value of X determined, the time required to fly a straightaway of value X with a wind component along the straightaway (w) is as follows:

$$\text{Tailwind: } t=\frac{X-\frac{w}{60}}{TAS+w}\ (3600)$$

$$\text{Headwind: } t=\frac{X+\frac{w}{60}}{TAS-w}\ (3600)$$

where t is time in seconds and TAS is true airspeed.

The use of an aeronautical type of navigational computer is an easier and quicker way to solve for aircraft time and headings on all searchlegs and crosslegs, and its use is highly recommended for all computations required for aircraft navigation.

e. Close Track Spacing

When searching for very small targets, or during periods of poor visibility, the track spacing must often be reduced to less than the turn diameter of the available search aircraft. This situation is not uncommon, and the aircraft commander is expected to accomplish his pattern at the specified track spacing without any further special instructions from the SMC or OSC. By simply staggering the searchlegs which are consecutively searched, the aircraft can easily turn from one leg to the next without any necessity for performing such maneuvers as S-turning or procedure turns. Figure 9–17 depicts this general procedure.

922 Mountain Search

a. Mountain Search Techniques

The primary prerequisite for safe and effective operation during mountain search is constant vigilance by the pilots and navigator. The full attention of one pilot should be devoted to evaluating forward terrain for clearance, hazards to flight, such as powerlines, cables, etc., and to flying the aircraft when operating in hazardous areas. Crewmen should be especially watchful for powerlines, cables, etc. which may be suspended across valleys and canyons. The following precautions and procedures should be observed:

1. Deteriorating weather and restricted visibility make contour search very hazardous. Weather conditions should be constantly evaluated and a close watch kept for any change.

2. Search crews should feel an area out for turbulence and downdrafts before desending to search altitude and flying close to a mountainside. Direction of wind and air currents in mountainous areas may vary from point to point.

Close Track Spacing

[Less than aircraft turn diameter]

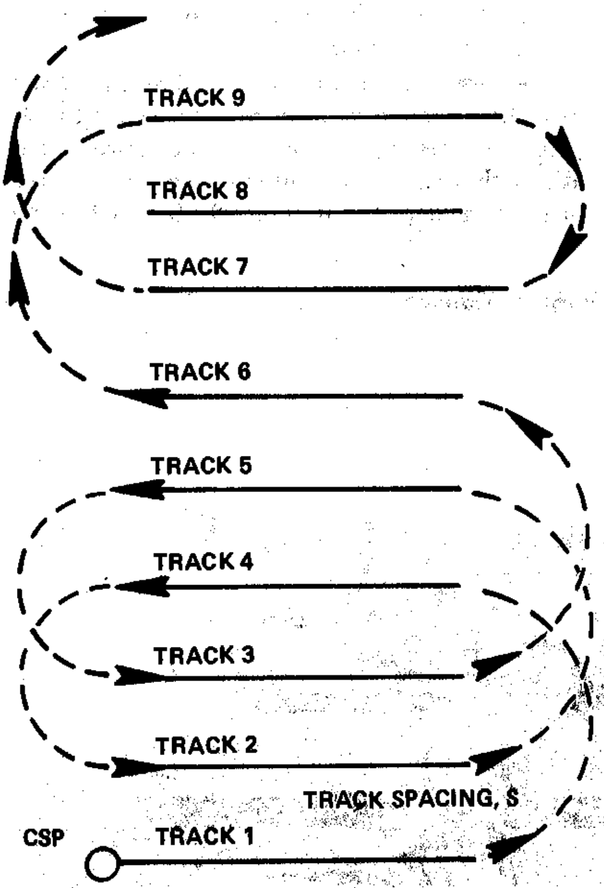


FIGURE 9–17

3. The search should be from top to bottom, never from bottom to top.

4. Extreme caution is required when searching in canyons and valleys. Assure adequate terrain clearance before entering such areas; always maintain an "Out" plan ahead of the aircraft and know which way to turn at all times in the event of an emergency. Special emphasis must be placed upon seeking out any powerlines and other hazards to low-level flight prior to entry into valleys or canyons for search.

5. The terrain elevations or contour lines printed on aeronautical charts should not be relied upon to assure safe terrain clearance. Errors in position, altimeter setting, or chart information (especially in foreign areas) make questionable terrain clearance extremely critical.

6. Crossing mountain peaks and ridges at low altitude under windy or turbulent conditions is very dangerous. The safest crossing can be made by flying downwind where any downdrafts will be met after the terrain is crossed. If this is not practical, altitude should be increased before crossing such areas. Caution must be used by pilots of low-powered aircraft and helicopters because downdrafts may be stronger than the aircraft's climb capability.

7. Search crews should fly close to one side of a canyon or valley so that the entire width may be used if a 180° turn becomes necessary.

8. All loose equipment should be securely fastened/tied down on all mountain searches.

9. Morning searches will often avoid heavy turbulence associated with afternoon heating.

10. Whenever possible, assign mountainous search areas to twin engine aircraft for safety purposes.

b. Helicopter Mountain Search

1. Effects of High Altitude. Engine power available at high altitude is less, and helicopter operations can easily be in a situation of limited hovering ability. High gross weight at altitude increases the susceptibility of the helicopter to blade stall. Conditions that contribute to blade stall are high forward speed, high gross weight, high altitude, low r.p.m., induced "G" loading and turbulence. Shallower turns at slower airspeeds are required to avoid blade stall. A permissible maneuver at sea level must be tempered at a higher altitude. Smooth and timely control application and anticipation of power requirements will do more than anything else to improve high altitude performance.

2. Turbulent Air. Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence: however, if encountered, immediate steps must be taken to avoid continued flight through it to preclude the structural limits of the helicopter being exceeded. Severe turbulence is often found in thunderstorms and helicopter operations should not be conducted in their vicinity. The most frequently encountered type of turbulence is orographic turbulence. It can be dangerous if severe and is normally associated with updrafts and downdrafts. It is created by moving air being lifted by natural or manmade obstructions. It is most prevalent in mountainous regions and is always present in mountains if there is a surface wind. Orographic turbulence is directly proportional to the wind velocity. It is found on the upwind of slopes and ridges near the tops and extending down the downwind slope. It will always be found on the tops of ridges associated with updrafts on the upwind side and downdrafts on the downwind side. Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down; however, there will still be some tendency to follow the slope. In this situation there will probably be severe turbulence several hundred yards downwind of the ridge at a level just below the top. Under certain atmospheric conditions, a cloud may be observed at this point. On more gentle slopes the turbulence will follow down the slope, but will be more severe near the top. Orographic turbulence will be affected by other factors. The intensity will not be as great when climbing a smooth surface as when climbing a rough surface. It will not follow sharp contours as readily as gentle contours.

Manmade obstructions and vegetation will also cause turbulence. Extreme care should be taken when hovering near buildings, hangars, and similar obstructions.

The best method to overfly ridge lines from any direction is to acquire sufficient altitude prior to crossing to avoid leeside downdrafts. When the wind blows across a narrow canyon or gorge as depicted in figure 9–18, it will often

Wind Flow Over Gorge or Canyon

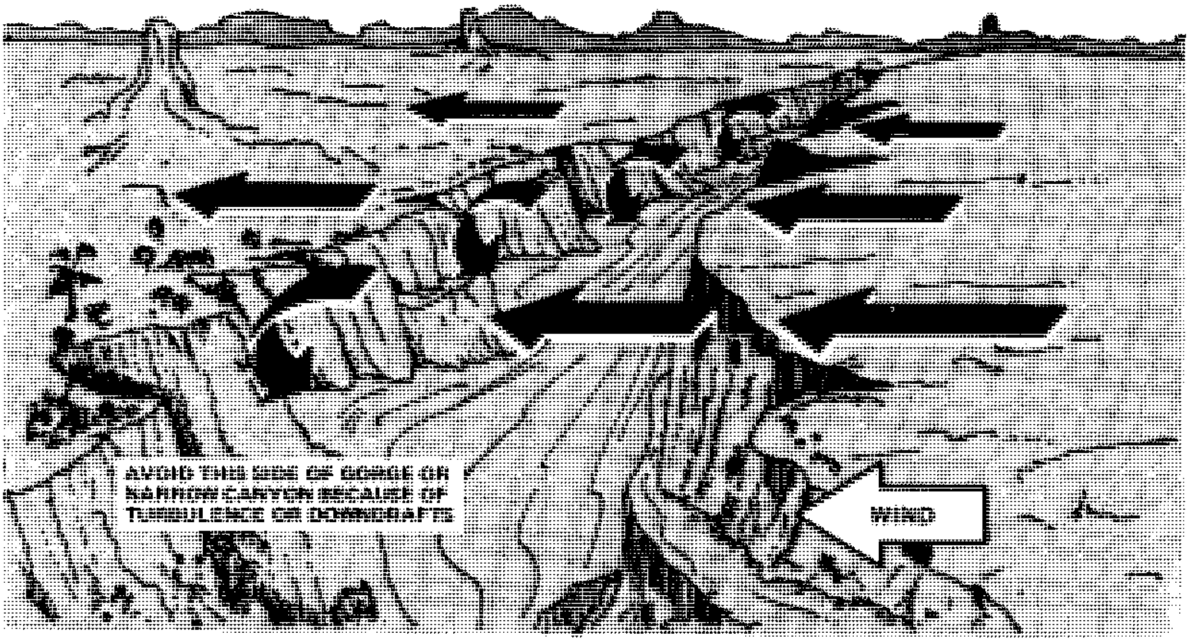


FIGURE 9–18

veer down into the canyon. Turbulence will be found near the middle and downwind side of the canyon or gorge.

When a helicopter is being operated at or near its service ceiling and a downdraft of more than 1.6 feet per second is encountered the helicopter will descend. Although the downdraft does not continue to the ground, a rate of descent may be established of such magnitude that the helicopter will continue descending and crash even though the helicopter is no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass is to fly close aboard that side of the pass or canyon which affords an upslope wind. This procedure not only provides additional lift but also provides a readily available means of exit in case of emergency. Maximum turning space is available and a turn into the wind is also a turn to lower terrain. The often used procedure of flying through the middle of a pass to avoid mountains invites disaster. This is frequently the area of greatest turbulence and in case of emergency, the pilot has little or no opportunity to turn back due to insufficient turning space.

Rising air currents created by surface heating causes convective turbulence. This is most prevalent over bare areas. Convective turbulence is normally found at a relatively low height above the terrain, generally below 2,000 feet. It may, however, under certain conditions, and in certain areas, reach as high as 8,000 feet above the terrain. Attempting to fly over convective turbulence should be carefully considered, depending on the mission assigned. The best method is to fly at the lowest altitude consistent with safety. Attempt to keep your flight path over areas covered with vegetation.

3. Adverse Weather. When flying in and around mountainous terrain under adverse weather conditions, it should be remembered that the possibility of inadvertent entry into clouds is ever present.

Air currents are unpredictable and may cause cloud formations to shift rapidly. Since depth perception is poor with relation to distance from cloud formations and to cloud movement, low-hanging clouds and scud should be given a wide berth at all times. In addition to being well briefed, the pilot should carefully study

Wind Flow in Valley or Canyon

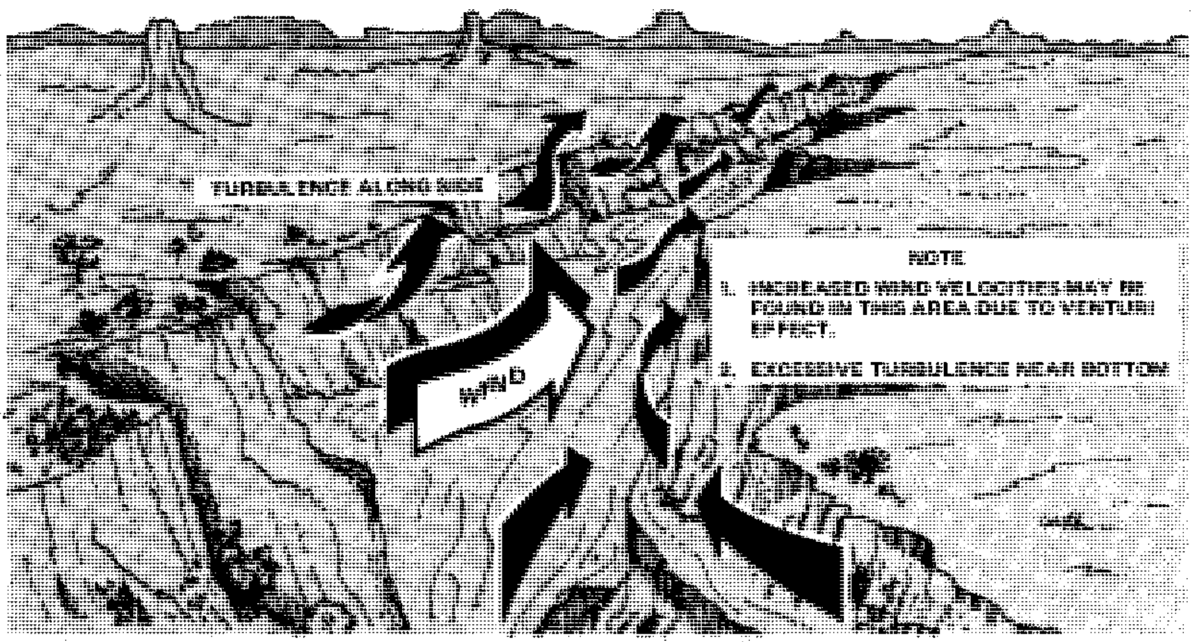


Figure 9–19

the route to be flown. A careful check of the helicopter compass should be maintained in order to fly a true heading if the occasion demands.

4. Summary of Mountain Cautions. The following guidelines are considered to be most important for mountain and rough terrain flying:

(a) Avoid flight in or near thunderstorms.

(b) Give all cloud formations a wide berth.

(c) Fly as smoothly as possible and avoid steep turns.

(d) Cross mountain peaks and ridges high enough to stay out of downdrafts on the leeside of the crest.

(e) Avoid downdrafts prevalent on leeward slopes.

(f) Plan your flight to take advantage of the updrafts on the windward slopes.

(g) Whenever possible, approaches to ridges should be along the ridge rather than perpendicular.

(h) Know your route and brief well for flying in these areas.

923 Locating the Position of an Emergency Position Indicating Radiobeacon/Emergency Locator Transmitter

The initial search for survivors equipped with an emergency position indicating radiobeacon (EPIRB)/emergency locator transmitter (ELT) should be at high altitude to take advantage of the increased range afforded by altitude, particularly for the VHF/UHF type. The receiver should be tuned to the frequency of the beacon with squelch off. The frequency should be guarded aurally, and visually if the search aircraft has suitable homing equipment. Initially an appropriate search pattern should be used to sweep the probable area until the distinctive signal is detected. At that time the aircraft detecting the signal should home in on it. If without a homing device or if the signal is too weak to actuate the homing device, the aircraft should execute one of the homing patterns using aural means. When this is done in an aircraft which has a homing device, the pilot should shift to homing procedure when the signal becomes strong enough.

924 Executing Aircraft Intercept

a. General

The concept of aerial interception is based on the capability of SAR aircraft to establish visual/electronic contact with an aircraft in distress, provide maximum inflight assistance, and escort it to a safe landing. In the event that bail-out, ditching, or crash landing is necessary prior to, or subsequent to, actual interception, rescue facilities are immediately available to conduct search and rescue operations without delay.

SAR coordinators may take steps to intercept and escort an aircraft when an alert phase exists and shall take steps to intercept and escort an aircraft when a distress phase exists or when a pilot specifically requests an intercept. Local liaison shall be effected to eliminate unnecessary duplication of escort services.

Under normal circumstances, escort service will be provided to the nearest adequate airport. Should the pilot of the disabled aircraft continue on to his destination after reaching a safe airport, or decide not to divert to the nearest safe airport, the escort plane is not obligated to provide further escort and may return to its home base. Further escort in such cases is discretionary with local commands and the decision usually depends upon the circumstances of the individual case.

The following types of incidents are those most often requiring an intercept. This listing may be used as a guideline in determining the need for an intercept when one has not been requested and/or a distress has not been declared.

1. An aircraft is unable to maintain altitude.
2. An aircraft has suffered structural damage.
3. The pilot's control of an aircraft is impaired.
4. Uncertainty exists as to the position of the aircraft.
5. Uncertainty exists as to whether there is sufficient fuel for an aircraft to reach a safe airport.
6. Less than three-fourths of the installed engines are operating normally (two-thirds in the case of three-engined aircraft). Examples of this are: Two engines out of four are out of order; or one out of four is out of order and another is running rough.

7. An aircraft is still far from a safe airport and is required to operate on three-fourths of the installed engines (two-thirds in the case of three-engined aircraft) and must operate these at excessive power for a long period of time. Uusually 2 hours flight time to reach the airport is used as a criteria in such cases.

8. An aircraft is in such other circumstances that it is threatened by grave and imminent danger.

b. Types of Intercepts

Aerial interception will be accomplished using a direct, offset, or a maximum rescue coverage procedure. Maximum rescue coverage interceptions are modified forms of direct interceptions. The method selected will be determined by the nature of the emergency, track of the distressed aircraft, and relative position of the SAR aircraft.

Assistance from a ground control intercept (GCI) site, an air intercept controller (AIC) or a carrier control intercept (CCI) is recommended when these are available.

c. Direct Intercept

The "direct" or "head on" intercept consists of the SAR aircraft flying out on the distressed aircraft's inbound track. This method is employed whenever the distressed aircraft is inbound to the SAR aircraft's base. A distressed aircraft will not be requested to change its heading for the purpose of conducting a direct intercept unless the aircraft is lost, requires minor changes in heading to correct for navigation error, or the aircraft is in imminent danger and cannot reach safety. The direct intercept problem is solved as follows:

1. The simultaneous positions of both the SAR and distressed aircraft are plotted.

2. The SAR aircraft flies a reciprocal track to that being flown by the distressed aircraft.

3. The distance between the simultaneous position plots is determined and the rate of closure computed (total of both ground speeds).

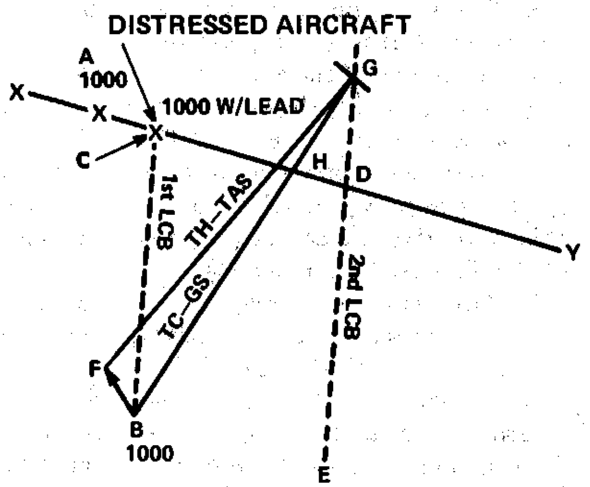
4. Time of interception is then computed by dividing the distance separating the two aircraft by the rate of closure.

d. Offset Intercept (Method 1)

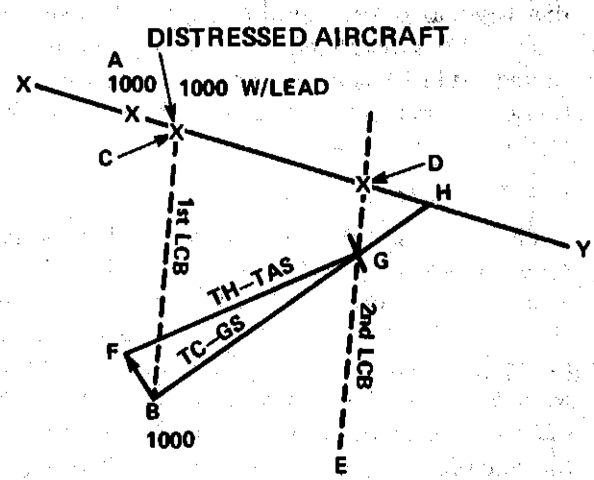
The "offset" intercept consists of intercepting the predetermined track of the distressed aircraft. This method is employed when the distressed aircraft is making good a track to a suitable landing area and the SAR aircraft is off to one side of that track. When the groundspeed of the distressed aircraft is greater than the groundspeed of the SAR aircraft, the SAR aircraft will have to be nearest the point of intended landing to make the offset interception possible. The offset intercept problem is illustrated in figure 9-20 and is solved by the following steps:

1. Plot simultaneous positions of the distressed aircraft (A) and the SAR aircraft (B).

Offset Intercept Problem



OFFSET INTERCEPTION BEFORE ONE HOUR



OFFSET INTERCEPTION AFTER ONE HOUR.

FIGURE 9-20

Add a 10-minute lead to the position of the distressed aircraft to allow for errors (C).

2. Draw a line of constant bearing (LCB) between these positions (BC).

3. Project a parallel LCB (DE) from position of distressed aircraft (with lead) 1 hour ahead on its proposed true course.

4. Draw a wind vector downwind from the original position of the SAR aircraft (BF).

5. Swing an arc equal to the SAR aircraft TAS through the projected LCB using the end of the wind vector as the center or origin. A line drawn between the origin (F) and the point (G) where the TAS arc crosses the projected LCB represents intercept true heading.

6. The point where the TAS arc crosses the projected LCB is also a point on the interception true course of the SAR aircraft. The bearing and distance of a line drawn from the original position of the SAR aircraft to this point (G) represents interception true course and ground speed, respectively. If necessary, extend this line until it crosses the projected true course of the distressed aircraft (H).

7. The distance to intercept the intended track of the distressed aircraft is measured between the original position of the SAR aircraft (B) and the point at which the interception true course crosses the projected true course of the distressed aircraft (H). Compute en route time for this distance and closure time for the lead distance. Add these times to determine total time required for collision point intercept with the distressed aircraft.

8. A turn to reciprocal of the track of the distressed aircraft should be executed when the course of the distressed aircraft has been intercepted. Interception of the course of the distressed aircraft can be confirmed by radio bearings from the distressed aircraft.

e. Offset Intercept (Method 2)

The above procedure will thus end with an approximate 10-minute direct intercept. However, it is not always feasible to allow for the 10 minute leadtime and final turn into a direct intercept situation. In this case, the 10 minute leadtime is disregarded, and greater reliance is placed upon maintaining a line of constant radio bearing to the distressed aircraft. This procedure is illustrated in figure 9–21 and is executed as follows:

1. After bearing to the distressed aircraft has been determined, the SAR aircraft is turned to a heading of 45° from this bearing in the direction the distressed aircraft is flying.

2. A relative bearing of 45° will be maintained by checking VHF or UHF bearings. Check frequently if close together and less frequently at greater distances.

3. If the check reveals that the bearing from the SAR aircraft has increased; e.g., from 235° to 246°, the interception course should be increased twice the amount of change between the last two bearings.

4. If the check reveals that the bearing from the SAR aircraft has decreased; e.g., from 236° to 226°, the interception course should be decreased twice the amount of change between the last two bearings.

5. By bracketing the bearings as described above, an interception course will be determined which will maintain a line of constant bearing as evidenced by frequent checks showing the bearing remaining constant.

Offset Intercept Homing

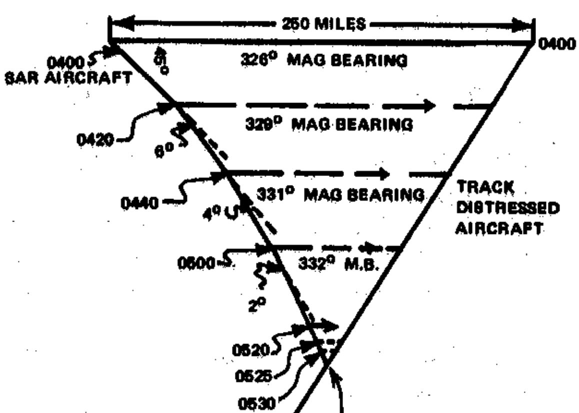


FIGURE 9–21

f. Maximum Rescue Coverage Intercept

The maximum rescue coverage intercept (MRCI) procedure was developed to cope with the problem of intercepting and escorting high-speed distressed aircraft with low-speed SAR aircraft. During emergency situations, "maximum continuous" power may be warranted to maintain escort position and additional aircraft may be dispatched by the RCC to assure that a SAR aircraft is in the immediate vicinity in case of bailout, crashlanding, or ditching. Because higher than normal power settings are not warranted for percautionary-type intercepts and because of the speed differential, it is necessary for the SAR aircraft to turn short of interception point on the distressed aircraft's track and provide maximum rescue coverage over the remaining distance to be flown. This is accomplished by computing a turn-around point for the SAR aircraft ahead of the distressed aircraft and allowing the distressed aircraft to overtake the SAR aircraft. The distance from the turn-around point to the distressed aircraft should be equal to the distance the SAR aircraft is from the distressed aircraft at the time the distressed aircraft lands. During the MRCI, the distressed aircraft should be constantly informed of the type of interception being performed and progress of same.

1. The MRCI should be usde only when all of the following conditions exist:

(a) The distressed aircraft is not in immediate danger of ditching, crashlanding, or bailout, and it is anticipated that this condition will remain until it overtakes the SAR aircraft.

(b) The distressed aircraft will have at least a 50-knot TAS/GS higher than the SAR aircraft.

(c) The time to a collision point interception will be greater than 30 minutes.

(d) A positive position of the distressed aircraft has been determined by means of Loran, IFF, radar. GCI, or visual fix.

2. The MRCI procedure is:

(a) Compute the estimated time of intercept (ETI) for a normal, direct intercept. (ETI is always stated as clocktime, either local or Greenwich time.)

(b) Compute the minutes to turn early before intercept (Z), by using formula or table.

(c) Subtract Z from ETI to obtain the clocktime of the time to turn (TTT).

3. The formulae for MRCI solutions are:

$$Z=\frac{60DV_{a1}(V_b-V_{a2})}{(V_{a1}+V_b)(V_b)(V_{a2}+2V_{a1}+V_b)}$$

and

$$TTT=ETI-Z$$

where:

Z = Minutes to turn early before intercept.

D = Total distance of intercept (distance between SAR aircraft and distressed aircraft at flight altitude).

V_{a1} = Groundspeed of SAR aircraft, outbound to intercept.

V_{a2} = Groundspeed of SAR aircraft, inbound after TTT.

V_b = Groundspeed of distressed aircraft.

TTT = Time to turn for SAR aircraft.

ETI = Estimated time of intercept—if no early turn made by SAR aircraft.

4. When time or other circumstances prevent the use of the Z-formula, the factor table of figure 9–22 may be used. It requires only about 45 seconds of the navigator's time, but its results are less accurate when great distances and speed differential exist. The results are, however, acceptable for most MRCI missions.

g. SAR Aircrew Duties

Maximum capability of interception will be exploited through the use of all interception methods and aids practicable. The SAR aircrew must effect close coordination with the distressed aircraft and assisting air/ground facilities.

1. Pilot. Will normally accomplish all VHF/UHF communications with the distressed aircraft and assisting facilities. Maximum use of automatic pilot is invaluable during this phase.

2. Copilot. Will maintain interphone contact with all crewmembers and coordinate pertinent data between the crew and pilot.

3. Radio Operator. Will keep the pilot, copilot, and navigator informed of all pertinent HF communications. Whenever possible, voice transmissions should be used to expedite procedures and permit the pilots and navigator to monitor the exchange of information.

4. Navigator. Will plot the progress of both aircraft. Every navigational aid will be utilized to determine the navigational accuracy of both aircraft. The accuracy of position reports received from the distressed aircraft should not be taken for granted, but should be carefully evaluated and verified by other checks as soon as possible. The system of navigation being used—Loran, consol, celestial, radar, dead reckoning, etc.—may furnish a clue to the navigational accuracy of the distressed aircraft. The navigator will compute a navigational interception as soon as possible after receiving pertinent data from the RCC. If not completed prior to takeoff, he will give the pilot an initial heading, approximate distance, and estimated time of interception with the distressed aircraft. The navigator will direct the interception until such time that electronic homing procedures establish reliable bearings or position fixes of the distressed aircraft. During this time, he will keep the pilot advised of proper heading and estimated time of interception. He will monitor, or be kept informed of, all positions, bearings, and fixes of the distressed aircraft. All data will be plotted and the navigator will be prepared to complete a navigational/visual interception in the event communications or electronic contact with the distressed aircraft fails.

Maximum Rescue Coverage Intercept Factors

GS distressed aircraft	TAS 150 knots, factors	TAS 175 knots, factors	TAS 210 knots, factors	TAS 290 knots, factors
Knots:				
200	0.010			
300	.013	0.011	0.008	
400	.012	.011	.010	0.005
500	.010	.010	.009	.007
600	.009	.009	.008	.007
700	.007	.007	.007	.007
800	.006	.006	.006	.006
900	.005	.006	.006	.006

Solutions: 1. Find GS of distressed aircraft. 2. Using the GS of distressed aircraft, go to the right and find the factor under appropriate TAS column. 3. Factor multiplied by distance distressed aircraft is from base=minutes to subtract from Estimated Time of Interception (ETI).

FIGURE 9–22

h. Intercept Altitudes

The altitude of the SAR aircraft will be such as to utilize the maximum capability of the primary method of interception being employed—visual or electronic. Except for high-altitude emergencies, the SAR aircraft will be flown at an altitude of 1,000 feet below or above the distressed aircraft as follows:

1. Visual. Normally, the SAR aircraft will be flown at 1,000 feet below the distressed aircraft to silhouette the latter against the sky and achieve maximum sighting distance. However, on clear nights the SAR aircraft may be flown 1,000 feet above the distressed aircraft to eliminate possible confusion between stars and lights of the distressed aircraft. When over land areas where lights from cities could cause confusion, flying 1,000 feet below the distressed aircraft may be desirable.

2. Instrument Conditions. The SAR aircraft will be flown 1,000 feet above the distressed aircraft for best overall utilization of radar and to clear lower altitudes in the event the distressed aircraft is unable to hold its assigned altitude. Where excessive "ground clutter" is encountered and the SAR aircraft is equipped with a radar antenna in the nose, best radar utilization may be obtained by flying 1,000 feet below the distressed aircraft. The latter procedure should be used only when the distressed aircraft is maintaining its assigned altitude. To insure safe vertical separation between aircraft, it is imperative that the altimeter setting of the intercepting aircraft be given to the pilot of the distressed aircraft prior to interception.

i. Intercept Communications

The success of establishing visual/electronic contact with a distressed aircraft and providing maximum in-flight assistance is greatly dependent on the methods and techniques of communications employed by the SAR aircraft. Direct communications will be established with the distressed aircraft as soon as possible. This will be accomplished on the distressed aircraft's HF en route frequency, emergency VHF/UHF frequency, or any other frequency used by the distressed aircraft to alert air/ground facilities. Communications procedures should instill confidence in the distressed crew so that they will know that skilled professional assistance is at hand. SAR crews will achieve this goal by the use of the following techniques:

1. Assume that communications may be lost or that the distressed crew may be forced to bail out, crashland, or ditch at any moment. Coordinate immediate action items first and supplemental items as the mission progresses.

2. Avoid long transmissions and provide pertinent data at periodic intervals to assure the distressed crew that contact is being maintained. Similar to GCA and position reporting, there are specific items to be exchanged during various phases of the interception and escort.

3. All messages, voice or CW, should be clear and concise. Know what to say and use a tone of confidence.

4. Do not burden the distressed crew with unnecessary information or instructions.

5. If direct communications are delayed or fail completely, pertinent data and instructions will be relayed through any air/ground station in contact with both aircraft.

6. In the event all efforts to contact the distressed aircraft fail, pertinent information and instruction, as subsequently outlined in this section, should be transmitted "in the blind" under the assumption that the distressed aircraft is receiving, but not able to acknowledge due to transmitter or atmospheric difficulties.

j. HF Communication Procedures

The high frequency (HF) en route channel used by the distressed aircraft to alert air/ground stations and to request interception will be used as the primary HF frequency. This frequency should be regarded as the "lifeline" to the distressed aircraft and no action will be taken which might break this contact unless absolutely necessary to perform the mission. A secondary HF frequency will be designated shortly after initial contact and the distressed aircraft will be instructed to change to this frequency if contact on the primary is lost for any 10-minute period. If conditions preclude suitable communications on the primary frequency, the distressed aircraft will be instructed to change to the secondary frequency. Changing from primary to a secondary frequency should not be attempted unless absolutely necessary and only after instructions have been acknowledged by the distressed aircraft. The radio operator in the SAR aircraft will attempt to establish contact with the distressed aircraft on HF before takeoff of the SAR aircraft, or as soon as possible thereafter. Upon establishing contact, the following will be accomplished:

1. Give identity and advise that the SAR aircraft is en route for intercept.

2. Instruct the distressed aircraft that the present frequency will be used as the primary frequency and not to break contact.

3. Designate a secondary HF frequency to be used if contact is lost for any 10-minute period.

4. Instruct the distressed aircraft to standby on the emergency VHF/UHF frequency for voice contact, if within normal VHF/UHF frequency for voice contact. If within normal VHF/UHF range and contact cannot be established on the emergency frequency, designate another frequency (normally a common approach control frequency).

5. Instruct the distressed aircraft to turn its IFF/SIF to the emergency mode/code.

6. Notify the SAR pilot and navigator when contact has been established. Transmit supplemental data as appropriate to the situation such as altimeter setting, weather, ETI, minimum safe altitude, signaling with landing lights or pyrotechnics, etc.

7. Provide instructions for distressed aircraft to home on MF signals if appropriate.

8. Change to voice transmission as soon as possible to expedite procedures and to permit the pilot and navigator to monitor the exchange of information.

9. If communications cannot be established or become unreliable, the SAR crew may transmit essential data and instructions "in the blind" under the assumption that transmitter or atmospheric difficulties preclude acknowledgment from the distressed aircraft.

k. VHF/UHF Communication Procedures

1. The emergency VHF/UHF frequencies, 121.5 MHz and 243.0 MHz are most suitable for interception missions. Use of either frequency has the following advantages:

(a) Immediate contact on a clear channel with all aircraft, military or civilian; United States or foreign. These aircraft will have one or the other of these frequencies. Eliminates the confusion and time in asking a distressed aircraft what VHF/UHF frequencies are available on board when it is known which of the two types of frequencies are available.

(b) Simultaneous contact with assisting air/ground facilities on one frequency. These facilities become familiar with SAR procedures and provide valuable assistance during precautionary or emergency interception.

(c) Suitable operation of VHF/UHF direction finding and homing procedures. During VHF homing, the "on course" beam may be wider when using 121.5 MHz; however, an accurate bearing and center of the beam may be determined hy beam bracketing.

2. A common approach control frequency will normally prove suitable for a secondary frequency as those frequencies are available on all aircraft. If using VHF, an approach control frequency in the operating range of 120–140 MHz is more desirable. If contact cannot be established, or if homing signals are not received from the distressed aircraft "in the blind", contact on a secondary VHF/UHF frequency may be arranged through HF communications. Prior to changing to a mutually agreed upon secondary frequency, the distressed aircraft will be instructed to return to the primary for further instructions if contact cannot be established on the seconddry within 30 seconds.

3. The pilot will attempt VHF/UHF contact with the distressed aircraft as soon as possible and accomplish the following:

(a) Give identity and advise that the SAR aircraft is en route for interception.

(b) Instruct the distressed aircraft that the present frequency will be used as the primary frequency and not to change frequency.

(c) Designate a secondary VHF/UHF frequency to be used if contact is lost for any 3-minute period.

(d) Instruct the distressed aircraft to monitor its HF en route frequency for further instructions if all contact is lost on VHF/UHF.

(e) Instruct the distressed aircraft to turn its IFF/SIF to the emergency mode/code.

(f) Notify the radio operator that VHF/UHF contact has been established with the distressed aircraft, to terminate further instructions to the distressed aircraft on HF, and to set up the liaison transmitter for transmitting MF homing signals if needed.

(g) Obtain/verify the distressed aircraft's nature of emergency and intentions of the pilot.

(h) Obtain and evaluate the latest position, time, true course, groundspeed, altitude, and flight conditions of the distressed aircraft.

l. Blind Communication Procedures

If contact cannot be established with the distressed aircraft, accomplish the following on VHF/UHF:

1. Monitor the emergency VHF/UHF frequency for homing signals transmitted by the distressed aircraft "in the blind" (as instructed by the RCC and flight planning documents).

2. If the above proves unsuccessful, issue instructions "in the blind" for the distressed aircraft to change to another frequency (common approach control frequency); advise if no contact within 30 seconds, return to and monitor the emergency VHF/UHF frequency for further instructions.

3. Instruct the distressed aircraft to monitor a suitable HF en route frequency for CW or voice contact.

4. Issue instructions "in the blind" for the distressed aircraft to transmit a continuous 30-second signal automatically every other minute for homing purposes.

5. If the distressed aircraft acknowledges the above instructions by transmission of the requested signals, accomplish VHF/UHF homing procedures and issue pertinent information between signals.

m. Supplemental Intercept Procedures

The pilot of the SAR aircraft must provide appropriate in-flight data to the distressed crew to permit them to devote full attention to the emergency at hand and to increase their confidence. He will also become cognizant of factors that might affect the success of the interception mission. Procedures outlined below should be followed.

1. Advise the distressed aircraft of the closest suitable airport. Provide location, elevation, type, and length of landing surface, landing aids, and any other pertinent data that may be of assistance.

3. Request immediate notification of any appreciable change in flight progress of the distressed aircraft, nature of emergency, intentions, weather conditions, and subsequent positions.

4. Ascertain the navigational aids being used by the distressed aircraft and crosscheck posi-

tions with electronic bearings or fixes as soon as practical. Approximate position may be determined or verified by any outstanding surface objects, landmarks, or conspicuous cloud formations, reported by the distressed aircraft.

5. Provide the correct altimeter setting, minimum safe altitude en route, and weather at destination.

6. Advise the distressed aircraft of estimated time of interception (ETI).

7. Contact available ground radar or DF facilities and obtain position, track, groundspeed, altitude, and interception course to the distressed aircraft, as applicable.

8. Obtain the loran or consol line being flown by the distressed aircraft, if applicable.

n. Close-in Procedures

Many simultaneous actions occur just prior to interception. The SAR crew must recognize the close-in approach of the distressed aircraft to guard against a missed intercept. The following additional procedures should be accomplished when close-in:

1. Monitor IFF interrogator when in range.

2. Initiate radar search 10 minutes prior to intercept. The navigator will notify the pilot when target is obtained giving range, bearing, and course corrections.

3. Five minutes prior to ETI, alert the distressed aircraft. Issue instructions to keep a sharp lookout and report sightings. Advise the distressed aircraft of the SAR aircraft's altitude.

4. Issue instructions for signaling with landing lights, collision lights, or pyrotechnics by either crew.

5. Request longer and more frequent VHF/UHF homing signals from the distressed aircraft to preclude undetected passage.

6. Request the distressed aircraft to advise when their radio compass needle indicates "station passage" on the SAR aircraft's MF homing signal, if one is being transmitted.

The IFF/SIF interrogator is usually the most effective electronic aid employed by the SAR aircraft as it is very dependable and requires little cooperation from the distressed aircraft, once the latter's IFF/SIF transponder has been turned on. Range and approximate bearing can be determined up to 200 nautical miles, providing the distressed aircraft is in front of and within 50° to either side of the SAR aircraft's centerline. In the event the IFF/SIF signal is not received, the SAR aircraft will verify that the IFF/SIF transponder has been turned on (emergency or numbered mode/code, as appropriate) by the distressed aircraft. If a signal is still not received, have distressed aircraft try other modes/codes. Advise appropriate radar control of those used. After a signal is received, the navigator will advise the pilot of range and bearing to the distressed aircraft. If a more accurate bearing or homing is desired, directions will be given to the pilot for turning the aircraft until the signal is centered on the trace line. Range and bearing of the distressed aircraft should be given at periodic intervals to the pilot.

Airborne search radar provides a positive method of interception and escort where restricted visibility (weather, night, etc.) precludes visual sighting. The capability of airborne radar is normally limited to short ranges (15–30 nm.). Radar search for a distressed aircraft should be initiated 10 minutes before ETI. Once the distresed aircraft has been identified on the scope, directions will be given to the pilot by the navigator for interception and escort. Extreme caution must be exercised to insure that the target is the distressed aircraft and not a transient aircraft.

Ground radar is very effective for assistance in intercepting lost aircraft and distressed aircraft without communications. Ground controlled interception of a distressed aircraft flying at 8,000 feet is possible at a range of 130 nautical miles—increase in altitude will increase the range. Whenever possible, radar plots of both aircraft and vectoring instructions should be given direct to the SAR aircraft by the radar controller.

Bearings and position fixes from ground DF stations may be used as a primary aid for interception when other aids are unsuccessful, or may be used to check the navigation accuracy of either aircraft. VHF/UHF DF is limited to line-of-sight operations with altitude the main factor affecting range—average range at 8,000 feet is approximately 110 nm. HF/DF may be utilized up to 1,000 nm.; however, short range operation may be unreliable.

If available, the utilization of Loran or Consol to check the accuracy of the navigation is an important step in performing a successful interception. Occasionally, the distressed aircraft will be flying a Loran or Consol line into base and interception in this instance is a simple operation. Merely by ascertaining the station being used, the SAR aircraft can fly outbound on the same line until interception occurs.

Radiobeacons may be utilized to obtain bearings and determine relative positions and groundspeeds of both aircraft. If the distressed aircraft is in close proximity to a radiobeacon, it can be instructed to fly a bearing inbound to the station and the SAR aircraft can complete the interception at the station or by flying outbound on the appropriate bearing.

o. Lost Aircraft Procedures

1. If the distressed aircraft is completely lost, the difficulty of interception is greatly increased. It is of paramount importance that communications contact be established with the distressed aircraft in order to initiate orientation procedures. Every possible aid must be utilized to locate the approximate position of the lost aircraft, and the entire communications system should be utilized. Normally, radar or direction finding stations will establish a bearing from the station to the lost aircraft and indicate the general direction to fly to accomplish the interception. The following procedures have proven very effective:

(a) The alert SAR aircraft is scrambled and commences attempts to contact the lost aircraft. While attempts are being made to establish communications, the SAR aircraft climbs to the highest practical altitude to try and increase the range of communications.

(b) If the lost aircraft is in contact with the rescue base, or an air/ground station within reasonable distance from the rescue base, the SAR aircraft should orbit at altitude over the appropriate station until the lost aircraft is contacted or until some clue is received which will indicate the general direction or position of the lost aircraft.

(c) If all communications prove unsuccessful, the SAR aircraft may proceed in the most logical direction to the lost aircraft as a last resort.

(d) A backup SAR aircraft is scrambled and directed to proceed on a course 90° to that of the first SAR aircraft. (This aircraft will be used to obtain a second bearing line on the distressed aircraft if communications can be established.)

(e) Instruct the distressed aircraft to maintain radio contact at all costs, orbit at its present position to keep from flying beyond communications range, and maintain highest practical altitude to improve communications.

(f) Ascertain the time of remaining fuel and number of personnel on board the lost aircraft.

(g) Maintain communications with air/ground stations capable of providing bearings, fixes, and any other assistance.

(h) The electronic aid that can provide the quickest and most reliable bearing or fix of the lost aircraft should be employed first. Other aids should be utilized as the mission progresses.

(i) As soon as the first reliable bearing or fix has been established on the lost aircraft, instruct it to leave its orbit position and take up a heading for the SAR aircraft or the closest suitable landing area.

(j) If in voice contact with the lost aircraft and unable to establish a bearing or fix, its approximate position may be determined from any surface objects, landmarks, or peculiar cloud formations that they can identify and report to the SAR aircraft. Landing lights and pyrotechnic flares may be used at night to improve detection capabilities.

2. If the situation demands that the lost aircraft land as soon as possible, and only one SAR aircraft is available, the following procedure may be used to fix the lost aircraft's position prior to vectoring it to a suitable landing field:

(a) With the lost aircraft orbiting a fixed-unknown position, and with the SAR aircraft orbiting a fixed-known position, a bearing is taken (see fig. 9–23).

(b) The SAR aircraft is then flown on a heading perpendicular to the bearing obtained for a period of 5 minutes and a second bearing is taken on the lost aircraft.

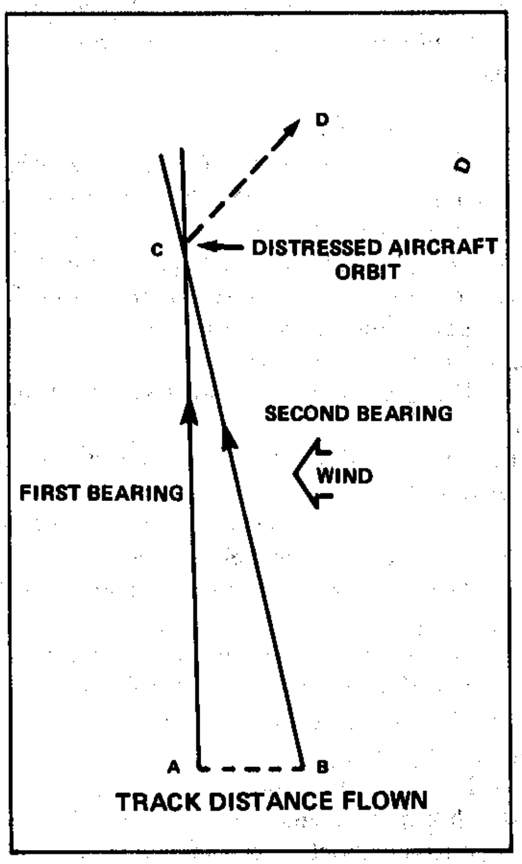
(c) Distance to the lost aircraft may be computed with the formula:

$$\text{Distance} = \frac{\text{TAS} \times \text{minutes flown}}{\text{bearing change}}$$

(d) Plot the bearings from the appropriate known positions of the SAR aircraft.

(e) The point where the two bearings cross is the approximate position of the lost aircraft. The bearing, distance, and ETA of the lost aircraft to the closest suitable airfield is then relayed to the lost aircraft, and the appropriate interception course is utilized to intercept and/or monitor the lost aircraft proceeding to base.

Lost Aircraft Fixing Procedure



A. POSITION OF SAR AIRCRAFT TAKING 1ST BEARING.
B. POSITION OF SAR AIRCRAFT TAKING 2ND BEARING.
C. POSITION OF LOST AIRCRAFT.

A-B TRACK OF SAR AIRCRAFT AND DISTANCE FLOWN.
C-D BEARING TO BASE OF NEAREST SAFE LANDING.

FIGURE 9–28

(f) The procedure previously outlined may be worked in reverse; i.e., SAR aircraft orbiting and taking bearings on the lost aircraft while it flies directed headings. The reverse procedure should not be utilized unless it is impossible for the SAR aircraft to accomplish the normal lost plane fixing procedure.

(g) Prior to vectoring a distressed aircraft in any direction, it is imperative that a reasonably accurate position be obtained and that the altitude of the lost aircraft clear all terrain by a safe margin.

p. Bailout or Ditching Prior to Intercept

When it appears that the distressed aircraft may have to ditch, crashland, or the crew may have to bail out prior to the arrival of the SAR aircraft, the following actions should be taken by the SAR aircraft:

1. Advise the distressed crew to delay bailout, crashlanding, or ditching until absolutely necessary for safety of personnel. This delay will give the SAR crew time to alert air/ground stations and request their assistance. It also precludes a distressed crew from taking emergency actions prematurely based on erroneous analysis concerning fuel reserve, navigation, or degree of emergency. Many times a distressed aircraft has been escorted to a safe landing even though the distressed crew has given up all hope.

2. Employ the electronic aids that will provide the quickest and most reliable bearing or fix on the distressed aircraft. Initiate homing procedures immediately to close the distance between the two aircraft as soon as possible.

3. Alert appropriate air/ground stations and accomplish the following:

(a) Advise of the emergency at hand, intentions, anticipated or actual incident site, and air/air frequency used to maintain contact with the distressed aircraft.

(b) Request continuous bearings and fixes be maintained on the distressed aircraft. Request that aircraft, surface vessels, rescue teams, or other required SAR facilities be dispatched to the incident site and to contact the SAR aircraft for further instructions.

4. Ascertain the number of personnel and and time of fuel remaining on board the distressed aircraft.

5. Provide the location and heading to the best area or the closest facility for bailout, crashlanding, or ditching. If over land, advise of the least hazardous land area for bailout or crashlanding. If over water, recommend bailout or ditching as follows:

(a) Next to an ocean station vessel or any other surface vessel in the area. Ocean station vessel personnel are equipped and trained to assist distressed aircraft and to rescue personnel immediately after ditching. The automated mutual-assistance vessel rescue system (AMVER) may be of assistance in locating the nearest merchant vessel when needed. The RCC should be able to provide such information if available as well as information on possible nearby naval and Coast Guard ships. Ocean station vessels and some of the latter ships can give complete weather information including the length, height, speed, and direction from which waves and swells are moving. They may also provide other assistance in ditching plus illumination at night.

(b) On the lee side of an island or in a lagoon.

(c) Continue on a collision course interecept with the SAR aircraft and bailout or ditch under the visual/electronic guidance of the SAR aircraft.

6. Assist the distressed crew with appropriate advice to continue flight or prepare for emergency action, such as:

(a) Jettisoning of cargo, equipment, and/or fuel.

(b) Use of maximum range power settings to obtain maximum miles per gallon of fuel.

(c) Provide proper altimeter settings, minimum safe altitude, and any other pertinent data.

7. If over water, the SAR pilot should evaluate sea surface conditions and provide the distressed pilot with a recommended ditch heading and advise on ditching techniques if required.

(a) If it is obvious that interception cannot be completed prior to ditching, descend on course and make a low-level observation of sea surface conditions.

(b) If time does not permit a low-level observation of sea surface conditions, make an estimate from the best information available.

8. Instruct the distressed aircraft crew to lock their CW transmitter key in the closed position just prior to bailout, crashlanding, or ditching.

9. Instruct the distressed crew to place their emergency position indicating radiobeacons in operation as soon as possible after abandoning their aircraft to permit homing by the SAR aircraft.

10. Request actual heading, altitude, and notification just prior to bailout, crashlanding, or ditching.

11. Plot the estimated position of the incident site and monitor emergency frequencies for transmissions from the distressed crew's emergency radio devices.

12. Maintain altitude while proceeding to the incident site to increase the receiving range of transmissions from emergency radios. Descend to search altitude just prior to reaching the estimated incident site.

13. If over water, drop sea dye and/or pyrotechnic markers over the estimated position of the incident site to be used as a reference point for search.

q. Intercept Checklist

1. Initial aircrew actions: (a) Aircrew briefing; (b) scramble preflight duties; (c) intercept course, distance, and ETI; (d) turn on all electronic aids; (e) contact appropriate ATC, GCI, etc., for supplemental briefing; and (f) cruise at best power and altitude.

2. Establish communications:

(a) Establish HF contact direct or through relay.

(b) Attempt VHF/UHF contact as soon as possible.

(c) If no contact, monitor emergency VHF/UHF frequency for homing signals.

(d) If still no contact, transmit essential data and instructions "in the blind."

3. Provide initial data and instructions:

(a) Identity and mission of SAR aircraft.

(b) Maintain contact on present frequency—designated primary.

(c) Designate a secondary frequency.

(d) Stand by on emergency VHF/UHF—or HF if initial contact is on VHF/UHF.

4. Obtain/verify essential data: (a) Nature of emergency and intentions; (b) position; (c) time; (d) true course; (e) altitude; (f) groundspeed; and (g) flight conditions.

5. Initiate most expeditious method of electronic DF and homing (employ all other methods as the mission progresses): (a) IFF/SIF; (b) medium frequency; (c) VHF/UHF; (d) GCI, ACW, DEW; (e) loran, consol, radiobeacon; (f) airborne radar, and (g) Gibson Girl—as a last resort.

6. Exchange supplemental data prior to interception, as appropriate:

(a) Advise of closest suitable airfield for precautionary landing—provide location, type and length of landing surface, elevation, landing aids, weather, etc.

(b) Ascertain the number of personnel aboard and the time of remaining fuel.

(c) Request notification of any change in plans of distressed aircraft.

(d) Ascertain the method of navigation and evaluate accuracy of position.

(e) Provide altimeter setting and minimum safe altitude en route.

(f) Keep distressed aircraft advised of distance and ETI.

7. Close-in procedure:

(a) Monitor IFF/SIF interrogator.

(b) Initiate radar search 10 minutes prior to ETI.

(c) Alert SAR and distressed aircraft crews 5 minutes prior to ETI to keep sharp lookout.

(d) Issue instruction for signaling with landing lights, Aldis lamp, or flares.

(e) Request longer and more frequent VHF/UHF homing signals.

(f) Request notification of "station passage" on radio compass of distressed aircraft.

8. Escort procedure:

(a) Take up proper escort position and maintain visual/electronic contact. The best escort position is 1,000 feet above the distressed aircraft and behind. If the distressed aircraft is going to jettison fuel, the escort must move to a position well clear of the dangerous fuel-air mixture which is formed behind the aircraft jettisoning the fuel.

(b) Provide position, heading, and ETA to selected destination.

(c) Notify home base of position and time of intercept—request latest weather, field conditions, and services of crash facilities at selected destination.

(d) Advise distressed aircraft of weather and field conditions at destination.

(e) Obtain instrument letdown clearance and request radar surveillance.

(f) Obtain landing instructions and remain overhead while the distressed aircraft lands.

9. Provide emergency assistance as appropriate:

(a) Delay bailout, crashlanding, or ditching until absolutely necessary.

(b) Provide location and heading to closest facility or best area for bailout, crashlanding, or ditching.

(c) Alert ground stations and request bearings, fixes, and dispatch of assistance.

(d) Advise on jettisoning cargo, equipment, and fuel.

(e) Advise on use of maximum range power settings.

(f) Advise on sea surface conditions—best heading and technique for ditching.

(g) Guide distressed aircraft to VFR area if practicable.

(h) Advise distressed crew to place emergency radio devices in operation as soon as possible after abandoning aircraft.

(i) Drop illuminating flares to assist in bailout, crashlanding, or ditching.

(j) If interception cannot be completed:

(1) Request heading, altitude, and notification just prior to emergency actions.

(2) Advise distressed crew to lock CW key in closed position and then home on signal.

(3) Monitor emergency frequencies for emergency radio transmissions.

(4) If over water, drop sea dye and pyrotechnic markers over estimated position of incident site.

10. If lost aircraft:

(a) Climb to altitude and proceed in best direction to improve communications.

(b) Instruct lost aircraft to orbit until bearing or clue to position is received.

(c) Establish bearing and provide heading to home on SAR aircraft.

(d) If on-course interception is impractical, accomplish lost aircraft fixing procedures and vector to closest suitable airfield for landing.

(e) If all other electronic aids fail or prove unreliable, home on Gibson Girl transmissions from the lost aircraft, if Gibson Girl is so used.

(f) If all electronic aids fail, estimate approximate position from landmarks, surface objects, or peculiar cloud formations in sight of the lost aircraft.

925 Escort of SAR Helicopters

a. General Escorting Procedures

Because of the limited navigational capability of many helicopters, they may be escorted by fixed-wing aircraft whenever directed to a distress scene or search area some distance offshore. In addition, SAR helicopters are normally escorted whenever en route over hazardous, remote, or hostile terrain. Generally the fixed-wing escort will provide navigational assistance, communication relay, and rescue assistance as required.

Visual and communication contact will be maintained at all times. MF, VHF, or UHF homing procedures may be used to aid navigation. In the event weather conditions are encountered en route, which prevent the escort aircraft from maintaining visual contact with the aircraft being escorted that aircraft will be so advised. Based upon fuel remaining, terrain, terminal facilities, terminal weather and mission urgency, a decision will be made on whether or not the helicopter should land and await favorable weather, return to its base or proceed with the mission. The escort will continue to monitor and assist the aircraft being escorted using any effective electronics or communications equipment. Prior to conducting escort, the escorted pilot will be briefed on the type escort pattern to be flown. The escort crew should determine the number of personnel aboard the escorted aircraft and advise what method of rescue would be employed if an emergency arises. The three recommended types of escort patterns for helicopters are the procedure turn, the dogleg, and the racetrack patterns. A minimum vertical separation of at least 200 feet must always be maintained whenever a fixed-wing aircraft passes over a helicopter. Otherwise the downwash and slipstream turbulence from the fixed-wing aircraft may cause the helicopter to go out of control.

b. Procedure Turn Escort Pattern

The escort aircraft will proceed on track in front of the helicopter, not to exceed the visual range of the helicopter. Upon notification from the helicopter, the escort aircraft will make a procedure turn and return to the helicopter's position. Altitude of the escort aircraft will normally be 300 to 500 feet higher than the escorted helicopter. This type of escort is designed to give the maximum in navigation assistance.

c. Dogleg Escort Pattern

This pattern is illustrated in figure 9–24. The escort aircraft normally stacks 300 to 500 feet above and flies legs 45° alternately to the left and right side of the escorted aircraft's flight path. Length of the legs are adjusted to insure that the escort aircraft passes approximately one-half mile behind the escorted aircraft.

d. Racetrack Escort Pattern

This pattern is illustrated in figure 9–25. The escort aircraft normally stacks 300 to 500 feet above and flies a racetrack pattern progressively along the flight path of the escorted aircraft. Size of the pattern flown by the escort aircraft may be adjusted to provide the maximum in rescue coverage.

e. Precautions With Helicopters

Although helicopters can operate at night and in near zero visibility weather conditions, under such circumstances they require more time to maneuver from one spot to another. Radio circuit discipline is essential not only for uninterrupted helicopter pilot-to-crew voice communication during the approach phase, but also to permit homing devices to function and give a steady bearing when homing on a survivor equipped with an emergency position indicating radiobeacon. Fixed-wing aircraft should avoid transmitting to helicopters anytime they are executing a hoist.

Extreme caution should also be exercised when dropping flares when helicopters are in the search area for the following reasons:

1. Descending flare chutes (either lighted or unlighted) are hazardous to helicopter rotors.
2. Flares degrade effectiveness of night visual detection aids (pyrotechnics, strobe lights, and flashlights) and induce vertigo in helicopter pilots during low-visibility weather.

After a survivor has been sighted, flares should be dropped only when requested by the helicopter pilot and then with due regard to the hazards noted above.

930 SEARCH BY MARINE CRAFT

Marine craft are used for searches with aircraft and when aircraft are not available or low ceiling and visibility make aircraft operations impossible. Care should be taken that marine craft, like aircraft, are not used for operations for which they are neither designed nor suited.