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NATIONAL SEARCH AND RESCUE MANUAL VOLUME I: NATIONAL SEARCH AND RESCUE SYSTEM

1 FEBRUARY 1991

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Washington, D. C. 20593-0001

CHAIRMAN, JOINT CHIEFS OF STAFF
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MEMORANDUM FOR: Distribution List

Subject: National Search and Rescue Manual, Vol I: National Search and Rescue System

1. This Manual has been prepared under the direction of the Interagency Committee on Search and Rescue (ICSAR). It describes in detail the national search and rescue (SAR) organization and provides consolidated guidance to U.S. federal forces, military and civilian, with civil SAR responsibilities under the National Search and Rescue Plan for planning, coordinating, conducting or otherwise supporting SAR operations.

2. ICSAR has overall responsibility for this Manual and has assigned coordinating responsibilities for all changes to the U.S. Coast Guard. Recommendations for changes should be forwarded through appropriate channels to Commandant (G-NRS-1), U.S. Coast Guard, Washington, D.C. 20593-0001. Proposed changes will be distributed to all ICSAR member agencies for coordination within their respective agencies.

3. Military Services can obtain additional copies of this Manual through their respective servicing Manual centers.

4. With this transmittal, this Manual, previously promulgated under U.S. Army FM 20-150, U.S Navy NWP-19, and U.S. Air Force AFM 64-2, has been administratively repromulgated within the Joint Publication System. The U.S. Coast Guard directive number (COMDTINST M16120.5 series) remains unchanged due to the interagency nature of this Manual.

5. The National Search and Rescue Manual, Volume I (FM 20-150, NWP-19, AFM 64-2, and COMDTINST M16120.5) of 1 August 1986 is superseded and cancelled. Stocks of old manuals shall be destroyed without report.

6. The major changes to Volume I included in this revision are:

a. Complete rewrite of Chapter 8, Inland SAR Operations

b. Inclusion of information on the Incident Command System, used by some federal, state, and local agencies to manage a SAR mission at the scene.

c. Expansion and update of information on the COSPAS-SARSAT system, and EPIRBs and ELTs.

d. Expansion and update of information on the Global Maritime Distress and Safety System.

e. Update of information and graph on water chill.

f. Expansion and update of FLAR sweep width tables.

g. Expansion and update of tables and associated information on sweep widths for visual distress signals.

h. Expansion of information on recorded radar systems (networks).

i. New organization information reflecting changes in Coast Guard and Air Force organizations.

j. Inclusion of 1986 National SAR Plan (Appendix A).

7. The lead agent for this Manual is the U.S. Coast Guard.

8. The Joint Staff doctrine sponsor for this Manual is the Director, J-7, Joint Staff.

For the U.S. Coast Guard:

/signature/

R.A. APPELBAUM
Rear Admiral, U.S. Coast Guard
Chief, Office of Navigation Safety and Waterway Services

30 October 1990

For the Chairman, Joint Chiefs of Staff:

/signature/

T.R. COBERLY
Colonel, U.S. Army
Secretary, Joint Staff

08 January 1991

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PREFACE

Volume I: National Search and Rescue System

1. PURPOSE. This Manual, prepared under the direction of the Interagency Committee on Search and Rescue (ICSAR), provides guidance to federal agencies concerning implementation of the National Search and Rescue Plan. It was promulgated primarily to establish standards and provide guidance to all federal forces, military and civilian, that support civil search and rescue (SAR) operations.

2. BACKGROUND.

a. The National Search and Rescue Plan, which is promulgated as Appendix A to this Manual, centers on three key concepts. First the plan implements the provisions of several conventions of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). These conventions require establishment of a national civil system with internationally recognized aeronautical and maritime SAR coordination responsibilities. Secondly, the plan includes provisions to satisfy national civil SAR requirements. Finally, since no single U.S. organization has sufficient SAR resources to provide adequate SAR services, the National Search and Rescue Plan establishes the principle that Rescue Coordination Centers (RCCs) should use "all available" resources, to include federal, state, local and private, to respond to cases of persons and property in distress.

b. ICSAR, sponsored by the U.S. Coast Guard, is a federal interagency standing committee chartered to accomplish the following objectives:

(1) Oversee the National Search and Rescue Plan and coordinate development of interagency policies and positions on SAR matters;

(2) Provide an interface with other national agencies involved with emergency services; and

(3) Provide a forum for coordinated development of compatible procedures and equipment to increase the effectiveness and standardization of SAR operations.

ICSAR member agencies include: the Department of Transportation, the Department of Defense, the Department of Commerce, the Federal Emergency Management Agency, the Federal Communications Commission, the National Aeronautics and Space Administration, and the Department of Interior.

c. This Manual serves both as a model for the international SAR manuals promulgated by ICAO and IMO, and incorporates provisions of those manuals. Civil SAR organizations worldwide, as well as state, local and private organizations nationally, often either use this Manual or base their own publications upon it.

3. SCOPE. This Manual was based on accumulated experience, research

and development and advances in search theory. It was designed to serve as both a training and operational tool for civil SAR operations.

a. SAR planning is both an art and a science, relying greatly on the creativity and experience of the personnel involved. Because of the many variables encountered during SAR operations and the individuality of each SAR case, the guidance provided in this Manual must be tempered with sound judgement, having due regard for the individual situation. Nothing in this Manual should be construed as relieving SAR personnel of the need for initiative and sound judgement. Therefore, few actions or procedures discussed in this Manual are mandatory. Use of the words "must" or "shall" only distinguish those actions or procedures normally considered mandatory from those that are discretionary.

b. Joint Pub 3-50.1/COMDTINST M16120.6 (series), National Search and Rescue Manual, Vol II Handbook, complements this Manual. It was intended to serve as a convenient search planning guide for operational units, and particular]y for search planners.

c. Additional SAR policies and procedures unique to a single agency should be promulgated by that agency as a separate addendum, using the following assigned colored coded pages:

Salmon - U.S. Coast Guard	Blue - U.S. Navy
Green - U.S. Air Force	Yellow - U.S. Army
Red - Civil Air Patrol	Pink - U.S. Civil Agency or Administration

Record of Changes

Change No.	Regular or interim	Date of change	By whom entered	Date entered

TABLE OF CONTENTS

Notes: {1} Volumes I and II are published separately. The contents of both volumes are included here for reference.

ABBREVIATIONS/ACRONYMS

A	Search Area
A/C	Aircraft
ACP	Allied Communications Publication
ACV	Air Cushion Vehicle
ADCOM	Air (Aerospace) Defense Command
ADF	Automatic Direction Finding
AECC	Aeromedical Evacuation Control Center
AFB	Air Force Base
AFRCC	Air Force Rescue Coordination Center
AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunications Network
AGIL	Airborne General Illumination Lightself
AIM	Airman's Information Manual
ALERFA	Alert Phase (ICAO)
ALNOT	Alert Notic
AM	Amptitude Modulation
Amc	Midpoint Compromise Search Area
AMVER	Automated Mutual-Assistance Vessel Rescue System
AOPA	Aircraft Owner's and Pilot's Association
ARC	American (National) Red Cross
ARINC	Aeronautical Radio Incorporated
ARS	Air Rescue Service
ARTCC	Air Route Traffic Control Center
ARTSIII	Automated Radar Tracking System
ASCC	Air Standardization Coordinating Committee
ASW	Anti-Submarine Warfare
ASW	Average Surface Winds
At	Total Attainable Search Area
ATC	Air Traffic Control
ATCC	Air Traffic Control Center
ATS	Air Traffic Service
AUTODIN	Automatic Digital Network
AUTOVON	Automatic Voice Network
AWACS	Airborne Warning and Control System
B	Cross-Over Barrier Pattern
BC	Bottom Current
BIAS	Battlefield Illumination Assistance System
C	Coverage Factor
C	Creeping Line pattern
CAP	Civil Air Patrol
CASP	Computer-Aided Search Planning
CASPER	Contact Area Summary Position Report
CCIR	International Radio Consultative Committee
C/C	Cabin Cruiser
CDR	Continuous Data Recording
CES	Coast Earth Station
CF	Drift Error Confidence Factor
CGAS	Coast Guard Air Station
CGAUX	Coast Guard Auxiliary

CHOP	Change Operational Control
CHRIS	Chemical Hazard Response Information System
CIC	Combat Information Center
CIRM	International Radio-Medical Center
Cm	Mean Coverage Factor
Cmc	Midpoint Compromise Coverage Factor
COMCEN	Communications Center

COSPAS	Cosmicheskaya Sistyema Poiska Avariynych Sudov - Space System for Search of Distressed Vessels (USSR Satel. Sys.)
COTP	Captain of the Port
CPA	Closest Point of Approach
CPI	Crash Position Indicator
CPR	Cardiopulmonary Resuscitation
CRS	Coastal Radio Station
CS	Call Sign
CS	Coastal Station
CS	Creeping Line Single-Unit
CSC	Creeping Line Single-Unit Coordinated
CSP	Commence Search Point
CSS	Coordinator Surface Search
CW	Carrier Wave
D	Total Drift
d	Surface Drift
Da	Aerospace Drift
DAN	Diver's Alert Network
DSC	Digital Selective Calling
DD	Navy Destroyer
De	Total Drift Error
de	Individual Drift Error
dea	Aerospace Drift Error
demax	Maximum Drift Error
demin	Minimum Drift Error
deminimax	Minimax Drift Error
DETRESFA	Distress Phase (ICAO)
DF	Direction Finding
DMAHT	Defense Mapping Agency Hydrographic Topographic Center
dmax	Maximum Drift Distance
DMB	Datum Marker Buoy
DME	Distance Measuring Equipment
dmin	Minimum Drift Distance
DMO	Directory Maintenance Official
DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of Interior
DOT	Department of Transportation
dp	Parachute Drift
DR	Dead Reckoning
DRe	Dead Reckoning Error
DRT	Dead Reckoning Tracer
DSC	Digital Selective Calling
DTG	Date-Time Group
E	Total Probable Error
E-ARTS	En Route Automated Radar Tracking System
ECM	Electronic Countermeasures
ELBA	Emergency Location Beacon
ELINT	Electronic Intelligence
ELR	Extra-Long-Range Aircraft

ELT	Emergency Locator Transmitter
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EOD	Explosive Ordnance Disposal
EPIRB	Emergency Position-Indicating Radio Beacon
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETI	Estimated Time of Intercept
EXCOM	Extended Communications Search
F	Flare Patterns
FACSFAC	Fleet Area Control and Surveillance Facility
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FBI	Federal Bureau of Investigation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FF	Navy Fast Frigate
Ff	Fatigue Correction Factor
FGMDSS	Future Global Maritime Distress and Safety System
FIR	Flight Information Region

FIS	Flight Information Service
FIXe	Navigational Fix Error
FLAR	Forward-Looking Airborne Radar
FLIP	Flight Information Publication
FLIR	Forward-Looking Infrared Radar
FM	Flare Multiunit
FM	Frequency Modulation
FNOC	Fleet Numerical Oceanographic Command
FOV	Field of View
FS	Flare Single-Unit
fs	Search Radius Safety Factor
FSS	Flight Service Station
FTS	Federal Telephone Service
Fv	Aircraft Speed Correction Factor
F/V	Fishing Vessel
Fw	Weather Correction Factor
GCI	Ground Control Intercept
GEOREF	Geographic Reference
GMDSS	Global Maritime Distress and Safety System
GS	Ground Speed
gt	Gross Tons
H	Homing Pattern
HEL-H	Heavy Helicopter
HEL-L	Light Helicopter
HEL-M	Medium Helicopter
HF	High Frequency
HFDF	High Frequency Direction-Finding
HQ	Headquarters
HS	Homing Single-Unit
IADB	Inter-American Defense Board
I/B	Inboard
IC	Incident Commander
ICAO	International Civil Aviation Organization
ICS	Incident Command System
ICSAR	Interagency Committee on Search and Rescue
IFF	Identification, Friend or Foe
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IMO	International Maritime Organization
IMOSAR	IMO Search and Rescue Manual
INCERFA	Uncertainty Phase (ICAO)
INMARSAT	International Maritime Satellite
INREQ	Information Request
INS	Inertial Navigation System
INTERCO	International Code of Signals
IP	Initial Position
IRC	International Red Cross
ITU	International Telecommunications Union
JANAP	Joint Army Navy Allied Publication

JASREP	Japanese Vessel Reporting System
JRCC	Joint Rescue Coordination Center
JRSC	Joint Rescue Sub-Center
kHz	Kilohertz
kt	Knot (Nautical Miles Per Hour)
L	Length
l	Search Subarea Length
LARC	Light Amphibious Resupply Cargo
LC	Lake Current
LCB	Line of Constant Bearing
LKP	Last Known Position
LOP	Line of Position
LORAN	Long-Range Aid to Navigation
LRG	Long-Range Aircraft
LUT	Local User Terminal
LW	Leeway

MAC	Military Airlift Command
MARAD	Maritime Administration, USMER vessels tracked by AMVER
MAROP	Marine Operators
MARSA	Military Assumes Responsibility for Separation of Aircraft
MAS	Military Agency for Standardization
MAST	Military Assistance to Safety and Traffic
MCC	Mission Control Center
MCW	Modulated Carrier Wave
M-DARC	Military Direct Access Radar Channel
MEDICO	International word meaning a radio medical situation
MEDEVAC	Medical Evacuation
MERSAR	Merchant Vessel Search and Rescue Manual
MF	Medium Frequency
MHz	Megahertz
MOA	Military Operating Area
MPA	Maritime Patrol Aircraft
MRA	Mountain Rescue Association
MRCI	Maximum Rescue Coverage Intercept
MRU	Mountain Rescue Unit
MSIS	Marine Safety Information System
MSO	Marine Safety Office
M/V	Merchant Vessel
N	Number of SRUs
n	Number of Required Track Spacings
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASAR	National Association for Search and Rescue
NAS Computer	National Airspace System Computer
NATO	North Atlantic Treaty Organization
NAVSAT	Navigation Satellite
NBDP	Narrow Band Direct Printing
NCIC	National Crime Information Center
NM	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NPS	National Park Service
NSM	National SAR Manual
NSP	National Search and Rescue Plan
NTAP	National Track Analysis Program
NTSB	National Transportation Safety Board
NWS	National Weather Service
O	Contour Pattern
O/B	Outboard
OCC	Coast Guard Operations Computer Center
OCMI	Officer in Charge, Marine Inspection
ODIN	Operational Digital Network
OM	Contour Multiunit
OPCEN	Coast Guard Operations Center
OS	Contour Single-Unit
OSC	On Scene Commander

OSE	On Scene Endurance
OSV	Ocean Station Vessel
P	Parallel Pattern
PANS	Procedures for Air Navigation Services
PB	Patrol Boat
Pc	Cumulative Probability of Detection
P/C	Pleasure Craft
Pd	Drift Compensated Parallelogram Pattern
PFD	Personal Flotation Device
PIW	Person in Water
PLB	Personal Locator Beacon
PM	Parallel Track Multiunit

PMC	Parallel Multiunit Circle
PMN	Parallel Track Multiunit Non-Return
PMR	Parallel Track Multiunit Return
POB	Persons on Board
POD	Probability of Detection
POS	Probability of Success
PRECOM	Preliminary Communications Search
PRU	Pararescue Unit
PS	Parallel Track Single-Unit
PSL	Parallel Track Single-Unit Loran
PSS	Parallel Single-Unit Spiral
R	Search Radius
RADF	Radarfind
RAE	Right of Assistance Entry
RATT	Radio Teletype
RB	Short-Range Coastal or River Boat
RC	River Current
RCC	Rescue Coordination Center
RDF	Radio Direction Finder
RNAV	Area Navigation
Ro	Search Radius Rounded to Next Highest Whole Number
RSC	Rescue Sub-Center
RU	Rescue Unit
RV	Long-Range Seagoing Rescue Vessel
S	Square Pattern
S	Track Spacing
SAC	Strategic Air Command
SAR	Search and Rescue
SARMIS	Search and Rescue Management Information System
SARSAT	Search and Rescue Satellite-Aided Tracking
SARTEL	SAR Telephone (Private Hotline)
SATCOM	Satellite Communications
SC	SAR Coordinator
SC	Sea Current
SEAL	Navy Sea-Air-Land Unit
SECRA	Secondary Radar Data Only
SIF	Selective Identification Feature
SITREP	Situation Report
SL	Sea Level
SLAR	Side-Looking Airborne Radar
SM	Searchmaster (Canadian)
SMC	SAR Mission Coordinator
Smc	Midpoint Compromise Track Spacing
SMIO	SAR Mission Information Officer
SOA	Speed of Advance
SOFAR	Sound Fixing and Ranging
SOLAS	Safety of Life at Sea
SPOC	Search and Rescue Points of Contact
SRG	Short-Range Aircraft
SRR	Search and Rescue Region
SRS	Search and Rescue Sector

SRU	Search and Rescue Unit
SS	Submarine
S/S	Steam Ship
SSB	Single Side Band
ST	Strike Team
SU	Search Unit
SUC	Surf Current
SURPIC	Surface Picture
S/V	Sailboat
SVR	Surface Vessel Radar
SWC	Swell/Wave Current
T	Search Time Available
T	Trackline Pattern
TACAN	Tactical Air Navigation
TAS	True Air Speed
TC	Tidal Current
TCA	Time of Closest Approach
TCA	Terminal Control Area
TD	Total Drift
TELEX	Teletype

TFR	Temporary Flight Restriction
TLX	Teletype
TMN	Trackline Multiunit Non-Return
TMR	Trackline Multiunit Return
TPL	Telephone Private Lines
TPX-42(DAIR)	TPX-42 Direct (Altitude and Identity Readout)
TRACON	Terminal Radar Approach Control Facility
TSN	Trackline Single-Unit Non-Return
TSR	Trackline Single-Unit Return
T/V	Tank Vessel
TWC	Total Water Current
TWPL	Teletypewriter Private Lines
TWX	Teletypewriter Exchange
U	Wind Speed
UDT	Underwater Demolition Team
UHF	Ultra-High Frequency
UMIB	Urgent Marine Information Broadcast
USA	United States Army
USAF	United States Air Force
USB	Upper Side Band
USC	United States Code
USCG	United States Coast Guard
USMER	U.S. Merchant Ship Vessel Locator Reporting System
USN	United States Navy
USSR	Union of Soviet Socialist Republics
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator Grid
V	Sector Pattern
V	SRU Ground Speed
v	Velocity of Target Drift
VARVAL	Vessel Arrival Data, List of vessels available to MSOs and COTPs.
VDSD	Visual Distress Signaling Device
VFR	Visual Flight Rules
VHF	Very High Frequency
VLR	Very-Long-Range Aircraft
VOR	Very High Frequency Omnidirectional Range Station
VORTAC	VHF Omnidirectional Range Station/Tactical Air Navigation
VS	Sector Single-Unit
VSR	Sector Single-Unit Radar
W	Sweep Width
w	Search Subarea Width
WC	Wind Current
WHEC	Coast Guard High-Endurance Cutter
WHO	World Health Organization
WMEC	Coast Guard Medium-Endurance Cutter
WMO	World Meteorological Organization
WPB	Coast Guard Patrol Boat
Wu	Uncorrected Sweep Width

X	Initial Position Error
XCVR	Transceiver
XSB	Barrier Single Unit
Y	SRU Error
Z	Effort
Zt	Total Available Effort

CHAPTER 1. SAR SYSTEM AND ORGANIZATION

100 SEARCH AND RESCUE (SAR)

Search and Rescue (SAR) is the use of available resources to assist persons and property in potential or actual distress.

101 The SAR System

The SAR system is an arrangement of components activated, as needed, to efficiently and effectively assist persons or property in potential or actual distress. Figure 1-1 is an illustration of how the SAR system functions to enable distress alerting and SAR activities.

102 Components of the SAR System

The SAR system has the following components:

A. Organization-The division of SAR responsibility into geographic areas to provide centralized control, coordination, and effective use of all available SAR facilities, including SAR coordinators (SCs), rescue coordination centers (RCCs), rescue sub-centers (RSCs), SAR mission coordinators (SMCs), on scene commanders (OSCs), and search and rescue units (SRUs). Some federal state, and local agencies employ the Incident Command System (ICS) which organizes SAR along the same lines but uses different terminology. See Chapter 8 and the glossary for an explanation.

B. Resources-The personnel and equipment that undertake one or more stages of the SAR system.

C. Communications-The media through which early detection, alerting, control support, and coordination are maintained throughout the SAR system.

D. Emergency Care-Emergency medical treatment at the distress scene, and life support enroute route to a medical facility.

E. Documentation-The collection and analysis of SAR case information.

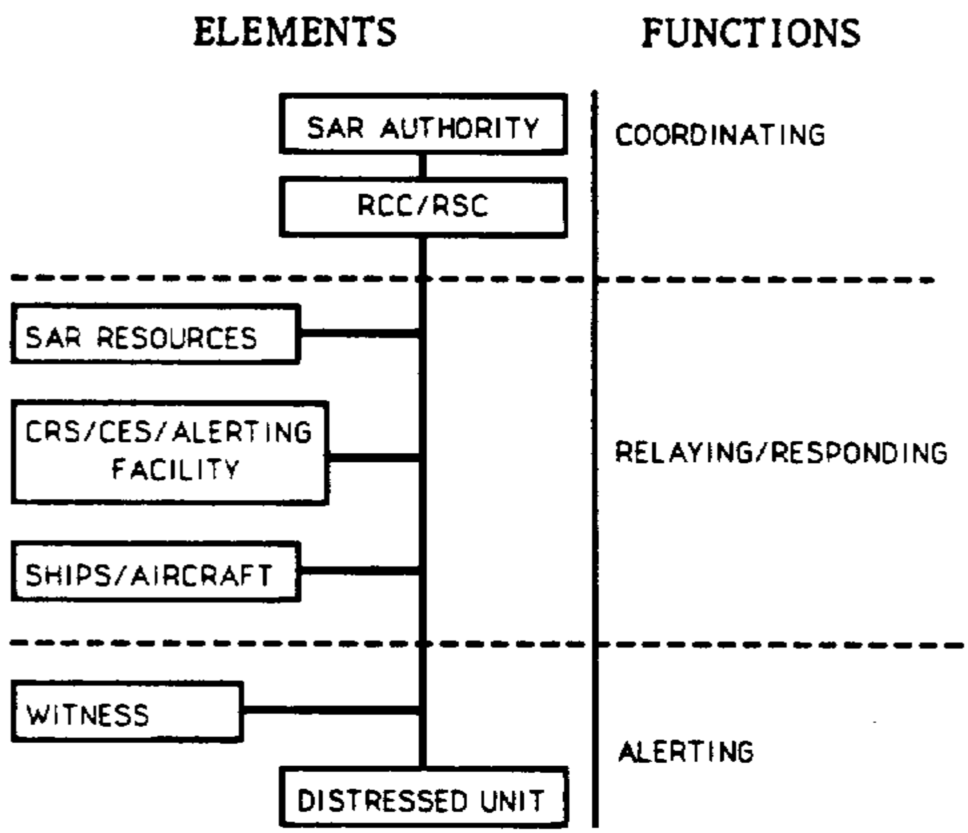

Figure 1-1. SAR System[1]

Figure 1-1. SAR System {1}

103 National Search and Rescue Plan (NSP)

The United States SAR system is implemented by the National Search and Rescue Plan (NSP) to provide greater protection of life and ensure efficient and effective SAR response. See Appendix A.

104 National SAR Manual (NSM)

The National SAR Plan is implemented by the National SAR Manual (NSM). This manual consolidates the information needed to effectively conduct SAR missions, and provides for the activation of components in stages as needed.

105 SAR Stages

The designated SAR stages define the nature of SAR assistance provided at any particular time. A mission may not necessarily include each and every stage, or the stages may overlap. The major stages are:

A. Awareness-Knowledge by any person or agency that an emergency situation may exist.

B. Initial Action-Preliminary action taken to alert SAR facilities and obtain amplifying information. This stage may include evaluation and classification of the information, alerting of SAR facilities, preliminary communication checks (PRECOM), extended communication checks (EXCOM), and in urgent cases, immediate action from other stages.

C. Planning-The development of operational plans, including plans for search, rescue, and final delivery.

D. Operations-Sending SRUs to the scene, conducting searches, rescuing survivors, assisting distressed craft, providing necessary emergency care for survivors, and delivering casualties to medical facilities.

E. Mission Conclusion-Return of SRUs to a location where they are finally debriefed, refueled, replenished, remanned, and prepared for other missions, and completion of documentation of the SAR mission by all SAR facilities.

110 SAR ORGANIZATION

The three major elements of the SAR organization are:

A. Defined geographic areas and regions of SAR coordination responsibility, each with its own SAR Coordinator and SAR plan.

B. A centralized RCC within each defined region.

C. A SAR mission organization for each defined area and region.

120 GEOGRAPHIC SAR ORGANIZATION

A. A SAR Coordinator is the agency or official within a given area or region responsible for the SAR organization and coordination of SAR operations. A SAR Coordinator may have more than one RCC, with each serving a Search and Rescue Region (SRR), or multiple RSCs with each serving a Search and Rescue Sector (SRS). SAR Coordinator functions are described in more detail in paragraph 131 and the National Search and Rescue Plan.

B. As party to both the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) SAR Conventions, the United States establishes RCCs for coordinating responses to both aeronautical and maritime incidents. Where possible, aeronautical and maritime SRRs are geographically identical; however, since SRR boundaries are negotiated with neighboring countries, some SRRs may not geographically coincide. SAR area and regional boundaries are used for general planning, and for designation of primary responsibility for the coordination of SAR services. SRRs should not be barriers to effective SAR action. Figure 1-2 depicts SAR area organization.

121 Geographic Divisions

A. The National SAR Plan establishes three primary geographic divisions of responsibility for United States SAR, each with its own SAR Coordinator. Unlike establishment of SRRs, geographic divisions provided under the National SAR Plan are not intended to assign primary responsibility for SAR to the U.S. in international waters or airspace. However, areas given in the Plan are intended to show which U.S. agency will normally have the lead in coordinating U.S. involvement in a SAR case, regardless of where in the world that case occurs.

1. Maritime SAR. The Commandant, U.S. Coast Guard, has divided the Maritime SAR Area into two sections, the Atlantic Maritime Area and the Pacific Maritime Area. The Commander, Atlantic Area, U.S. Coast Guard, is the Atlantic Area SAR Coordinator, and the Commander, Pacific Area, U.S. Coast Guard, is the Pacific Area SAR Coordinator. Each maritime area is made up of multiple SRRs.

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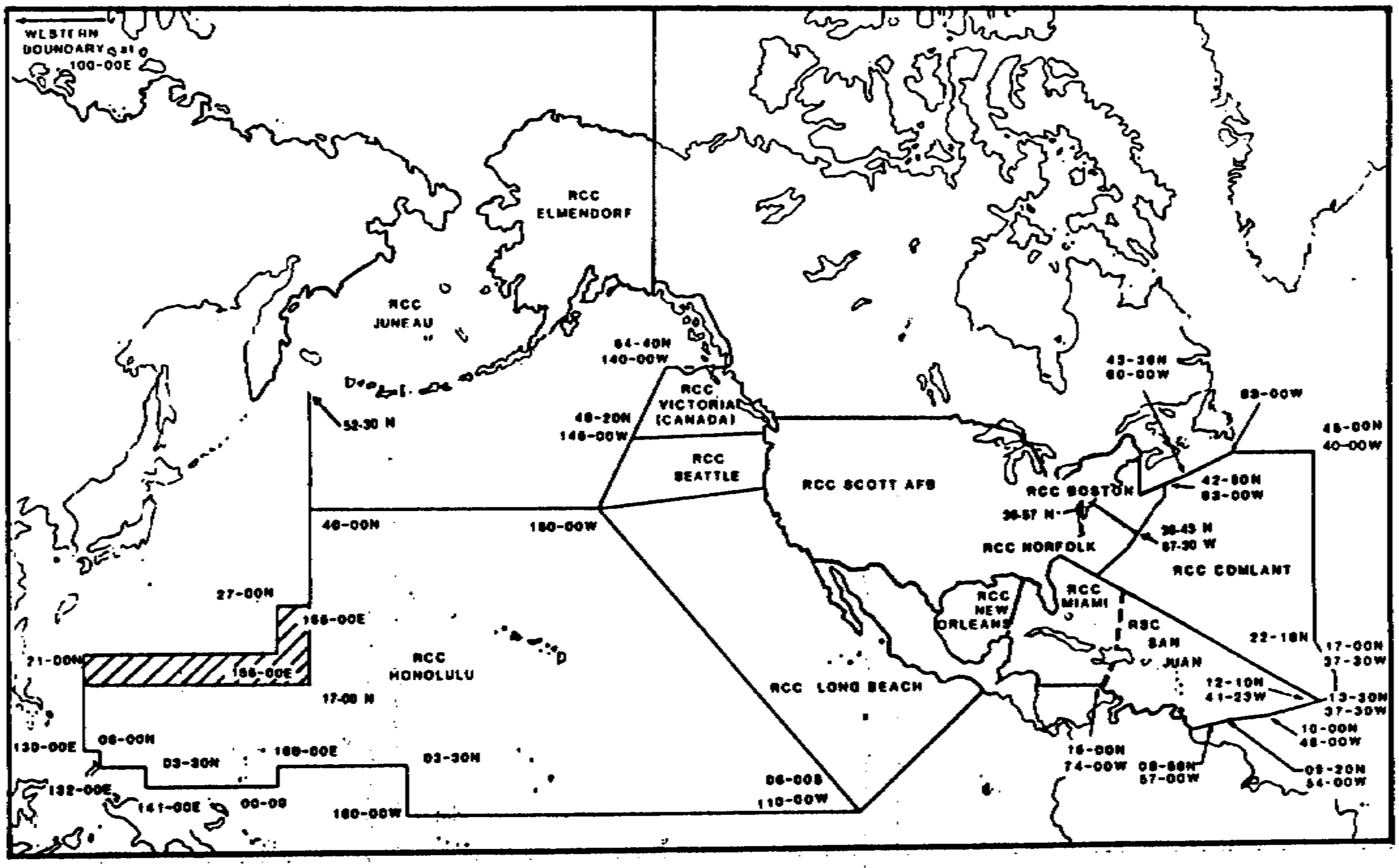

▨ Area of SRR overlap between U.S. and Japan

* U.S. - U.S.S.R. regions in the Bering Sea are separated by a line which generally follows the U.S. - U.S.S.R. Maritime Boundary.

Figure 1-2. United States Search and Rescue Regions {2}
(SRRs do not extend into foreign territorial seas)

2. Inland SAR. The Commander, Air Rescue Service (ARS), is the executive agent for the U.S. Air Force Chief of Staff, designated to implement the National SAR Plan for the Inland SAR area. The Commander, ARS, has established a single SRR with its RCC at Scott Air Force Base (AFB), IL.

3. Overseas SAR. The Overseas Area includes Alaska and all other portions of the globe not within the Maritime and Inland Areas. Various Unified Commands implement the National SAR Plan within the Overseas Area, and usually assign subordinate commands as SAR Coordinators.

B. While the Maritime and Inland Areas are generally composed of internationally recognized SRRs and SRSs, the Overseas Area established for national purposes is not so organized, but instead overlaps SRRs and SRSs of other nations. Unified Commanders perform SAR in the Overseas Area only after considering the laws, policies, and SAR capabilities of all countries possibly involved and only when the SAR response does not interfere with their primary mission. Other nations are normally expected to assume primary responsibility for coordinating SAR in these areas.

C. Geographic SAR responsibilities have been established as follows:

MARITIME AREA

ATLANTIC SAR COORDINATOR
Commander, Coast Guard Atlantic Area, responsible for SRRs and SRSs detailed below and shown in Figure 1-2.

RCC COMLANTAREA NY
Commander, Coast Guard Atlantic Area

RCC BOSTON
Commander, 1st Coast Guard District

RCC ST LOUIS
Commander, 2nd Coast Guard District

RCC NORFOLK
Commander, 5th Coast Guard District

RCC MIAMI
Commander, 7th Coast Guard District

RSC SAN JUAN (Under RCC MIAMI)
Commander, Greater Antilles Section

RCC NEW ORLEANS
Commander, 8th Coast Guard District

RCC CLEVELAND

Commander, 9th Coast Guard District

PACIFIC SAR COORDINATOR-Commander, Coast Guard Pacific Area, responsible for SRRs detailed below and shown in Figure 1-2.

RCC LONG BEACH
Commander, 11th Coast Guard District

RCC SEATTLE
Commander, 13th Coast Guard District

RCC HONOLULU
Commander, 14th Coast Guard District
(jointly operated by Coast Guard, Air Force, and Navy personnel)

INLAND AREA-Commander, ARS, responsible for the SRR detailed below and shown in Figure 1-2.

RCC SCOTT
Commander, AFRCC, SCOTT AFB

OVERSEAS AREA-Commander-in-Chief, U.S. Air Force, Pacific, responsible for the State of Alaska-appropriate Unified Commanders are SAR Coordinators elsewhere in the world.

RCC ELMENDORF
Commander, Alaskan Air Command

122 SAR PLANS

Each SAR Coordinator develops SAR Plans detailing procedures for conducting SAR missions. Each plan should include the following information:

A. A list of available SAR facilities, by primary and secondary usage, and a list of other potential facilities, such as Air Route Traffic Control Centers (ARTCCs) and Flight Service Stations (FSSs), along with contact points for requesting the aid of any resource.

B. The organization of communications, including:

1. The locations, call signs, hours of watch, and frequencies of all radio stations, services, and agencies likely to be used in SAR.

2. SAR mission communications, including assignment of control channels, on scene channels, monitor channels, and call signs.
3. Communications schedules.

4. SAR message formats and SAR message routing.

5. Methods of alerting aircraft and vessels, and of obtaining ship position information in maritime areas.

C. The conduct of SAR operations, including:

1. Responsibilities of SAR personnel.

2. Joint SAR operations with adjacent national and foreign areas.
3. Arrangements for refueling and servicing of aircraft, vessels, and vehicles engaged in SAR.

4. Procedures for assisting ditching aircraft.

5. Contingency plans for equipment deployment.

6. Coordination with accident investigation boards, medical teams, aircraft operators, and merchant vessel agents.

7. Criteria, policies, and procedures for suspension of SAR cases.

D. The manner of gathering essential information, including Notices to Airmen (NOTAMs), notices to mariners, weather and oceanographic data, and distressed craft's movement data, along with records and photographs of all unremoved and unobliterated aircraft or vessel wreckage. These records may be maintained in the RCC instead of the SAR plan.

E. The establishment of training programs and SAR personnel orientation visits to RCCs and SAR facilities.

F. The recording of information on such subjects as SAR system efficiency, SAR mission critiques, emergency procedures used by airmen and mariners, emergency and survival equipment carried by vessels and aircraft, and SAR facility improvement.

130 SAR MISSION ORGANIZATION

The SAR Coordinator mandates SAR mission organization, assigning the responsibilities and interrelationships of the SMC, OSC, and SRUs for any mission. Figure 1-3 shows the typical SAR mission organization.

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          SC
           |
          SMC
           |
          OSC
           |
    _______|_______
   |               |
  SRU             SRU
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Figure 1-3. Typical SAR Mission Organization {3}

131 The SAR Coordinator

A. The SAR Coordinator (SC) ensures SAR operations are coordinated efficiently through the use of available SAR resources. To achieve this, SAR coordinators may make SAR agreements with Federal, State, local and private agencies, providing for the maximum practicable cooperation. Agreements with foreign SAR authorities may be made only as prescribed by Service directives.

B. SAR missions are normally coordinated at the lowest practical level within an SRR. For missions involving several RCCs, a SAR Coordinator may coordinate the mission. However, military commanders may retain control of their own forces conducting SAR for their own units. If a SAR mission encompasses areas normally under the control of different SAR coordinators (i.e., a craft's path crossed more than one SRR) the SAR Coordinator within whose region the last position report was received assumes overall responsibility. If the last report was received at the boundary of two regions, or if no position report was received, the SAR Coordinator to the region the craft was entering usually assumes responsibility.

C. Major duties of the SAR Coordinator include:

1. Identifying all SRUs and SAR resources that may be used within the area, establishing close liaison and agreements with other Services, agencies, and organizations having SAR

potential, and with SAR authorities of neighboring nations, to ensure mutual cooperation and coordination.

2. Preparing and distributing a current comprehensive area SAR plan.

3. Establishing RCCs to coordinate SAR resources within the region of responsibility and RSCs for areas where RCCs cannot exercise direct and effective coordination, and ensuring that operations conform with the SAR plan and the National SAR Manual.

4. Conducting SAR, assigning SMC and SRUs until assistance is no longer necessary or rescue has been effected. Suspend SAR cases when there is no longer a reasonable chance of success, and report results to the parent operating command or agency.

132 SAR Mission Coordinator (SMC)

A. A SAR Mission Coordinator (SMC) is designated by the SAR Coordinator to manage a specific SAR mission, and has the full operational authority of the SAR Coordinator. An SMC is usually assigned for each SAR mission. While the SAR Coordinator retains overall responsibility, the SMC plans and operationally coordinates and controls SAR missions from the time assigned until conclusion, prosecuting each mission with resources available. The SMC must use good judgement to modify, combine, or bypass SAR stages and procedures to cope with unique, unusual, or changing circumstances.

B. The SMC may be predesignated, and may be the SAR Coordinator, an official of the SAR Coordinator's agency, or an official of another agency in a better position to coordinated and control a particular SAR mission. Any agency likely to be assigned SMC functions should ensure that agency personnel are identified and trained in SAR operations and SMC duties, and that adequate communications capability is maintained. A SAR Coordinator may divide a SAR mission between multiple SMCs, specifying the boundaries of each SMC effort.

133 Rescue Coordination Centers (RCCs)

A. Rescue Coordination Centers (RCCs) usually function as SMCs and control and coordinate SAR operations within an assigned SRR, requesting assistance from other RCCs or RSCs as needed. The RCC chief supervises operations and personnel, including RCC controllers and other watchstanders. Senior RCC controllers or experienced SAR officers should supervise missions requiring extensive planning and coordination. All personnel assigned to RCC watches should be fully trained and capable of performing their duties.

B. International guidelines have been established to help determine which RCC should be responsible for coordination of a distress situation when an alert is received.

1. The shore station nearest the reported alert should acknowledge it; other shore stations receiving the alert should acknowledge it if the nearest station does not appear to respond. The shore station that acknowledges the alert should maintain communications with the casualty unless relieved of this duty under SAR arrangements described below.

2. The RCC affiliated with the shore station that first acknowledges the alert (First RCC) should assume responsibility for all subsequent SAR coordination unless and until responsibility is accepted by another RCC better able to take action. If it is not immediately clear which RCC has become the First RCC because more than one shore station has acknowledged the alert, the RCCs concerned should as soon as possible agree which is to become the first RCC to ensure the distress is acted upon promptly.

3. If the distress situation is within the SRR of the First RCC, that RCC should coordinate the SAR response using national resources and requesting assistance from other RCCs if needed.

4. If the distress situation is within the SRR of another RCC, the First RCC should:

   a. Inform the responsible RCC of the alert and confirm that it has assumed coordination.

   b. Maintain communication with the casualty until the responsible RCC confirms it has established reliable communications with the casualty.

   c. Exchange information with the responsible RCC.

   d. If for any reason the responsible RCC informs the First RCC that it cannot take effective action, the First RCC should, until the responsible RCC makes alternative arrangements, retain SAR coordination, maintain communications with the casualty, alert shipping in the vicinity of the distress, and seek assistance from other RCCs if appropriate.

5. If the distress situation is outside any established SRR, the First RCC should assume SAR coordination. If another RCC appears better able to take responsibility, inform that RCC of the alert and request it to assume coordination. If accepted, proceed as in paragraphs 4.b. and 4.c. above. If declined, proceed as in paragraph 4.d. above.

C. The RCC controller is the SAR Coordinator's duty officer, and is the predesignated SMC for most SAR missions. The RCC controller automatically acts as SMC for all SAR missions until relieved, or until another SMC is assigned. When another SMC is designated by the SAR Coordinator for a specific mission, the RCC controller monitors that mission to ensure that established policies are followed. The RCC controller has the full operational authority of, and is accountable to, the SAR Coordinator and should always be prepared to take immediate action.

1. The RCC controller should be fully qualified to perform SMC duties before being assigned to RCC watches. A controller should be thoroughly familiar with the National SAR Manual, local SAR plans, and the communications capabilities in the area. A controller should maintain an effective and efficient RCC watch, and be able to rapidly perform all functions required, often without complete information or advice from seniors.

2. RCC Controllers should:

a. Be familiar with available lines of communication, including parent agencies, other Military Services, civilian agencies, law enforcement agencies, and commercial sources.

b. Be familiar with geographic features of the SRR, such as terrain heights, hazards to low-level aircraft searches, navigational aids, and water depths, and the capabilities, limitations, and recommended use of available facilities.

c. Upon reporting for duty,

(1) Receive a complete briefing, including past, present, and forecast weather, from the relieved watch.

(2) Review all entries in the SAR Operations Log pertaining to ongoing missions, unsuccessful missions closed during the past 24 hours, and any other items requiring action.

(3) Determine the mission-ready status of all SAR resources.

(4) Test primary lines of communication.

D. The assistant RCC controller is designated by the SAR Coordinator, is subordinate to the RCC controller, functions as assistant SMC, and may function as SMC when several SAR missions are in progress. Assistant RCC controllers should be qualified to perform SMC duties, and may receive the same briefings and perform the same functions as the RCC controller. Normally, the assistant RCC controller relieves the RCC controller of plotting, information retrieval, investigative work, and other routine details. Such functions include continuously monitoring availability of SAR forces assigned, updating status boards, reading and filing message traffic, ensuring that the controller sees all pertinent messages, assisting the controller in preparing messages, and making entries in pertinent files, logs, and folders.

E. Supplemental RCC personnel provide a continuous live watch. While the usual duty shift consists of an RCC controller and an assistant RCC controller, additional personnel relieve them of time-consuming tasks and allow time for detailed SAR planning.

F. RCC communications equipment and procedures are crucial to effective SAR operations.

1. SAR coordinators should establish a rapid and reliable communications net linking all primary and secondary SAR facilities. SAR-dedicated lines may be needed. Communications should access major military commands, adjacent RCCs/RSCs, SRUs, other agencies that can supplement SAR resources, Air Traffic Control (ATC), military airway air/ground stations and communications centers, coastal radio stations, and regional weather, radar, and direction-finding (DF) stations.

2. All communications equipment, including RCC telephones, should be attached to a multichannel tape recorder with a timing channel. This allows the RCC to review

information received over a voice system, and may resolve disputes about information received. Tapes should be retained per agency directives.

G. RCC equipment varies, but should include:

1. Charts

a. Large-scale wall charts showing assigned SAR area and locations of resources listed in the SAR plan, along with a SAR Facility Status Board or computer file reflecting the current status of SAR facilities.

b. A SAR Unit Response Chart providing a pictorial view of time and range capabilities, and limitations, of all primary SAR aircraft, vessels, boats, and vehicles, and all medical facilities with helicopter landing areas.

c. Aeronautical charts, pilot charts, bathymetric charts, operating area and warning area charts, oceanic vessel track charts, lake survey charts, geological survey charts, topographical charts, small craft nautical charts, marine waterway charts, civil defense charts of water reservoirs and airfields, population density charts, township maps, road maps, three-dimensional terrain and ocean-bottom charts, wreckage location charts cross-indexed to the wreckage locator file, and low-level hazard charts depicting obstacles to low-level flight.

2. Plotting equipment for plotting mission information, bearings, search areas, SRU assignments, reported leads, and sightings. Clear plastic on top of plotting tables allows protection of search planning nomographs and frequently used charts. An underlit adjustable plotting table allows use of multiple transparent search overlays, and enhances planning during extended SAR missions.

3. Rapid information Retrieval/Display for information previously accumulated. Any system, such as quick reference cards, computers, or checklists, that reduces time lost by the SMC or RCC controller should be considered. Rapid-dial telephone equipment may ease information retrieval and speed operations.

H. RCC information should generally include:

1. Data Files

a. A SAR Facilities Liaison File on primary and secondary SAR facilities within the SRR, and SAR facilities in adjacent regions, including locations, operational capabilities and constraints, SAR and communications capabilities, specialization, names and positions of key personnel, and methods of contact.

b. A Wreckage Locator File with all known aircraft and vessel wreckage sites within the region which might be mistaken for SAR targets. Used with the wreckage locator chart, this file contains data such as geographical location, wreckage description, including type and identification of the craft, color, and distinctive markings, and information such as prior SAR case number and pilot/operator name. If photographs of a wreck are available, they should also be included, dated and marked with an arrow indicating true north.

c. An Experimental File with information acquired from previous SAR cases or local knowledge, possibly of use in future cases. The file may contain such information as peculiarities of water currents, effects of local weather on sighting ranges and sweep widths, peculiarities of survival craft drift in certain areas, and charts containing plotted historical drift tracks of SAR cases.

d. A Missing/Stolen Craft File with data on unlocated craft reported missing, overdue, or stolen. Data are entered after a mission has been suspended, or when received if no mission is prosecuted. This file may include craft type and identification, color and distinctive markings, owner/operator name, flight or float plan, date of mission suspension, case number, and other appropriate facts. Periodic review keeps SAR personnel updated on missing craft.

e. An Advanced SAR Staging Base Data File listing all bases within the SRR suitable for an advanced SAR staging base. Information in the file should include communications, operating hours, instrument landing systems, terrain limitations, runway lengths and weight limits, ramp capacity, refueling capacity, maintenance and ground support, SAR crew briefing space, moorage or docking facilities, transient housing capacity, and food-serving capacity.

2. Reference material, including:

a. SAR Coordinator RCC Manual on search

planning and operations.

b. RCC and adjacent RCC directives.

c. SAR publications of ICAO and IMO including Merchant Vessel SAR Manual (MERSAR).

d. Aviation planning publications, such as military Flight Information Publications (FLIPs), Federal Aviation Administration (FAA) Airman's Information Manual (AIM), information sheet for aircraft frequently used as SRUs, Aircraft Owner's and Pilot's Association (AOPA) Airport Directory for small fields with telephone numbers and points of contacts, and airport heliport/hospital landing site directories.

e. Communications and other SAR-related publications such as Joint Army Navy Allied Publications (JANAP), Allied Communications Publications (ACP), ICAO series, nautical and air almanacs, nautical and tidal publications, Civil Aircraft Registry (microfiche), Lloyd's Register of Ships, manuals governing emergency procedures, and oceanographic atlases showing ocean currents, wind, and sea surface temperatures.

134 Rescue Sub-Centers (RSCs)

The SAR Coordinator establishes Rescue Sub-Centers (RSCs) when the RCC cannot exercise direct and effective control over SAR facilities in remote areas, or where local facilities can be directed only through local authorities. RSCs should have immediate voice or printed communications via direct landline or radio link with the parent RCC, and rapid and reliable communications with flight-following and DF stations serving the RSC, adjacent RSCs, primary and secondary SAR facilities in the RSC operational area, and sources of meteorological information. RSC staffing is assigned by the parent RCC. RSCs do not always maintain a continuous watch. Regardless of the readiness state required, RSCs should have sufficient personnel to perform assigned duties. When activated, RSC personnel have the same responsibilities and authority as in an RCC. Since the RSC is responsible for SAR operations in only part of the area, RSC equipment is comparable to, but usually less extensive than, that of an RCC.

135 Advanced SAR Staging Bases

When SAR missions occur in remote areas, or where communications facilities are inadequate, advanced SAR Staging Bases are occasionally used. A SAR Coordinator may transport an SMC, and supporting staff, to an advanced base of operations. This base should have appropriate communications equipment, transient dining and housing facilities, SMC working spaces, and SRU refueling facilities. If and advanced base is foreseeable, RCCs and RSCs should maintain SMC kits. The kits may contain appropriate publications, charts of the RCC/RSC's area of operation, the National SAR Manual and area SAR plan, telephone directories, SMC planning and documentation forms, aircraft clearance forms and purchase order forms, and plotting equipment.

136 On Scene Commander/Incident Commander (OSC/IC)

A. The SMC designates an On Scene Commander (OSC) (Incident Commander (IC) is used by some federal, state, and local agencies which employ the Incident Command System (ICS)) to manage a SAR mission at the scene. The OSC may be assigned from the SMC's Service or from some other agency. Like an SMC, the OSC can be assigned by name and rank or by a particular facility. An OSC is not required for all missions, although one is usually assigned if two or more SRUs are on scene. An OSC should be designated whenever on scene coordination could be improved. If an OSC is not designated, the first SRU on scene assumes OSC responsibilities, advising the SMC. An OSC need not be an SRU. An advanced staging base may serve as an OSC to relieve an SRU of that burden.

B. An OSC prosecutes the SAR mission on scene using resources made available by the SMC, and should safely carry out the SAR action plan. If the SMC does not provide a sufficiently detailed SAR action plan, the OSC completes SMC duties for on scene operations, notifying the SMC. The unit designated as OSC retains OSC responsibilities from the time of designation until relieved or until the mission is completed.

C. Frequent changes in OSC assignment are not desirable. To provide continuity of command, any individual arriving on scene who is senior to the OSC should not normally assume command unless ordered to do so by the SMC. If the senior officer concludes that a change of command is essential to mission success and the SMC concurs, or if the OSC specifically requests relief, an OSC change should take place. The relieved OSC reports OSC relief to the SMC.

D. An OSC has full operational authority of the SMC, and operational control of all SRUs on scene. The parent agency retains operational control of SRUs en route to and from the scene. If an agency must withdraw its SRUs from a SAR mission, it should advise the SMC as early as possible to permit suitable reliefs to be dispatched to maintain OSC resources.

E. Multiple OSCs may be assigned, especially when the area to be searched is large. When this is done, the SMC specifies areas of responsibility for each OSC. Multiple OSCs may also be needed when several aircraft are participating with surface craft. For flight safety, it may be wise to split OSC responsibilities between surface and air; in this case, geographic boundaries are not specified. Surface and airborne OSCs are also assigned when there is no communications link between the surface craft and aircraft.

F. OSCs should have adequate manning and equipment, and should be thoroughly familiar with the National SAR Manual and appropriate SAR plans. Since continuity of operations enhances coordination, OSCs should be able to remain on scene for extended periods of time, and to communicate with all on scene SRUs, the SMC, and the distressed craft.

1. Large fixed-wing SAR aircraft make excellent OSC platforms because of their extensive communication capability, relatively long on scene endurance, and adequate space for planning, plotting, and coordination duties. For large searches the SMC should consider augmenting a flight crew with qualified personnel to assist with OSC duties.

2. Medium- and high-endurance Coast Guard cutters (over 150 feet in length) and Navy vessels of destroyer-escort size and above make excellent OSC platforms. They possess extensive communications capabilities, ample working space, and enough personnel to establish effective reliefs.

3. A suitably equipped ground facility may serve as an OSC if communications and adequately trained personnel are available.

4. The training and experience of OSC personnel are important. Preference should be given to units having SAR as a primary mission.

G. OSCs perform the following duties (Land SAR OSC/IC described in Chapter 8):

1. Establish and maintain communications with the SMC, assume operational control and coordination of all SRUs assigned, and execute SAR action plans; modify plans to cope with changing

on scene conditions advising the SMC of all major changes.

2. Establish and maintain communications with all SRUs using assigned on scene channels, requiring all aircraft to make "operations normal" reports to the OSC every 15 minutes (30 minutes for multi-engine fixed-wing). Position reports from SRUs are not required as long as they remain in their assigned search areas. However, if practical, SRU positions should be obtained periodically and plotted so that their navigation can be verified.

3. Establish a common altimeter setting for all on scene aircraft.

4. Obtain necessary information from arriving SRUs, provide initial briefing and search instructions, and provide advisory air traffic service to aid pilots in maintaining separation from one another.

5. Receive and evaluate sighting reports from all SRUs, and divert SRUs to investigate sightings.

6. Obtain search results from departing SRUs.

7. If the OSC must depart, shift OSC duty to the SRU remaining which is best able to perform OSC duties; brief the relief OSC on the current situation, advising the SMC of the change.

8. Submit serially numbered situation reports (SITREPs) to the SMC at regular intervals. Include the on scene weather in SITREP ONE, and submit it immediately upon arrival on scene or upon assuming OSC. When an OSC is relieved, the new OSC continues the SITREP numbering sequence. SITREP information and formats are discussed in Vol. I, Chapter 3, and Vol. II, Chapter 5.

H. Coordinator Surface Search (CSS) is an "OSC" established in the Merchant Vessel Search and

Rescue Manual (MERSAR). If SRUs are not available to act as OSC, but merchant vessels are involved, one is designated by mutual agreement as CSS. The CSS should be designated before vessels arrive on scene.

137 Search and Rescue Unit/Strike Team (SRU/ST)

A. The Search and Rescue Unit (SRU) (Strike Team (ST) is used by some federal, state and local agencies which employ the ICS) is a resource performing search, rescue, or similar operations. It may have SAR as a primary duty, or it may be made available for a SAR mission by a parent agency not having primary SAR duty. SRUs are normally assigned by name if a large vessel, submarine, or ground party, or by type, "TAIL" number, or call sign if an aircraft, boat, or ground vehicle. SRU designation by classified, tactical call signs should be used only in hostile territory. Some SAR coordinators authorize more specific SRU abbreviations, such as Search Unit (SU), Rescue Unit (RU), Pararescue Unit (PRU), and Mountain Rescue Unit (MRU).

B. SRUs should be manned, equipped, and proficient in the SAR skills necessary to accomplish the mission. Normally, SRUs having SAR as a primary duty are used first. If the SRU is alone on scene, it performs OSC duties and keeps the SMC advised. Multiple SRUs comply with OSC directions, ensuring that SRUs in adjacent areas are not endangered, search efficiency is not reduced by duplication of search effort, and all areas are searched.

C. SRUs should contact the OSC approximately 15 minutes before arrival, informing OSC of Estimated Time of Arrival (ETA), operational limitations, on scene communications capability, planned search speed, and on scene endurance. If no OSC is assigned, the SRU is under the direct operational control of the SMC while on scene.

D. SRUs normally:

1. Execute SAR action plans; after searching, report to the OSC the area searched, ceiling, visibility, wind, and search results, including any electronic searches; after return to base, debrief the SAR Mission Debriefing Officer or SMC.

2. Maintain communications with the OSC from 15 minutes before arrival on scene until released by the OSC. Aircraft SRUs make "operations normal" reports every 15 minutes (30 minutes for multi-engine, fixed-wing).

3. When survivors are sighted, advise the OSC as soon as possible, including position, survivor identity and physical condition, wind, weather, sea conditions, and SRU endurance on scene. Signal to the survivors, keep them in sight if possible and effect a rescue if this is within SRU capability. If a rescue is not possible and the SRU must depart, note survivor position precisely, and mark if possible.

4. When wreckage, unusual ground disfiguration, debris, empty

lifeboats or liferafts, oil slicks, sea dye marker, flares, smoke, or any other unusual object is sighted, inform the OSC of the position, nature of the sighting, concentration of objects (if several are sighted), wind, weather and sea condition, and SRU evaluation of the sighting.

5. If a radio, radar, sonar, emergency signal, or survivor transmission is detected, advise the OSC of signal type, and exact times, SRU position, course, speed, and altitude when signal was detected and when signal was lost or ended, bearing, frequency and strength of signal and evaluation of signal, and SRU action.

138 SAR Liaison, Local Base, and Briefing Officers

A. SAR Liaison Officers may be sent by the SMC to major military commands providing SRUs, to help coordinate activities, provide briefing and debriefings, and keep the SMC informed of SRU availability. A liaison officer from the parent command of a missing unit may be sent to the SMC to provide background information, develop hypotheses on what actions might have been taken by the missing craft, provide expertise about the craft to aid in search planning, and keep the parent command fully informed of progress. Liaison officers may also be sent to foreign RCCs to help coordinate United States SAR efforts with their governments.

B. Local Base SAR Officers should be appointed by commanding officers of major operational military bases to coordinate the use of their resources with the SRR. SAR officers should be familiar with the National SAR manual and be prepared to act as SMC, OSC, RCC controller, SAR liaison officer, and SAR briefing officer.

C. SAR Briefing Officers should be appointed by an SMC during SAR missions involving many SRUs. This officer briefs departing SRUs and debriefs returning SRUs on SAR mission progress, the SAR action plan, and requirements. The briefing officer may prepare SRU briefing folders containing essential information, charts, and messages. Briefing should take place close to SRU departure time. Untrained personnel should be briefed on scanner techniques, sighting report procedures, and methods for minimizing fatigue.

CHAPTER 2. SAR ORGANIZATIONS, AGENCIES, AND RESOURCES

200 SAR ORGANIZATIONS AND AGENCIES

Organizations and agencies that perform SAR are international, Federal, State, county, municipal, commercial, or private in nature.

210 INTERNATIONAL ORGANIZATIONS

International organizations have been formed to standardize SAR operations requiring international cooperation. While signatory nations of a treaty, convention, or agreement (see Appendix B) do not pledge themselves to always conform, they do seriously consider standards outlined in such documents. Major international organizations and agencies are described below.

A. International Civil Aviation Organization (ICAO) has more than 150 member nations, including the United States. ICAO administers the Convention on International Civil Aviation (see Appendix B). The Convention promotes safe, orderly, and efficient growth of international civil aviation, and recommends comprehensive standards, practices, and procedures for SAR by such aircraft. Each signatory nation provides appropriate assistance to a distressed aircraft within its territory. The nation may also permit assistance by owners of the aircraft or by authorities of the nation of registry. The United States has agreed to provide some SAR services for its own territory and international waters. Detailed worldwide requirements for SAR are stated in the Annexes to the Convention. Other ICAO standards and recommended practices, indirectly affecting SAR, that deal with air navigation and transportation include the following:

1. Annex 6 (Operation of Aircraft) requires aircraft to carry certain emergency equipment.

2. Annex 9 (Facilitation) establishes procedures for SRU entry into different countries.

3. Annex 10 (Aeronautical Telecommunications) specifies certain emergency communications and equipment.

4. Annex 11 (Air Traffic Services) provides for the alerting of SAR services by use.

Agreed procedures are contained in ICAO's Procedures for Air Navigation Services (PANS), and supplement Convention standards and recommended practices. Detailed suggestions for operation of services are in the ICAO technical manuals, including the ICAO Search and Rescue Manual. Detailed plans for each world region are contained in regional "Air Navigation Plans." The SAR sections of these documents contain lists of facilities including RCCs, aircraft, and marine craft, charts showing the geographic areas of responsibility of each member country, and lists of regional recommendations. Many standards and recommended practices adopted under the Convention, and portions of other ICAO documents accepted by the United States, are incorporated into the National SAR Manual.

B. International Maritime Organization (IMO) is similar to ICAO and governs shipping. IMO coordinates and issues international procedures for SAR at sea. It administers the International Convention for Safety of Life at Sea (SOLAS) (see Appendix B), and requires some merchant vessels to carry emergency and survival equipment including radios equipped with an automatic alarm device. SOLAS also requires merchant vessels to respond to distress signals. IMO's International Code of Signals (INTERCO) includes sections on emergencies, distress, and SAR. IMO's Merchant

Ship SAR Manual (MERSAR) contains procedures for merchant ships involved in SAR. IMO Search and Rescue Manual (IMOSAR) assists governments in meeting objectives of various international SAR conventions, provides for internally standardized SAR polices and procedures, and is closely aligned with the ICAO Search and Rescue Manual.

C. International Telecommunications Union (ITU) coordinates international radio regulations and recommendations (see Appendix B). It prescribes the frequencies and signals for uncertainty, alert, distress, emergency, and safety messages. ITU provides the Coast Guard, RCCs, and other organizations concerned with safety of life at sea, with information on ships in distress or in need of assistance. The information may be requested by TELEX during ITU office hours (0800 - 1800 hours Z+1), TELEX No. 23 000/23 000.

D. World Meteorological Organization (WMO) establishes standard weather report terminology and format, and maintains a worldwide weather watch.

E. World Health Organization (WHO) coordinates worldwide health efforts, establishes standard immunization forms, and coordinates health requirements for entry into a participating nation's territory.

F. Inter-American Defense Board (IADB) publishes the IADB SAR Manual (DOC C-1542) for use by member states. It standardizes SAR procedures in English, Spanish, Portuguese, and French. The United States Joint Chiefs of Staff has approved use of the manual in SAR involving United States forces with the other IADB member countries of Argentina, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela.

G. NATO Military Agency for Standardization (MAS) enables North Atlantic Treaty Organization (NATO) forces to effectively operate together by standardizing operations and equipment.

H. Air Standardization Coordinating Committee (ASCC) consists of Air Force officers from the United States, United Kingdom, Australia, New Zealand, and Canada. ASCC conducts studies, reviews procedures and equipment, and recommends agreements, called Air Standards, to standardize the Air Forces of member nations.

I. Search and Rescue Satellite-Aided Tracking (SARSAT) is an interagency, internationally sponsored system of low altitude, near-polar orbiting satellites and ground receiving stations. The network is designed to provide the approximate positions of distress beacon signals from maritime Emergency Position-Indicating Radio Beacons (EPIRBS) and aviation Emergency Locator Transmitters (ELTs). The USSR provides an interoperable segment, COSPAS, which is combined to form the COSPAS/SARSAT system. SARSAT detects emergency signals on the distress frequencies of 121.5 and 243.0 MHz. Positions provided using these frequencies normally have a navigational accuracy of 12 nautical miles or less. SARSAT also detects the 406 MHz beacon which is being developed specifically for satellite detection and for position accuracy of less than 4 miles. EPIRB/ELT signals picked up by satellite are retransmitted to ground receiving stations called Local User Terminals (LUTs). Coverage on 121.5/243.0 Mhz requires line of sight for the EPIRB/ELT, the satellite, and the LUT. A SARSAT position should be available approximately every hour because of the existence of multiple satellites. The 406 MHz beacon will incorporate information storage so that line-of-sight mutual visibility is not needed with all three segments to determine a position. The SARSAT Mission Control Center (MCC) in the United States provides SARSAT position information to appropriate RCCs and exchanges data with similar MCCs in other countries.

J. Foreign SAR authorities exist in many nations. Some are similar to the Coast Guard and the 23rd Air Force/USAF Aerospace Rescue and Recovery Service (ARRS) and specialize in SAR services. Others depend on military operational units, or on operational units of the civil branches of the government and volunteer groups. Most, like Canada, are a combination.

K. International Radio-Medical Center (CIRM), a humanitarian organization based in Rome, Italy, provides medical advice and assists in arranging the evacuation of injured or seriously ill merchant seamen from vessels worldwide. It covers areas where no other medical advice facilities are available. Coast Guard coastal radio stations relay CIRM traffic at no cost, as do many foreign radio stations. CIRM uses certain documents:

1. Radio-Medical Assistance, Vol. I - Code Book, creates five letter code groups for medical

messages addressed to CIRM Roma.

2. Radio-Medical Assistance, Vol. II - Medical Guide, provides diagnosis, initial treatment, advanced treatment, first aid, and medico message information for mariner use at sea.

L. International Red Cross (IRC) coordinates disaster relief on an international basis, without regard to political considerations. United States RCCs normally effect liaison through the American National Red Cross (ARC).

M. Lloyd's of London, a major insurance firm, collects shipping information for underwriting purposes. If requested, it supplies information to SAR authorities when a marine casualty or overdue vessel is reported. United States SAR authorities can contact Lloyd's through international TELEX No. 886691.

220 DOMESTIC AGENCIES

In the domestic settings, agencies for SAR activities exist at all governmental levels and throughout the private sector.

221 Federal Agencies

Federal agencies with SAR relevance are coordinated by the National SAR Plan (NSP) (Appendix A) to fulfill international, national, and local responsibilities. The Interagency Committee on Search and Rescue (ICSAR), created by interagency agreement (Appendix A), is composed of agencies signatory to the NSP. ICSAR oversees the NSP and coordinates interagency SAR. Sponsored by the Coast Guard, ICSAR is chaired by the Chief, Office of Navigation Safety and Waterway Services, and reports, through the Commandant, to the Secretary of Transportation. Agencies with substantial SAR responsibilities are described below.

A. United States Coast Guard (USCG) is an agent of the Department of Transportation and a branch of the United States Armed Forces. In wartime, or when directed by the President, it operates as a specialized service within the Navy. The Coast Guard develops, establishes, maintains, and operates SAR facilities, and aids distressed military and civilian persons and property on, over, and under the high seas and waters subject to United States jurisdiction. Under the NSP, the Coast Guard organizes facilities, including its own resources, into a SAR network for the Maritime Area.

B. Department of Defense (DOD) facilities can be used under the NSP for civil SAR, provided it does not interfere with military missions; each Armed Service provides its own SAR for Service operations. Major military installations have SAR plans implementing the NSP. Each Armed Service also has other responsibilities under the NSP:

1. The Department of the Air Force, through the Air Rescue Service (ARS), is the designated SAR Coordinator for the

Inland Area. The ARS operates the Air Force Rescue Coordination Center (AFRCC) at Scott AFB, IL. The AFRCC coordinates SAR missions throughout the 48 contiguous States employing Federal, State, and local agencies. Usually the Civil Air Patrol (CAP) is used. ARS also deploys RCC controllers and SMCs to support SAR in designated areas.

2. The Department of the Navy provides civil SAR resources worldwide.

3. The Department of the Army, in addition to providing SAR forces worldwide, is the SAR coordinator for military operations responding to natural disasters within United States territory.

C. Federal Aviation Administration (FAA) is responsible for air safety. It maintains a current registry, including owner name and address, of all licensed United States civilian aircraft. Though the FAA does not conduct SAR, it provides electronic and communications assistance through ARTCCs and FSSs, and provides other important facilities and resources.

D. Federal Communications Commission (FCC) is a regulatory agency operating medium-frequency (MF) and high-frequency (HF) direction-finding (DF) networks that assist in locating persons in distress. This net operates between 400 kHz and 40 MHz and covers the inland United States, Pacific Ocean, and Atlantic Ocean. FCC field office personnel can respond to 121.5 and 243 MHz distress calls with mobile and portable radio DF equipment. SAR coordinators should establish procedures with regional FCC authorities for using the nets and radio frequencies. The FCC also designates the national SAR radio frequencies.

E. Other Federal Agencies have a special interest in emergency services, or can provide helpful ancillary SAR services, or special facilities needed for SAR.

1. National Oceanic and Atmospheric Administration (NOAA) provides environmental information and predictions. NOAA has a small fleet of ships which may be available for SAR missions. It maintains the United States space segment of SARSAT and is the lead agency in administering SARSAT.

2. National Aeronautics and Space Administration (NASA) has some aircraft and worldwide tracking, data acquisition, and communications networks.

3. National Park Service provides emergency services in units of the National Park System, and has "all-risk" emergency management resources that can respond outside of these areas.

4. United States Forest Service provides emergency services in national forests and other federal lands. The National Interagency Fire Center in Boise, ID has "all-risk" overhead management teams and extensive logistical resources that can be dispatched to emergencies.

5. Federal Emergency Management Agency (FEMA) coordinates civil defense planning, management, mitigation, and assistance functions of executive agencies, and assists State and local governments in civil emergency preparedness, response, and recovery activities. It operates telecommunications, warning, and electronics systems, and uses the Incident Command System (ICS), a combination of facilities, equipment, personnel, procedures, and communications, to manage resources at the scene of an incident.

6. Federal Bureau of Investigation (FBI) operates the National Crime Information Center (NCIC) in Washington, D.C. This center is the computerized hub of a nationwide criminal justice information network indexing crime and criminals, and storing and retrieving crime information furnished by all levels of government. NCIC provides data to any authorized criminal justice agency on six categories of stolen/missing property, a category on wanted persons, and another on criminal histories. Contact with NCIC is normally made by law enforcement agencies.

7. National Transportation Safety Board (NTSB) investigates and determines probable causes of aircraft, marine, highway, railroad, and pipeline accidents, and recommends improvements to prevent accidents.

222 State Agencies

SAR arrangements in the States vary considerably. Some States have a designated SAR Coordinator. Most States have a statewide law enforcement agency that handle locating lost, stranded, or overdue persons, boats, aircraft, and other vehicles. States can assist elsewhere through interstate communications. Some States have highly sophisticated communications networks, including automatic message routing and processing, priority preemption, and automatic relay. State officials, such as Aviation Directors, State Boating Law Administrators, and Park Service Directors or their equivalent, can also assist. While coordination with State agencies may be important to SAR efforts, operational control of Federal resources is not normally assigned to States.

223 County Agencies

In almost all areas, county agencies can provide SAR assistance. Most counties have a sheriff, some with land, water, or air SAR responsibility. Some sheriff's departments have highly developed SAR resources and extensive communications networks. The sheriff is usually empowered to form ground search parties, requisition rescue equipment, and coordinate municipal, county, and State efforts during a SAR mission.

224 Municipal Agencies

The municipal agencies and resources that are most helpful are police and fire departments, and hospitals. Some have helicopters, light aircraft, boats, or vehicles that can perform local SAR and provide emergency care within the immediate area of a mishap. In some areas lifeguard and beach patrols provide trained swimmers, scuba divers, boats, and emergency care equipment.

225 Law Enforcement Agencies

On all government levels, law enforcement agencies provide a variety of services and facilities, including aircraft, boats, patrol cars, ambulances, snowmobiles, scuba teams, and tracking dog teams. Most of these facilities are radio equipped and coordinated by a central communications system. These agencies can perform harbor, small boat launching ramp, and airport checks. They also can provide data, recover drowning victims, coordinate ground search teams, provide vehicle and spectator control at distress scenes, and transport survivors.

226 Commercial Agencies and Resources

Assistance of various types may be available from various commercial agencies and resources. Oil companies, fishing companies, rescue squads, and aeroclubs may voluntarily help with SAR missions. Aircraft and vessels in transit, while not suited for extensive searching, often assist in SAR. They may have a moral or legal obligation to assist. The SAR coordinator can only request assistance from such craft, not compel them. Commercial towing and salvage companies have a variety of equipment to assist distressed vessels, and may provide vessels to take over towing or salvage of a vessel no longer in immediate danger. The owner or agent of the disabled vessel usually arranges for such services. SRUs should not interfere if commercial facilities can safely complete the operation. SAR coordinators usually do not have authority to hire commercial facilities or personnel for SAR missions, and should be guided by agency directives. SAR coordinators may be able to have local or State officials procure such services, if they are legally able.

227 Private Agencies and Resources

SAR services may be provided by various private organizations and resources. Such organizations should be asked to coordinate activities with RCC SAR operations. If such groups want to assist, the RCC may advise them of cases occurring in their area. Specialized private groups are described below.

A. National Association for Search and Rescue (NASAR) members are dedicated to increasing Federal, State, local, and volunteer coordination, to making improvements in SAR services, and to promoting survival education programs. NASAR promotes improvement in SAR throughout the United States, but has no dedicated SAR facilities.

B. Mountain Rescue Association (MRA) mountain rescue teams are located in Alaska, Canada, and more than a dozen States. Mountain rescue teams are proficient in conducting rough terrain or mountain searches and rescues of lost or stranded persons. These teams may be requested by contacting AFRCC, which maintains a 24-hour alert list.

C. National Ski Patrol members are trained in first aid, search in snow-covered and avalanche areas, and ground evacuation of injured persons from such terrain. Ski patrol rescue teams can usually be alerted through any major ski resort.

D. National Speleological Society members explore and map underground caves. They have established a national cave rescue coordinator and staff for compiling procedures and practices for cave rescues. Each "grotto" (local club) throughout the United States maintains a rescue team, often including a doctor. Assistance can be requested by contacting AFRCC.

230 SAR RESOURCES

Resources available for SAR response include any SRU, station, operational activity, or other resource that can be used during a SAR mission. SAR coordinators organize them to provide the most effective response. SMCs normally select resources from those listed in the SAR plan, but may request other resources during a SAR mission. An SRU is any craft, vehicle, or team that can operate independently. The use of any SRU depends on SMC judgment, and is governed not only by SRU ability to reach the distress scene, but also by other SRU capabilities, training, and experience. While many resources exist, the National SAR Manual details only resources commonly available.

231 Aircraft SRUs

Aircraft SRU can quickly search large areas, intercept and escort aircraft or other SRUs, and perform aerial delivery of supplies, equipment, and personnel. While the pilot is the final judge of SRU capability during a mission, SMCs should consider the following when using aircraft SRUs.

A. General Aircraft Types and Capabilities

1. Helicopters, because of their slow speed and hovering ability, are effective aircraft SRUs, particularly for small targets or for close scrutiny of terrain or sea. Their ability to land in confined areas and to operate from ships usually enables them to aid survivors long before

surface SRUs can arrive.

a. SAR helicopters are usually equipped with a hoisting device for rescue and delivery operations. Most non-SAR helicopters do not have this equipment and must land or hover just off the surface to pick up survivors. Amphibious helicopters operate on both land and water surfaces, providing an optional method for rescuing survivors. Hovering ability decreases with increasing altitude, and is generally limited to about 6,000 to 10,000 feet maximum altitude.

b. Small, light helicopters are usually limited to visual flight or, in some cases, daylight flight only. While SAR helicopters are normally instrumented for both inclement weather and night flying, some may be prohibited from night hovering. Short- and medium-range helicopters usually have some navigational capability; many SAR helicopters have full navigational capability for isolated and oceanic area flight. Turbulence, gusting winds, or icing may limit helicopter use.

2. Land-based fixed-wing aircraft are excellent search platforms and can transport droppable supplies or pararescue personnel. Large aircraft normally require prepared surfaces from which to operate, while many small aircraft are capable of safely conducting operations from grassy or improvised strips. Where suitable landing strips are not far from the distress scene, fixed-wing aircraft can be used to expedite the evacuation of survivors brought out by helicopter, ground party, or other means. Fixed-wing aircraft can also direct surface craft or a ground rescue party to the scene once the target is located. If equipped with skis, they may effect rescue by using frozen lakes or rivers as runways. Such operations may be hazardous, and the urgency of the situation should be carefully considered before undertaking them.

3. Ship-based aircraft, usually helicopters, operate with great flexibility because of their well-equipped, mobile base. They are often capable of sustained search operations in remote areas where lengthy en route time reduces on scene endurance of land-based SRUs. The ship itself is usually well equipped to assist in rescue operations, and to receive and medically assist survivors.

4. An abbreviated SAR classification of aircraft; has been published by IMO and ICAO:

a. Fixed-wing aircraft	Abbreviation
Short-range (radius of action of 150 NM, plus 1/2 hour search remaining)	SRG
Medium-range (radius of action	

of 400 NM, plus 2 1/2 hours search remaining)	MRG
Long-range (radius of action of 750 NM, plus 2 1/2 hours search remaining)	LRG
Very-long-range (radius of action 1,000 NM or more, plus 2 1/2 hours search remaining)	VLR
Extra-long-range (radius of action of 1,500 NM or more, plus 2 1/2 hours search remaining)	ELR

b. Helicopters	Abbreviation
Light helicopter (maximum capacity for evacuating one to five persons/radius of action up to 100 NM)	HEL-L
Medium helicopter (maximum capacity for evacuating 6 to 15 persons/radius of action 100 to 200 NM)	HEL-M
Heavy helicopter (capacity for evacuating more than 15 persons/radius of action more than 200 NM)	HEL-H

Note: The categories L, M, H refer to the load-carrying capabilities. Some military helicopters have air refueling capability to extend their range.

B. General Operational Considerations

1. Range and endurance should be sufficient to allow the SRU to proceed to the distress, remain on scene as long as required, and return to base with the required fuel reserve. Range and endurance may be increased if a refueling site is available closer to the distress than the SRU's home base.

2. Speed and altitude requirements are determined by the SAR mission. Electronic search for an ELT or EPIRB requires a fixed-wing aircraft, capable of operating at high altitude and high speed, while a visual search for a small target may indicate the need for an aircraft capable of operating low and slow.

3. Maneuverability is necessary for SAR in mountainous areas but is less crucial for SAR over flat terrain. A measure of maneuverability is the smallest safe turning diameter. As turning diameter generally increases directly with true airspeed (TAS), a rule-of-thumb to compute fixed-wing turning diameter, in nautical miles, is:

$$\frac{TAS + 10}{100} = \text{TURNING DIAMETER (NM)}$$

4. Weather affects SRU capability to operate. Generally, the larger the SRU, the better the capability. Helicopters may have limited weather capability and some are prohibited from flying in conditions worse than light turbulence or light icing. Most SRUs are prohibited from flying in thunderstorms, severe turbulence, and severe icing. Weather conditions en route, on scene, and at the SRU departure airport must be considered.

5. Lookout transport is a major function of SRUs. The larger the number of lookout search positions, the more suitable the SRU. Aircraft with only one pilot are the least effective. Aircraft are high-noise, high-stress platforms on long missions, causing fatigue which decreases lookout effectiveness and flight safety. Multiple SRUs and shorter sorties, rather than fewer SRUs with longer sorties, are preferable.

6. Electronic capabilities may determine SRU ability to effectively navigate and complete a SAR mission, and also determine SRU mission use.

   a. Accurate navigation is essential not only for safety, but for search area coverage and reporting survivor position. Some small SRUs are not equipped with instrumentation adequate for flight under instrument flying rules (IFR). If instrument meteorological conditions (IMC) are forecast for any portion of the mission, the aircraft must have full instrumentation and a pilot licensed for instrument flight.

   b. SRUs should, as a minimum, be able to communicate with the OSC. Communication with the distressed craft or survivors is desirable, but may not be possible. Long-range SAR aircraft usually have communications capabilities comparable with medium-size ships. Sensors such as DF equipment and radar, which electronically detect the search object or survivors, often allow SRUs to expand track spacing.

7. Use also may be affected by other capabilities and equipment, such as the ability to make short field or amphibious landings, add auxiliary fuel tanks to increase range, effect rescue or aerial delivery, provide emergency care and life support, provide on scene illumination and contact with survivors, or self-start in remote areas.

232 Marine SRUs

Marine SRUs are usually most effective when combined with aircraft SRUs for a coordinated air/surface search, where their long endurance allows assignment as OSC, or when responding to nearby incidents where search is not a major factor. They are most satisfactory for rescues involving large numbers of survivors. A marine SRU may also be used to escort or tow disabled surface craft, and for surface delivery of supplies, equipment, and rescue or medical personnel to the distress scene. While the SRU commander is the final judge of SRU capability for each mission, SMCs should consider the following factors when using marine craft as SRUs.

A. General Craft Types and Capabilities

1. SAR boats, 30 to 65 feet in length, are generally short range and operate in sheltered or semi-sheltered waters, or for a limited distance offshore in moderate sea and weather conditions. Some are built to operate offshore in relatively heavy seas.

2. SAR patrol boats, 80 to 110 feet in length, can operate at distances farther offshore than SAR boats. Usually capable of conducting visual and electronic searches, their average search endurance is 3 days.

3. SAR vessels (ships) can participate in operations at considerable distances from base. Their main advantages are maneuverability and seaworthiness, range, speed, communications, and space for a large number of survivors and equipment. Coast Guard cutters and Navy vessels make excellent medium- and long-range SAR platforms.

4. Merchant vessels (M/Vs) can rendezvous with each other when one has a doctor and the other

has an ailing seaman, and can rescue crewmen abandoning a vessel or ditching an aircraft. They cannot be ordered to assist, and if they voluntarily comply with SMC requests, they should be thanked for their assistance. Many merchant vessels have surface radar, DF, satellite communications, VHF-FM voice, MF and HF voice, or CW capability. Their navigation equipment usually includes LORAN, and some have NAVSAT. Merchant vessels may have poor maneuverability, particularly if in ballast condition, and may not be able to reverse course in high winds and seas. Many merchant vessels carry lifeboats and liferafts.

5. Fishing vessels (F/Vs) are usually equipped with HF and VHF-FM voice radio and navigation capability. Those engaging in offshore operations may have loran receivers and DFs. Their SAR use is usually limited to multiple-unit sweeps through an area with adjacent fishing vessels in continuous sight of each other, rescue of survivors in close proximity, and communications relay.

6. Pleasure craft, including vessels of the Coast Guard Auxiliary (CGAUX), frequently are the first to report other vessels in distress, and often aid each other. Some larger pleasure craft are equipped with surface radar, LORAN, and DF.

7. Hydrofoil marine craft, capable of speeds in the range of 30 to 80 knots, are best used in coastal or semisheltered water SAR when fast response is desired. If they are equipped with fixed hydrofoils, which tend to keep them away from survivors in the water or from another marine craft, their rescue capability is limited. These craft are operated commercially, privately, and by the Navy.

8. Hovercraft (air-cushion vehicles) are often ideal SRUs where water and flat land abut. Amphibious capability and high speed, often 30 to 80 knots, also make them ideal for rescue in ice-covered areas, swamps, and shallow coastal areas. Most can maintain a position 2 to 6 feet off the surface and thus are not usually hindered by moderate seas, floating debris, or small obstructions.

9. Amphibious marine craft are used by the Armed Services. The type most commonly used for SAR is the Light Amphibious Resupply Cargo (LARC), which combines a boat hull on a wheeled land vehicle.

10. Specialized marine craft, both surface and submersible, may be needed for underwater search and recovery. Craft designed for other purposes, such as oceanographic work, may assist in underwater cases. Icebreakers designed for polar operations may be the only craft that can assist in heavy ice conditions. Some seagoing buoy tenders also have limited icebreaking capability.

B. General Operational Considerations

1. Speed must be maintained to cope with sea conditions. While small boats usually search at under 15 knots, hovercraft search at 30 to 80 knots, and large vessels search at 10 to 30 knots. Vessels will be unable to maintain such speeds in rough seas. High speed in some cases will affect SRU stability.

2. Radius of action is determined by SRU ability to proceed to the scene, remain on scene as long as required, and return to base with sufficient fuel reserve. Small boat endurance is limited to about 10 hours, SAR patrol boat duration is normally a maximum of 100 hours, and SAR vessel duration can be 30 days or more.

3. Maneuverability is essential for SAR operations in crowded harbors, near irregular shorelines, and in high-density surface traffic areas.

4. Seaworthiness, the ability to operate in adverse sea conditions, is important. Generally, larger SRUs have the better seaworthiness, seakeeping qualities, and weather/sea penetration capability. As sea conditions become more extreme, an SRU must decrease speed to reduce pounding and crew fatigue, and may be unable to maintain a desired course. SAR boats are usually limited to 4-foot seas and 25-knot winds, while larger boats can operate in more extreme wind and sea conditions.

5. Depth of water in which a vessel can safely operate must be compared with the depth of water at the scene of distress. The average draft of a SAR boat is 4 to 6 feet, with some only 1 foot; a SAR patrol boat, 6 to 12 feet; a medium-size SAR vessel, 12 to 16 feet; large SAR vessels, 16 to 25 feet. Supertankers and other deep draft vessels may draw 80 feet or more.

6. Lookout capability is determined by SRU

manning and configuration. Larger vessels are often more suitable because more crew members, positioned higher to see farther, may be lookouts.

7. Electronic capabilities help determine the ability to effectively navigate and complete a SAR mission, and also determine SRU selection and use.

a. While navigational accuracy of vessels is within 5 miles in oceanic areas, sophisticated navigation equipment may reduce errors to less than a mile. Small boats may have only minimal navigation equipment. The ability to home on a distressed craft is desirable; the homing range is usually line of sight. Some SRUs are not equipped with automatic direction finding.

b. Communication with the OSC and distressed craft or survivors is the desired minimum. Small boats generally have limited communications, consisting of VHF-FM, and possibly HF, equipment. SAR vessel communications usually span the low frequency, medium frequency, high frequency, very high frequency (both AM and FM), and ultra-high frequency bands. Medium- and high-endurance Coast Guard cutters and Navy vessels of frigate size and above may also have radio teletype, facsimile, and data communications capability.

c. Only specially equipped surface vessels and submersibles can conduct underwater search and recovery operations. The Navy operates, or contracts for, most of these vessels.

8. Other capabilities and equipment

a. Surface delivery. Marine craft are usually reliable platforms, especially under adverse conditions, for towing or delivering resources such as dewatering pumps, firefighting equipment, and damage control and medical personnel.

b. Surface recovery. SAR boats are ideal for recovery of persons in sheltered and semisheltered waters. SAR vessels are used for personnel recovery offshore and in open seas. SAR vessels may be able to recover persons from the water by launching small boats, using rescue swimmers, or bringing the vessel alongside.

c. Survivor support. Medium- and high-endurance Coast Guard cutters and Navy vessels of frigate size and above can usually accommodate 100 to 150 survivors for several days. SAR vessels can usually provide emergency care and continuing life support for survivors. SAR boats provide more limited emergency care, but may be capable of providing first aid.

d. Rescue and illumination equipment. SAR vessels normally carry a variety of specialized equipment, including loud hailers, portable radios, searchlights, scramble nets, boarding ladders, rescue slings and rescue baskets, portable floodlights, line-throwing guns, heaving lines, grapnels, cutting tools, body splints, litters, emergency care supplies, rafts, boats, high-line transfer equipment, survival equipment, food, water, floating lights, and other markers such as smoke generators and electronic beacons. SAR boats are more limited and are normally equipped only to rescue personnel from the water, give basic first aid, and rapidly transport survivors to a nearby harbor or SAR vessel. Boat rescue equipment is usually limited to heaving lines, liferings, life jackets, litters, boathooks, boarding ladders and, in some cases, dewatering pumps and firefighting apparatus.

e. Helicopter platform. Many SAR vessels can bring aboard, transport, launch, and in some cases refuel, helicopters. The SRU helicopter deck and facilities must be compatible with the helicopter.

233 Land SRUs

A. Personnel utilizing animals, vehicles, and other equipment, may be used as land SRUs to penetrate inaccessible areas to provide immediate emergency medical care and subsequent evacuation of survivors, or to track survivors. Although search by land SRUs alone is usually impractical for large search areas, it can be conducted in most weather conditions, and can provide complete coverage of the area searched.

B. Although many SRUs are organized for search, rescue, or both, and many are specialized for a particular environment, SMCs may organize a land search from available personnel and equipment rather than use specialized teams. SRUs should not normally be used without adequate transportation, navigation, rescue and medical training and equipment, physical training, skill in communications and survival, leadership, and familiarization with the locale and terrain.

C. Air Force pararescuemen are highly trained land SAR personnel and the first considered for supervision of ground search teams. Specialized teams such as Army, Navy, and Air Force explosive ordnance disposal (EOD) teams, Navy sea-air-land (SEAL) teams, or CAP ranger teams should be considered next.

D. Nonmilitary governmental SAR teams, such as those of county sheriffs, and United States Forest and National Park Services are normally also well qualified. Privately organized, amateur rescue teams active in land SAR exist nationwide. Volunteers may be used for land search missions if appropriate equipment and supervision are provided. Chapter 8 provides guidance for land SRU use.

234 Primary Federal SAR Resources

The principal Federal SAR resources are maintained by the Coast Guard, other Armed Services, the FAA, and the FCC. Each SAR Coordinator establishes procedures for alerting and using SAR area or regional resources. Generally, use of any resource is arranged by contact between the RCC and the parent agency. Primary SAR resources are described below, by agency.

A. The Coast Guard maintains a wide variety of SAR resources, primarily dedicated to maritime SAR throughout the United States and its territories. Coast Guard operations are supported by an extensive communications network of coastal radio stations, specialized land-line circuits, and communications centers, all guided by RCCs. Primary resources include:

1. Aircraft, the long-range HC-130 and medium-range HU-25 fixed-wing and HH-3, and HH-65 helicopters.

2. Cutters, classified as high-endurance cutters (WHECs), medium-endurance cutters (WMECs), and patrol boats (WPBs), along with buoy tenders, icebreakers, and harbor tugs.

   a. WHECs, 378 feet in length, are capable of sustained search operations at sea without replenishment for approximately 30 days. They are equipped with helicopter flight decks and support equipment for servicing helicopters at sea, and have air and surface search radar, "Identification, Friend or Foe" (IFF) interrogator and transponder, DF, sonar, and oceanographic equipment.

   b. WMECs, 180 to 270 feet in length, are capable of sustained operations and usually have surface search radar, IFF interrogator and transponder, and DF. WMECs 210 and 270 feet in length are equipped with helicopter flight decks and support facilities for servicing helicopters. Replenishment of supplies and refueling can extend WHEC and WMEC endurance.

Their sustained operational capability, especially when they are paired with a SAR helicopter, makes them ideal SRUs. Patrol boats, 80 to 110 feet in length, are capable of sustained operations for 4 days, and usually have surface search radar and DF.

3. Boats ranging up to 65 feet in length. The 30- and 41-foot utility boats and 30- and 44-foot motor lifeboats are especially designed for short-range SAR operations. They are excellent for water rescue and can be used for search. The 44-foot motor lifeboats have surface search radar, DF, and LORAN C and are self-righting and self-bailing in severe weather or surf. The 52-foot motor lifeboat has the same capability.

4. Stations, located along the coastlines of the United States, on the shores of the Great Lakes, and on some of the major river systems. They are equipped with various types of SAR boats, four-wheel-drive vehicles, direct communications links with an RCC, and, in some cases, amphibious vehicles or helicopters. A primary purpose of these stations is to obtain early information of life and property in danger within the operational range of station SRUs and take immediate action to assist. These stations also supervise SAR land parties, usually limited to shoreline or beach areas.

5. Groups, consisting of two or more SAR stations and sometimes including WPBs and a Coast Guard Air Station (CGAS). Group commands are an operational level, designed to coordinate SRU efforts, between the Coast Guard District Commanders and Coast Guard stations.

6. Coast Guard Auxiliary (CGAUX), a volunteer civilian organization formed to assist the Coast Guard in preventive and direct SAR activities, consisting of smallboat, yacht, aircraft, or amateur radio station owners, or persons with

special qualifications desirable in the field of either boating safety or SAR. Members train in seamanship, navigation, communication, SAR, patrol procedures, weather, and administration. CGAUX provides several thousand privately owned SRUs throughout the United States for SAR operations. In some locations CGAUX SRUs are the only available SAR facilities. CGAUX personnel may also supplement Coast Guard personnel at various SAR stations during heavy SAR operations. Single-engine CGAUX aircraft are limited to operations within gliding distance of the shoreline for coastal search. The CGAUX communications net often supplements the established coastal radio net.

7. Automated Mutual-Assistance Vessel Rescue System (AMVER), a computerized system for maintaining the DR position of participating merchant vessels worldwide. Merchant vessels of all nations making coastal and oceanic voyages are encouraged to send movement reports and periodic position reports to the AMVER center in New York via assigned coastal or international radio stations. Only two nations, the United States and Norway, require their merchant vessels to participate; other merchant vessels participate voluntarily. The AMVER center can deliver a surface picture (SURPIC) of vessels in the area of a SAR incident, including predicted positions and SAR capabilities. This service is available to any SAR agency worldwide for SAR incidents. SURPICs can usually be obtained for periods 24 hours into the future and up to 90 days into the past. SMCs handling oceanic SAR can request a SURPIC anytime it might be considered useful.

B. Air Force missions are coordinated by the Air Force Rescue Coordination Center (AFRCC), at Scott AFB, IL. AFRCC is also the liaison between other SAR coordinators and the FAA National Track Analysis Program (NTAP). Other Air Force resources may be controlled by other commands. Primary resources are described below.

1. Air Rescue Service (ARS) aircraft of the Military Airlift Command (MAC) include various short and long range helicopters, some of which can air refuel from tanker aircraft, providing a versatile SAR asset. ARS units are globally deployed and are equipped for personnel or equipment recovery, and pararescue missions.

2. Jet interceptors can proceed at high speed to intercept a distressed aircraft, fix the location, provide navigation and communications aid, and escort. If the intercept cannot be made before the distressed unit is forced to land, the jet may be in position to locate the landing or crash site. FAA ATC facilities are equipped to provide intercept advisories to all SAR aircraft.

3. Air Force MAC aircraft also perform aeromedical evacuation of military personnel, their dependents, and authorized civilian

patients worldwide. Within the United States, the 375th Aeromedical Airlift Wing is headquartered at Scott AFB. Subordinate detachments, plus almost 50 Air National Guard and Air Force Reserve aeromedical units, are located throughout the United States and are available for airmedevac missions. Aeromedical Evacuation Control Centers (AECCs) are continuously manned.

4. Special-Purpose Aircraft, such as photographic reconnaissance aircraft, operated by the Strategic Air Command (SAC), or Side-Looking Radar Reconnaissance (SLAR) aircraft, can be used over both water and land. In addition, Electronic Intelligence (ELINT) and Electronic Countermeasures (ECM) aircraft are equipped with a variety of sensors for determining the location of electromagnetic emitters. Their equipment includes sophisticated DF and usually some type of filmstrip recording capability for photographic, radar, and electronic targets. Flights may be requested through AFRCC. Other aircraft also have Airborne General Illumination Lightself (AGIL), sometimes called a Battlefield Illumination Assistance System (BIAS). It is effective in search efforts and invaluable in the lighting of distress areas. This system is more dependable, more economical, and less hazardous than parachute flares.

5. The Civil Air Patrol (CAP), using corporate and privately owned aircraft, flies the majority of SAR missions in the Inland Region. The CAP, composed of aviation-oriented civilians, military reservists, and active duty military volunteers, is organized along conventional military lines, by state wings. CAP facilities operate in every state and Puerto Rico. At least one RSC, normally unmanned except while conducting an active mission, is usually maintained in each wing. CAP forces are activated by the AFRCC, which authorizes CAP SAR missions. In the Alaskan

Overseas Region the Alaskan CAP Wing is activated by the regional SAR coordinator. Except in Hawaii and Puerto Rico, single-engine CAP aircraft are not used over water beyond gliding distance of a shoreline. CAP works closely with FEMA on a ground and airborne radiological survey mission. CAP also has SAR ground teams supported by other CAP members who can establish base camps providing meals and shelter.

6. Air Force Special Operations Command pararescue units, SAR personnel highly trained in such fields as parachuting, mountaineering, survival in all environments, advanced emergency medical care, underwater scuba swimming, and aircraft crash fire fighting, can deploy from aircraft over any type of terrain or ocean, day or night, to assist survivors. The pararescue team usually consists of two pararescuemen equipped with emergency medical care kits, survival kits, and either scuba or forest penetration parachute kit.

7. Air Defense Command (ADCOM) radar net, along with the FAA, provides coverage around the perimeter of the continental United States. Input from radar sites is fed into various ADCOM direction centers located at strategic points within the United States. These centers continuously monitor all radar targets approaching United States borders and coastlines. If a radar target is not positively identified within minutes, ADCOM scrambles fighter/interceptor aircraft to intercept. Radar coverage may extend as much as 500 miles offshore, and may provide a precise position where an aircraft has ditched, or where a bailout has occurred. This service may entail a search of previous ADCOM radar net information. The ADCOM radar net can be alerted when aircraft are reported lost in coastal and oceanic areas of the United States, when a radar check may be helpful, when an intercept of a distressed aircraft is needed, or when on scene search and radar control are desired.

8. Recorded Radar Systems

a. 6521st Test Squadron, Edwards AFB Range Control. In support of the mission of the USAF Flight Test Center located at Edwards AFB, CA, the 6521st Test Squadron records primary and secondary radar data received from 10 radar sites (2 long range/8 short range). These data are recorded by means of an MODARC processing and display system. Data recorded by the 6521st M-DARC system is retained for approximately 30 days and can be retrieved via a playback of the recording medium.

b. 552nd Airborne Warning and Control Wing (AWACS). In support of the global mission of the USAF, the 552nd AW&C Wing, based at Tinker AFB, OK, operates the Boeing E-3 "Sentry". Many of the aircraft operate within domestic U.S. airspace during the course of their daily flight operations.

During airborne operations, radar data from the on-board search radar records both primary and secondary data. Although much of the information regarding the E-3's operating system are classified, recorded data is normally retained for 10 days and can be retrieved via a playback of the system recording. Additionally, recorded data can by hard copied to a printer or a plotter by 552nd AW&C Wing (ADUE) personnel. Initial request for a search of data should include date and time (UTC), and a latitude/longitude position.

c. USAF Air Defense Radar Systems. USAF Defense radars, although capable of recording, do not normally record radar data unless a specific airborne target is designated as a special interest track. Due to the requirement that a specific track be identified as special interest before it would be recorded, Air Defense radars are the least likely to assist in SAR cases.

9. Military Assistance to Safety and Traffic (MAST) assists in serious civilian medical emergencies in areas that do not have available civilian services. Assistance is given if it does not interfere with primary military missions.

C. Navy resources include extensive numbers and types of aircraft, surface and submarine vessels, sea-air-land (SEAL) teams, diving teams, pararescue teams, salvage forces, and radar nets, Sound Fixing and Ranging (SOFAR) nets, and worldwide communications and DF networks. Naval commanders will normally assist SAR coordinators in handling SAR missions. Primary resources are described below.

1. Aircraft types include, both fixed-wing and helicopters. The P-3 Orion long-range aircraft is equipped with radar, extensive communications, and a variety of sophisticated sensors, including, forward looking infrared radar

platform. Also of use for SAR are carrier-based antisubmarine warfare (ASW) (S-3 Viking) and early warning fixed-wing (E-2 Hawkeye) aircraft. The primary SAR helicopter for visual conditions is the HH-46A, and the SH-3 Sea King is an excellent all-weather SAR helicopter. The SH-2 Sea Sprite, carried on some cruisers and destroyers, can also be used. The endurance of these helicopters can be increased if used with ships having helicopter refueling facilities. Special-purpose aircraft, similar to those operated by the Air Force, are also available.

2. Vessels most often used for SAR are destroyers (DD) and fast frigates (FF) for surface search, aircraft carriers for air search, and submarines, salvage vessels, and oceanographic vessels for subsurface search. Destroyers and fast frigates are comparable to Coast Guard WHECs in operational capabilities and equipment for SAR missions, and many can refuel a hovering helicopter equipped to receive a fueling hose. Shipboard Aviation Facilities Resume, NAEC-ENG-7576, describes helicopter refueling capabilities.

3. Boats, such as crash-rescue boats, patrol craft, patrol torpedo boats, and river craft, may be used for sheltered or semisheltered water surface search. They are most effective in rescuing personnel from the water.

4. Navy "salvage" units may salvage public and private vessels, and claim reimbursement for such operations. Navy policy is to assist in the salvage of non-Navy shipping when such assistance is requested, and where adequate privately owned salvage facilities are not available. Seagoing tugs or salvage vessels may be deployed for salvage missions. Stocks of salvage equipment and material suitable for airlifting are also maintained.

5. Pararescue units are located in isolated areas, such as the Antarctic. Also, underwater demolition and sea-air-land (UDT/SEAL) teams are qualified in parachuting, underwater swimming, survival, and demolition. Each UDT/SEAL team normally has at least one member highly trained in advanced emergency medical care.

6. A Movement Reporting System monitors Navy vessel positions worldwide. If an SMC wants to find a suitable Navy ship for an oceanic SAR mission, the appropriate fleet commander can be queried, via Contact Area Summary Position Report (CASPER), for Navy vessels in the area. Navy vessel movements are classified and will not normally be released. While individual vessel data may be provided, the information source, code words, departure points, and destinations are not revealed.

7. Sound Fixing and Ranging (SOFAR) nets can pinpoint the

location of small SOFAR devices detonating at predetermined depths underwater. SOFAR nets are effective only in ocean depths greater than the continental shelves (600 ft). Land masses, including underwater sea mounts, will block the SOFAR sound signals.

a. SOFAR devices may be released by aircraft, vessels, or boats experiencing difficulties, or by survivors adrift on the ocean; if time does not permit release before the distressed craft ditches or sinks, a device may automatically arm itself at approximately 800 feet and detonate between 2,400 and 4,000 feet. One station can obtain a line of position (LOP) and an approximate range on each signal. Two stations can cross LOPs to obtain a fix with an accuracy of approximately 2 miles.

b. SMCs can query the SOFAR net any time a craft known to carry a SOFAR device is missing. If a craft is definitely overdue, the SOFAR net can search its recordings for SOFAR signals from the last contact with the distressed craft to the present, since survivors may have SOFAR devices in rafts as well as in their vessel.

c. SAR aircraft carrying SOFAR devices can use them in conjunction with SOFAR stations to maintain a constant bearing with a distressed craft. When a SAR aircraft arrives on scene, the SOFAR net may be able to vector it directly to the SOFAR datum. The SAR aircraft may also be able to release a SOFAR device at a distress scene where a lack of navigational aids prevents accurately fixing the distress position.

8. The High-Frequency Direction-Finding (HFDF) net has a frequency range between 2000 kHz and 30,000 kHz, and covers both the Atlantic and the Pacific oceans. This net is alerted when there is a reasonable expectation of locating the distressed craft. To alert, SMCs provide certain information, outlined by Navy OPNAVINST C2520.1 series and Coast Guard COMDTINST

3130.16 series. The SMC should de-alert the net as soon as possible after the distressed craft is located.

9. Recording Radar Systems.

a. USN Fleet Area Control and Surveillance Facility (FACSFAC). The U.S. Navy operates FACSFAC facilities at Oceana, VA, Jacksonville, FL, San Diego, CA, and Honolulu, HI. These facilities utilize both long and short range radars in support of the Navy's offshore surveillance requirements for aircraft operating in coastal warning areas. These facilities generally provide radar coverage from the shorline, out to sea. FACSFAC facilities record primary and secondary radar data shich is retained for a period of 15 days. Data can be rapidly extracted via a visual playback of the recording medium while also producing a hard copy of the playback.

b. TPX-42(DAIR) Terminal ATC Radar Systems. USN and Marine Corps Air Stations record terminal ATC radar data via the TPX-42(DAIR) recorder. Data from these systems are limited to secondary radar only to a maximum range of 60 nautical miles. Recorded data is retained for 15 days and can be rapidly extracted via a playback of the recording medium.

D. The Army, the designated SAR Coordinator for military operations responding to natural disasters within United States territory, maintains a large variety of resources, including a large number of helicopters, light aircraft, ground vehicles, and surface detection nets. Primary resources are described below.

1. Aircraft, either helicopters or light fixed-wing, are excellent search aircraft. Some helicopters do not have hoisting capability, and must land or hover just off the terrain to retrieve survivors, or use alternative devices. Some aircraft have SLAR and other sensors for electronic and radar searches. Pilots are experienced in low-level flying and highly trained in visually detecting search targets. Aircraft are usually restricted to operations over land.

2. Land SRUs are numerous, and vary widely. Many personnel are trained in land search operations, providing an excellent source of SRUs for incidents requiring large numbers of personnel and equipment.

3. Disaster equipment includes portable hospitals that can be transported by truck or airlifted. Stocks of cots, food, medicines, and other equipment exist to meet the Army mission of disaster assistance. Equipment may be issued directly at disaster sites or to the American National Red Cross.

E. The Federal Aviation Administration (FAA), in addition to other resources, maintains a nationwide communications net, coordinated with international aeronautical communications services for the control, coordination, and assistance of civil and military air traffic. Primary resources which may be used for SAR are:

1. Aircraft of various types, usually operated to check the proper functioning of aids to air navigation and to perform other regulatory missions. These aircraft are equipped with sophisticated sensors and area navigation equipment.

2. Flight-following and alerting services. ARTCCs provide flight-following service for aircraft on flight plans under instrument flight rules (IFR) and alert RCCs when an aircraft is overdue. Flight Service Stations (FSSs) provide flight-following service for aircraft on flight plans under visual flight rules (VFR) and alert RCCs when these aircraft become overdue.

3. Radar nets, independent and joint radar sites operated by the FAA and ADCOM. They provide almost complete coverage of the continental United States, Alaska, Hawaii, Panama, and Puerto Rico. All sites are equipped with IFF interrogators for use in ATC. Most major civil and military aerodromes have short-range terminal radar which may obtain radar contact with distressed aircraft in the vicinity. The National Track Analysis Program (NTAP), formerly known as ITAP, can retrieve computer-stored radar data up to 15 days old to pinpoint a missing aircraft's last known position. The key item for a successful NTAP solution is the objective's last fix. NTAP information should be requested through AFRCC, Scott AFB. In addition to the recording radar nets listed for USAF and USN, FAA recording Radar nets include:

a. Air Route Traffic Control Centers (ARTCC) facilities operated by FAA within the continental U.S. and at offshore locations, record primary and secondary radar data through a series of long range radar sited via NAS computers. Recorded data is retained for a period of 15 days. Data can be extracted in a hard copy form. In some cases, data can be viewed on a CRT providing a more rapid form of review.

b. Automatic Radar Terminal System 3 (ARTSIII). The FAA operates 62 Terminal Radar Approach Control (TRACON) facilities equipped with the ARTSIII tracking computer. ARTSIII systems generally record both primary and secondary radar. Recorded data is retained for 15 days and is extracted in a hard copy format.

4. VHF direction-finding nets, covering the frequency bands of 118-156 MHz. These nets, composed of DF sites at airports and FSSs, are supplemented by military airport DF sites, and provide almost complete coverage of the continental United States and Alaska. DF sites are also located in Puerto Rico, the Virgin Islands, the Hawaiian Islands, and Wake Island.

a. The FAA operates approximately 27 ARTCCs for all areas where the United States provides ATC services. Each ARTCC is responsible for maintaining a VHF DF net within its area of control, and acts as the net control station. ARTCCs may pass net control to any DF station within their net. VHF DF nets locate aircraft that are lost or experiencing an emergency and then vector them to the nearest suitable airport. The net can also vector SAR aircraft to the same line of bearing as the distressed aircraft, help the SAR aircraft to maintain the same bearing line, and aid in completing an intercept.

b. A DF net is alerted any time a pilot admits being lost or declares an emergency, and may be alerted via any ARTCC, FSS, FAA tower, military tower, or RCC. When an RCC alerts a net, it should provide the following:

(1) Call sign or other identification of the distressed aircraft.

(2) Frequency and type of transmission (MCW or voice) being used by the distressed aircraft.

(3) Call sign or other identification of intercepting aircraft.

(4) Whether the distressed aircraft is or is not transmitting at the time of the call, or when it is next scheduled to transmit.

(5) Nature of the emergency, including emergency phase (Distress, Alert, or Uncertainty).

(6) Organization requesting DF assistance.

The net usually continues alert status for aircraft forced to ditch, or crash land, to obtain bearings on emergency radio beacons or crash position indicator (CPI) radio beacons. The net control station de-alerts the net automatically when the emergency is over.

F. The Federal Communications Commission (FCC) operates a 400 kHz to 40 MHz Direction-Finding Net that covers the inland United States, the Pacific Ocean and the Atlantic Ocean. A Watch Office in Washington D.C. monitors MF, HF, and VHF distress calls 24 hours a day. The FCC also operates field offices with personnel who can locate ELTs and EPIRBs using mobile and portable DF equipment. FCC services should be used for urgent SAR only and are generally not available to the public.

1. SMCs may activate the net by calling the FCC Watch Officer at 202-632-6975, or the nearest FCC office during normal business hours, and providing the same information needed to alert the FAA net. SMCs should ensure the FCC net is de-alerted as soon as possible after the distressed unit is located.

2. The FCC net provides an elliptical area containing the most probable location of the distress and the longitude and latitude of the ellipse's center. While the net usually does not provide DF bearings with a fix, SMCs should request all available bearings.

G. The National Transportation Safety Board (NTSB) based on the requirement to rapidly locate recorded radar data in conjunction with accident/incident investigations, developed a computer program containing a database of all U.S. Civilian (FAA), U.S. Military, and Canadian (civil) ground based radars capable of providing recorded radar data.

The program, known as RADARFIND (RADF), provides the user with a listing of all radar sites with the potential for recording data within range of the sites. The individual site listings provide identification of the owning facility (3 letter designator), along with true bearing (degrees) and nautical mile distance regarding a specific latitude/longitude listing.

The latest version of the RADF program is used by AFRCC. Additionally, the program has been provided to the other U.S. and Canadian operated RCC's in an MS/DOS format. The RADF is updated as required and additional MS/DOS copies are available to recognized SAR organizations upon request. The RADF program may be ordered through:

NTSB (TE-30)
ATTN: RADF
800 Independence Avenue, S.W.
Washington, DC 20594

When ordering specify: IBM PC-MS/DOS 360K (5 1/4") or 720K (3 1/2") format or TANDY2000 720K (5 1/4") format.

CHAPTER 3. SAR COMMUNICATIONS

300 GENERAL

SAR Communications may be the most important, and often the weakest, link in the SAR system. SAR communications occur between the distressed unit and the SAR system, and between the components of the SAR system. Ensuring that the message sent is the message received is crucial to the success of SAR operations. See Chapter 8 for specifics involving Land SAR.

310 EMERGENCY COMMUNICATIONS

Personnel in distress have a variety of methods, ranging from sophisticated electronic devices to waving a piece of cloth, for alerting the SAR system. SAR personnel should be familiar with emergency signals and devices.

311 Visual Signals

The visual signals most commonly used are listed in Appendix C. In addition to these signals, daylight visual signals may include mirrors, fluorescent material, sea dye markers, or smoke signals. Night devices may include strobes, incandescent or chemical lights, fires, and star shells or other pyrotechnics or reflective materials.

312 Electronic Signals

A. Radio alarms are international radio alarm signals to alert other craft or radio stations:

1. A radiotelegraph alarm signal, a series of twelve, 4-second dashes with 1-second spacing, transmitted on 500 kHz for actuating automatic alarm devices on ships and coastal marine radio stations not maintaining a continuous listening watch on 500 kHz.

2. A radiotelephone alarm signal, a warbling two-tone signal on 1300 Hz and 2200 Hz, alternating 4 times per second and continued for 30 seconds to 1 minute. It is transmitted on 2182 kHz or 156.8 MHz (channel 16) in alert or emergency situations to attract attention and actuate automatic alarm devices.

3. An All Ships Selective Call signal, actuating the receiving selectors on all ships that are equipped with Digital Selective Calling (DSC), regardless of code number. It is a continuous sequential transmission of 11 unique audio frequencies. The total duration of an "All Ships Call" signal should be at least 5 seconds.

4. A Navigational Warning signal, a one-tone signal at 2200 Hz, interrupted so that the duration and space are 250 milliseconds each. The signal is transmitted by coastal stations continuously for a period of 15 seconds before navigational warnings on radiotelephone in the medium-frequency maritime bands. The signal attracts the attention of a watch or actuates an automatic device to activate a loudspeaker.

B. Distress signals indicate that a craft or person is threatened by imminent danger and requires immediate assistance. A voice distress signal is preceded by the word "Mayday". Units hearing the distress signal should cease transmitting and listen for at least 3 minutes before resuming communications. Appendix C lists distress signals.

C. Urgency signals indicate that a calling station has an important safety message to transmit. In radiotelegraph transmission the urgency signal is a CW transmission of the characters XXX. In radiotelephone transmission it is the words, "Pan, Pan" spoken three times immediately before transmission. Units hearing the urgency signal should cease transmitting and listen for at least 3 minutes before resuming normal communications.

D. Safety signals indicate that a calling station is about to transmit a message concerning safety of navigation or give important meteorological warnings. In radiotelephone transmission it is the spoken word "Securite" (pronounced say-cure-etay), transmitted three times immediately prior to transmission of the safety message. Units hearing the safety signal should listen and not interfere with the safety message.

313 Emergency Frequencies

Several frequencies in different radio bands are assigned for distress, urgency, safety, or SAR signals and messages. SAR personnel should thoroughly understand the frequencies and their authorized use. The designated frequencies are:

A. Emergency Communications Frequencies. The unit in distress, or a station that has been assigned controlling responsibility by the unit in distress, controls distress traffic. However, for cases involving international civil aviation, the station addressed by the distress message controls distress traffic. Once communications are established with a distressed unit, they should be maintained on the same frequency. The following frequencies have been assigned as distress or emergency frequencies:

1. 500 kHz - International CW/MCW distress and calling (Navy ships are no longer required to maintain a listening watch or log on this frequency).

2. 2182 kHz - International voice distress, safety, and calling.

3. 4125 kHz - International voice distress, safety, and calling (backup frequency not presently guarded by Coast Guard units).
4. 6215.5 kHz - International voice distress, safety, and calling (backup frequency not presently guarded by Coast Guard units).
5. 8364 kHz - International CW/MCW lifeboat, liferaft, and survival craft.

6. 121.5 MHz - International voice aeronautical emergency, ELTs and EPIRBs.

7. 156.8 MHz (channel 16) - VHF-FM international voice distress and international voice safety and calling, Class C EPIRBs (alternating 156.8 and 156.75 MHz).

8. 243.0 MHz - Joint/Combined military voice aeronautical emergency and international survival craft and ELTs and

EPIRBs.

9. 27.065 kHz (Citizens Band channel 9) - Monitored by many public service organizations and, to a limited extent, by Coast Guard shore stations.

B. SAR Dedicated Frequencies. The following frequencies have been dedicated for SAR use:

1. 3023 kHz - International voice/CW SAR on scene.

2. 5680 kHz - International voice/CW SAR on scene.

3. 123.1 MHz - International voice SAR on scene.

4. 156.3 MHz (channel 6) - VHF-FM merchant ship and Coast Guard SAR on scene.

5. 282.8 MHz - Joint/Combined on scene and DF.

6. 40.5 MHz (FM) - United States Military Joint Common Frequency (previously Air Force distress frequency).

7. 8364 kHz - During Navy Maritime Patrol Aircraft (MPA) operations in support of fleet units, a listening watch, governed by NWP-19, should be maintained by supporting units or the "guard" ship.

314 IFF Equipment

Identification Friend or Foe (IFF) equipment consists of a radar interrogator and a transponder. The interrogator, incorporated into an air search radar system, transmits an electronic challenge. Any transponder within range replies with a user-entered code and, in most transponders, altitude. Transponder replies may be detected at greater range than the radar return of the craft itself. The user can dial codes into the transponder to signal a message to the interrogator operator. Code 7700 indicates a distress, Code 7600 a communications failure, and Code 7500 an unlawful interference with the aircraft. When no other code is assigned, Air Force and Coast Guard aircraft are authorized to use Mode 3, Code 1277 in domestic airspace, on official SAR missions, and en route to or within an assigned search area.

315 EPIRB and ELT

The Emergency Position Indicating Radio Beacon (EPIRB) and the Emergency Locator Transmitter (ELT) are small emergency radios that may be fully automatic, semi-automatic, or hand activated. They may be transmitters only, transceivers, beacons only, or a combination. The various types are described below.

A. EPIRBs are passive devices for transmitting maritime distress alerts. Six classes of EPIRBs are currently in use by United States vessels:

1. Class A EPIRBs operate on 121.5 and 243 MHz and are automatically activated. They are now carried aboard all Coast Guard vessels of the WPB class and larger, and are required on all vessels inspected for ocean and coastal trade whose route extends more than 20 miles from a harbor of safe refuge. They transmit for at least 48 hours.

2. Class B EPIRBs operate on 121.5 and 243 MHz and are manually activated. Their use is voluntary for uninspected vessels, but all vessels which travel more than 20 miles offshore are encouraged to carry either Class A or Class B EPIRBs. They transmit for at least 48 hours.

3. Class C EPIRBs operate on VHF/FM. They transmit a 1.5-second alert signal on channel 16 (156.80 MHz) to call attention to a distress, then transmit a 15-second locating signal on channel 15 (156.75) to allow homing. Both signals repeat periodically, and are designed after the international two-tone alarm signal. They automatically transmit for 24 hours and then shut off. They can then be manually reactivated.

4. Class S EPIRBs operate on 121.5 and 243 MHz and are used in survival craft. These EPIRBs can be automatically or manually activated and (optionally) be required to float. These EPIRBs may provide either continuous or intermittent operation. If intermittent, the duty cycle is 50 percent for a 2 minute period.

5. Category I 406 MHz Satellite EPIRBS are automatically activated, float free devices operating in the 406 MHz band internationally allocated for satellite EPIRBs. These devices are coded with vessel information and when activated, this coded information will be transmitted via the satellite system to the appropriate RCCs. These devices provide accurate location information worldwide. Similar to Class A EPIRBs in usage, SOLAS and other classes of vessels (e.g. fishing

vessels) will be required to carry Category I 406 MHz Satellite EPIRBs. These EPIRBs transmit for at least 48 hours.

6. Category II 406 MHz EPIRBs are similar to the Category I devices except the Category II EPIRBs are manually activated. Similar to the Class B EPIRBs in usage, vessels are encouraged to replace aging 121.5 MHz EPIRBs with the 406 MHz Satellite EPIRBs. These EPIRBs transmit for at least 48 hours.

B. ELTs, also referred to as Crash Position Indicators (CPIs) and as Emergency Location Beacons-Aircraft (ELBAs), emit a distress signal on 121.5 MHz and/or 243.0 MHz either when turned on manually or when subjected to G-forces, such as an aircraft crash. They are required on most noncommercial aircraft registered in the United States. Certain classes of aircraft, such as agricultural and aerobatic, are not required to carry an ELT. Commercial aircraft with extended overwater operation carry an ELT for use in one liferaft. 406 MHz satellite ELTs are coming into international use; these devices will provide accurate positions worldwide.

C. COSPAS-SARSAT

1. A national glossary of terms and abbreviations for COSPAS-SARSAT was developed to help standardize and clarify terms, and reduce national use of multiple terms with the same or similar meaning. Since COSPAS-SARSAT is part of the GMDSS and serves the SAR system, account was taken of terminology already used internationally for SAR. Terms selected are those likely to be encountered and used by SAR personnel and have been incorporated into the Abbreviations/Acronyms and Glossary of this manual.

2. COSPAS-SARSAT alerts not determined to result from signals emanating from beacons are

```
                              ALERTS
          -------------------------|-------------------------
          |                        |                        |
     NON-BEACON                 BEACON                 UNRESOLVED
       ALERTS                   ALARMS                   ALERTS
     ______________________________|______________________________
     |                   |                    |                   |
   HOAX              DISTRESS            INADVERTENT          UNRESOLVED
                       ALARM                ALARM                ALARM
```

Figure 3-1. Explanation of COSPAS-SARSAT Alerts {1}

either unresolved or determined to result from a non-beacon source. Once alerts are determined to be the result of beacon signals, they are referred to as alarms.

3. For COSPAS-SARSAT purposes, beacon alarms are either distress-related, inadvertent, intended to deceive, or unresolved. The terms "false alerts" and "false alarms" are used in various ways. Generally, as shown in Figure 3-1:

a. False alerts include non-beacon alerts and those unknown number of unresolved alerts that did not result from a beacon signal (unresolved alerts may include some unknown beacon signals).

b. False alarms include hoaxes, inadvertent alarms, and those unknown number of unresolved alarms that are not related to a distress incident.

4. See Volume II, Chapter 5 for standard international message formats for communicating with any COSPAS-SARSAT MCC.

D. EPIRB/ELT false alarms

1. Incidents involving activation of EPIRB/ELTs, in non-distress or non-emergency situations, which result in the deployment of SAR units, are frequent. Often these false alarms can be attributed to improper storage and handling of these devices. It is important that users of EPIRB/ELTs understand that beacon activations result in the expenditure of SAR resources; misuse cannot be tolerated. The FCC will issue warning letters or violation notices and fines, if appropriate, in cases involving non-distress activation of EPIRB/ ELTs. Before the FCC can take action, each case of false activation must be fully identified, documented and reported.

2. Cases involving activation of an EPIRB/ELT as a hoax or through gross negligence should be reported to the FCC field office nearest to the infraction locations citing:

a. Non-compliance with FCC Rules and Regulations, Subpart G, 47 CFR 80.311, for violations involving hoax EPIRB/ELT transmissions; or

b. Non-compliance with FCC Rules and Regulations, Subpart G, 47 CFR 80.332, for violations involving gross negligence.

3. Cases involving violations by federal agencies or foreign governments should be referred to the Reporting Agency or Department's Frequency Management Office.

316 Sound Communications

Sound communications of various sorts are used in underwater and surface search operations. SOFAR devices have been detected as far as 6,000 miles when detonated underwater. Self-contained pingers, actuated by immersion in salt water or by remote sound signals, can be detected by sonar at ranges of up to 3 miles, but have an average range of 1 mile. Surface sound devices include gunshots, whistle signals, sirens, and the human voice. Gunshots are usually limited to a range of approximately 1 mile, while whistles are limited to about 100 yards. Detecting sound on the earth's surface depends on the loudness of the device, the amount of moisture in the air, and the direction and force of the surface wind.

317 SAR Transponder (SART)

The Search and Rescue Transponder (SART) has been defined by the IMO as the main means for locating a survival craft within GMDSS. This device operates in the 9.2-9.5 GHz frequency band and generates 20 dots on a radar display on being interrogated by a shipborne or airborne radar operating in this frequency band.

318 Global Maritime Distress and Safety System (GMDSS)

A. This system was established to provide distress and safety communications between ships at sea and rescue coordination centers on shore. GMDSS uses technological advances in ship telecommunications, replacing the existing Morse Code-based system used on ships for over fifty years. When phase in of all functions of GMDSS is completed, international distress communications will have changed from a primarily ship-to-ship based system to a ship-to-shore (Rescue Coordination Center) based system. Currently, SAR radio facilities aboard ships and ashore are mandated for commercial vessels by the International Conference on Safety of Life at Sea (1974, amended 1988) and the International Telecommunications Union Final Acts of the World Administration Radio Conference for Mobile Services (Geneva 1987). These treaties allow GMDSS to be implemented through IMO. GMDSS uses existing and new technology to improve speed and reliability of distress communications. Both satellite and radio communications will be used for ship-to-shore, shore-to-ship, ship-to-ship, and RCC-to-RCC alerting. System features include Digital Selective Calling (DSC) and Narrow Band Direct Printing (NBDP).

B. GMDSS shipboard radiocommunication functions include:

1. Transmit distress alerts by at least two separate and independent means.

2. Receive shore-to-ship distress alerts.

3. Transmit/receive ship-to-ship distress alerts.

4. Transmit/receive SAR coordinating communications.

5. Transmit/receive on scene communications.

6. Transmit/receive locating signal.

7. Transmit/receive maritime safety information.

8. Transmit/receive general radiocommunications to/from shore.

9. Transmit/receive bridge-to-bridge communications (bridge-to-bridge radio watchkeeping requirements not adopted).

C. GMDSS elements:

1. INMARSAT (International Maritime Satellite Organization) satellite terminals.

2. EPIRBs.

3. NAVTEX.

4. INMARSAT safetyNET, also called Enhanced Group Call. Used to provide high seas maritime safety information outside NAVTEX coverage. HF telex allowed as a substitute.

5. HF telex (also called sitor or NBDP).

6. HF radiotelephone.

7. VHF radiotelephone.

8. VHF handheld (for survival craft).

9. SART.

10. MF DSC, used to initiate ship-to-ship call or ship-to-shore call when within 100 NM of shore. Call can be initiated without anyone listening to radio.

11. HF DSC, same purpose as MF DSC, except provides worldwide coverage

D. Alerting signals in GMDSS include the frequencies listed below. Shore facilities providing these future services are scheduled to have 24-hour guards and direct connection to the area RCC.

1. Satellite EPIRB signals, 406.025 MHz, and 1.6 GHz.

2. Satellite Ship Earth Station signals, 1.6 GHz band.

3. Digital Selective Calling, 2, 4, 6, 8, 12, and 17 MHz (FM) band.

4. Navigation, Meteorological, and Urgent information broadcasts shore-to-ship on 518 kHz, using NBDP telegraph equipment (NAVTEX).

320 COMMUNICATION FACILITIES

A. Voice Communications provide the most rapid means of transmitting urgent information, and usually are the most practical for directing on scene operations. They may be accomplished by using:

1. Telephone Private Lines (TPL). When established specifically for SAR nets, they may be called SARTELs. ARTCCs have widespread voice circuits for domestic and international traffic control. These can be extremely valuable for SAR, particularly in aircraft incidents. Urgent communications between two RCCs can often be relayed by an ARTCC.

2. Automatic Voice Network (AUTOVON), a worldwide direct-dial system of voice communications for United States military agencies.

3. Federal Telephone System (FTS), a direct-dial system within the United States for use by United States government agencies.

4. Commercial telephone, the most widespread method of domestic and international voice communications. It often provides the most rapid means of transmitting or obtaining information.

5. Radiotelephone, the most common type of radio communications among surface, air, and fixed stations. There are innumerable uses of radiotelephone circuits and a considerable number of networks that can be used in SAR operations. Radiotelephone

links, commonly called phone patches, provide important links through the commercial telephone system and marine operator to craft at sea and by aeronautical radio stations to en route aircraft.

6. The International Maritime Satellite Organization (INMARSAT), telephone direct-voice communication, via geostationary satellites, which is available to INMARSAT-equipped vessels.

B. Printed Communications that may be used are:

1. Teletypewriter Private Lines (TWPL), installed when the volume of traffic justifies a private line dedicated to printed communications. In some areas, particularly the continental United States, special SAR dedicated circuits have been established to carry operational SAR traffic.

2. Automatic Digital Network (AUTODIN), a widespread teletype network using automatic switching circuits, used extensively for military communications and by other government agencies for operational and administrative printed communications.

3. Aeronautical Fixed Telecommunications Network (AFTN), an international teletype network based on ICAO requirements for air navigation services, including SAR. FAA Flight service stations (FSSs) are the normal points of interface for United states RCCs. Diagrams of implemented and planned circuits are contained in the communications sections of the ICAO Regional Air Navigation Plans. AFTN may be helpful when language is a barrier. AFTN should not be routinely used for maritime SAR when reliable alternative systems exist. However, ICAO has agreed that it can be used by maritime RCCs. It has the advantages of being global and of allowing message priorities to be established, and is often the best alternative when communicating with developing nations.

4. FAA Domestic Teletype Networks, operated extensively within the United States, primarily for ATC service. They carry information concerning missing or overdue aircraft. ARTCCs and FSSs work directly with RCCs.

5. Teletypewriter Exchange (TWX), a commercial method of establishing direct communications with subscribers within the United States and Canada, connecting subscribers through a commercial switchboard. The switchboard can also connect with international TELEX systems.

6. Teletype (TELEX), an international commercial service similar to TWX, which in some foreign countries also serves domestic needs. While in some countries the various TELEX systems provided by different international companies interconnect, it is possible to have two or three different and separate systems. In such cases, the use of TELEX for SAR can be complicated.

7. Radio Teletype (RATT), a generic term for teletype circuits which use radio connection instead of cable or landline. They may be integrated with some of the systems described above or they may be special purpose. More and more ships and aircraft are becoming equipped with RATT. SMCs may find it convenient in many cases to use a RATT circuit for the control channel during a mission.

8. NAVTEX is an internationally adopted, automated system for instantly distributing marine navigational warnings, meteorological information and search and rescue information to approximately 200 nautical miles offshore.

9. INMARSAT which allows direct TELEX service to and from INMARSAT-equipped vessels. Priority is given to distress and related SAR communications.

C. Telegraphy used in SAR communications is usually radiotelegraphy between fixed stations and ships. It is most often used with large ships at sea through a coast radio station.

D. Facsimile (by either cable or radio) is used for transmission of a picture, and is most often used to transmit charts, such as weather maps.

E. Data Link, used in several contexts in communications, generally indicates communications circuits designed for transmitting raw data from one place to another. They are most useful when transferring data to and from computers.

330 SAR MISSION COMMUNICATIONS

A. The SAR Coordinator should establish and publish in the SAR plan the frequencies available for assignment as control, on scene, monitor, homing, and press channels. The SMC selects SAR-dedicated frequencies, informs the OSC or SRUs of the assigned frequencies, and establishes communications between adjacent RCCs and with parent agencies. The OSC maintains communications between all SRUs and with the SMC. A primary and secondary frequency in the HF, VHF, or UHF band should be assigned as an on scene channel.

B. The OSC controls communications on scene and ensures that reliable communications are maintained. SRUs normally report to the OSC on an assigned on scene frequency. If a frequency shift is necessary, instructions should be provided in case communications cannot be reestablished. All SAR ships and aircraft in maritime areas should carry a copy of the International Code of Signals (Defense Mapping Agency Hydrographic Topographic Center Pub 102), which contains communications information internationally recognized by aircraft, vessels, and survivors.

C. Armed Forces, Civil Air Patrol, or CGAUX aircraft should use the word "rescue" in their call sign when priority handling is critical. The use of rescue in the call sign for ATC communications should be arranged locally between aviation units and ATC authorities. SRUs initially checking in with the OSC should use their full plain-language call sign. Thereafter, search area assignments, such as Alpha-3 or Bravo-2, should be used as call signs.

331 General Channels

A. Control Channels are used for communications between the OSC and the SMC. This link may be direct or, if necessary, via a radio station monitored by the SMC. The SMC assigns control frequencies from those available in the SAR plan. The control channel should be a dedicated frequency apart from the on scene frequency.

B. On Scene Channels are used between SRUs and the OSC. The SAR Coordinator lists the available on scene frequencies in the SAR plan;

3023 kHz (USB), 123.1 MHz, and 282.8 MHz are the primary on scene frequencies. All SRUs on scene should use the same frequency. Distress frequencies should not be used for on scene SAR communications. Non-SAR units on scene are prohibited from using on scene channels unless authorized by the OSC.

C. Monitor Channels are guarded by SRUs throughout the search for possible transmission from distressed craft or survivors. The SMC assign monitor frequencies based on the type of survival radio equipment believed to be available to the distressed craft.

D. En Route Channel Frequencies are used by SRUs en route to the SAR operations area. SRUs do not change operational control (CHOP) from their parent agency to the OSC until shortly before arriving on scene. When departing the scene, the SRU CHOPs back to its parent agency and establishes communications on en route channels.

E. Homing Channels are used to locate a distressed craft or person. Any distress or on scene frequency may be used as a homing channel subject to availability of DF equipment for the frequency.

F. Press Channels are used by news media personnel for filing stories.

332 Aircraft/Marine Channels

A. Aircraft normally communicate on voice channels only, and usually guard at least one channel. Both military and civilian aircraft use HF (AM/SSB) for long-range. Civil aircraft use VHF (AM) for short-range, and military aircraft use UHF (AM) or VHF for short-range. If the ground aeronautical radio station that is working the aircraft is known, contact may be established through it. Military aircraft flights normally maintain communications guard with a military ground aeronautical radio station. Civil commercial aircraft on both long-range and short-range flights normally maintain communications guard with Aeronautical Radio Incorporated (ARINC) radio stations. Military aircraft not on IFR flight plans normally maintain communications guard with a parent activity's radio station, usually "home base." All aircraft on IFR flight plans maintain a communications guard with an ATC facility and may be contacted through the nearest ARTCC.

B. Merchant vessels normally communicate on MF or HF telegraph or voice frequencies. INMARSAT provides satellite voice and TELEX services to vessels equipped with an INMARSAT terminal. The NAVTEX system can also be used to contact vessels equipped with NAVTEX receivers. When attempting to establish contact with a merchant vessel, a call should be made first on 500 kHz (CW), 2182 kHz voice, or 156.8 MHz voice. Use of 500 kHz will be phased out when GMDSS is implemented. Since some merchant ships do not keep a continuous guard on these frequencies, if a distress occurs the auto alarm signal should also be transmitted. After contact is made, a shift to a working frequency should be made.

1. Commercial marine radio stations such as Mackay, RCA, and ITT

World Communications handle most communications for merchant ships worldwide. Certain stations broadcast a "Traffic List" every 2 hours, copied by many merchant ships. If a maritime SAR Coordinator or SMC is unable to contact a ship directly, assistance from a commercial station may be obtained by notifying either New York or San Francisco RCCs. That RCC can contact the commercial radio station and request that the ship's call sign be included in the next traffic list. If the ship does not establish contact after two traffic list broadcasts, the SAR Coordinator should begin the process again.

2. Ships equipped with INMARSAT terminals may be contacted immediately by voice or TELEX. If desired, INMARSAT can alert all ships in an area simultaneously. Information on procedures and participating ships is available from COMSAT General Corporation, 950 L'Enfant Plaza S.W., Washington, D.C. 20024.

3. Merchant ships under way in United States harbors and waterways monitor bridge-to-bridge or vessel traffic system frequencies.

C. Small craft, such as fishing vessels and pleasure craft, normally communicate on MF voice and VHF-FM voice. Only commercial boats carrying passengers for hire are required to guard 2182 kHz continuously. If initial attempts to contact fishing boats or pleasure craft on 2182 kHz or 156.8 MHz (channel 16 FM) are unsuccessful, the following voice frequencies may be used:

1. 2003 kHz, Great Lakes.

2. 2635 kHz, all areas.

3. 2638 kHz, all areas.

4. 2738 kHz, all areas except Great Lakes and Gulf of Mexico.

5. 2830 kHz, Gulf of Mexico.

6. 156.3 MHz (channel 6), all areas.

340 SAR MISSION MESSAGES

SAR mission messages include SITREPs, search action plans, rescue action plans, all ships broadcasts, aircraft alerting messages, and miscellaneous SAR messages. These messages are normally unclassified and, in plain language, use no tactical call signs, and preferably require no key to interpret. RCCs should establish a "canned" message file to aid in quickly drafting and releasing often-used messages.

341 Situation Reports (SITREPs)

A. The OSC uses SITREPs to keep the SMC informed of on scene mission progress and conditions. The SMC uses SITREPs to keep interested agencies informed of mission progress. The OSC addresses SITREPs only to the SMC unless otherwise directed. The SMC may address SITREPs to as many agencies as necessary, including other RCCs and RSCs, to keep them informed. SITREPs prepared by an SMC usually include a summary of information received from OSCs. Often a short SITREP is used to provide the earliest notice of a casualty or to pass urgent details when requesting assistance. A more complete SITREP is used to pass amplifying information during SAR operations, or to pass information to the agency SAR authorities of the craft in distress. Initial SITREPs should be transmitted as soon as details of an incident become clear enough to indicate SAR system involvement, and should not be delayed unnecessarily for confirmation of all details.

B. While SITREP format is usually established by agency directives, a standard format that has been adopted internationally is shown in Vol. II, Chapter 5. It should be used, along with the standard codes, for international communications between RCCs. It may be used nationally at the discretion of the SAR coordinators. Whatever the format, SITREPs should normally provide the following information:

1. Identification - Usually, in the subject line, the SITREP number, identification of the distressed unit, and a one- or two-word description of the emergency. The perceived phase of the emergency should be indicated. SITREPs should be numbered sequentially throughout the entire case. When an OSC is relieved on scene, the new OSC continues the SITREP numbering sequence.

2. Situation - A description of the case, the conditions that affect the case including on scene weather, and any amplifying information that will clarify the problem. After the first SITREP, only changes to the original reported situation need

be included.

3. Action Taken - A report of all action taken since the last report, including results of such action. When an unsuccessful search has been conducted, the report includes the areas searched, a measure of effort such as sorties flown or hours searched, and the coverage factor or probability of detection (POD).

4. Future Plans - A description of actions planned for future execution, including any recommendations and, if necessary, a request for additional assistance.

5. Case Status - Used on final SITREP only either CASE CLOSED, or for SC use only, ACTIVE SEARCH SUSPENDED PENDING FURTHER DEVELOPMENTS.

C. Initial SITREPs are released by the SMC as soon as possible after the first information is received. Subsequent SITREPs are released when important new developments occur, and at least once daily by a maritime SMC. For inland SAR cases, AFRCC normally transmits information via teletype in a Mission Summary, issued at the end of each day. For all missions involving Navy or Marine Corps units in distress, the Naval Safety Center, NAS Norfolk, VA should be an information addressee on all SITREPs originated by the SMC.

D. For missions where pollution or threat of pollution exists as a result of a casualty, the appropriate agency tasked with environmental protection should be an information addressee on all SITREPs.

342 Search Action Plan

A. The search action plan is a message adaptation of the standard operation organization plan, and is used to normally pass actions required of participating

SRUs and agencies. A search action plan should be developed by the SMC, or by the OSC if the SMC does not do so. The search action plan should arrive at parent agencies providing SRUs 6 hours prior to their required departure time, or earlier for SRU crews that may need to begin planning before resting for a "first light" search. If debriefing reveals factors not previously considered, the SMC can modify the original plan.

B. The search action plan may be abbreviated depending on mission size, but usually contains the following:

1. Situation

   a. Brief description of incident, position, and time.

   b. Number of persons on board (POB).

   c. Weather forecast and period for forecast.

   d. SRUs on scene.

   e. Primary/secondary search targets, including amount and type of survival equipment.

2. Search Area, by columns: Area, Size, Corner Points, Other.

3. Execution, by columns: Area, SRU, Parent Agency, Pattern, Creep Direction, Commence Search Point (CSP), and Altitude.

4. Coordination

   a. SMC designated

   b. OSC designated

   c. On scene time for units

   d. Track spacing/coverage factor desired

   e. OSC instructions (include DMB instructions)

   f. Air space reservations

   g. Aircraft safety comments

   h. SRU CHOP instructions

   i. Parent agency relief instructions

   j. Authorization for non-SAR aircraft in the area

5. Communications

   a. Control channels, primary and secondary

b. On scene channels, primary and secondary

c. Monitor channels

d. SAR vessel's aerobeacon and IFF identification

e. Press channels

6. Reports

a. OSC collects on scene weather reports from SRUs, collates information, and resolves discrepancies prior to reports to SMC.

b. Parent activities report to SMC at end of day's operations: sorties, hours flown, area(s) searched, and coverage factor(s).

c. OSC reports to SMC.

C. Special Passing Instructions may be added to ensure that proper personnel receive the search action plan. Such instructions are inserted immediately before the message subject line. For example:

ATTN: Command Post Duty Officer 55 ARRS.
Pass to Aircraft Commander Coast Guard 1275.

343 Rescue Action Plan

A. The rescue action plan uses the same general format as the search action plan and formally details actions required of participating SRUs and agencies to carry out an effective, efficient, and safe rescue. A rescue action plan is not required for most SAR missions, since either it is combined with the search action plan or the rescue may logically follow a successful search action plan.

B. The basic rescue action plan, discussed further in Chapter 7, should be self-explanatory and usually has the following:

1. Situation

a. Brief description of incident.

b. Number of persons requiring rescue.

c. Extent of injuries of persons involved.

d. Amount and type of survival equipment.

e. Weather forecast and period for forecast.

f. SRUs on scene

2. Rescue Area

a. Position of the incident described by proper name and latitude/longitude, or by bearing and distance from a well-known geographical point.

b. Detailed description of access route to be followed by SRUs, including beaching sites and overland routes, in relation to well-known and easily identifiable geographical features, such as roads, rivers, and highway mileage markers.

3. Execution

a. SRUs assigned, call signs, and parent agencies.

b. Rescue method to be attempted by SRU.

c. Aerial delivery of SRU supplies and supporting equipment.

d. SMC supportive arrangements.

4. Coordination

a. SMC designation

b. OSC designation

c. On scene/rendezvous time for SRU

d. SRU CHOP instruction

e. Parent agency relief instructions

f. Temporary flight restrictions

g. Authorization for non-SAR aircraft in area

5. Communications

a. Control channels, primary and secondary.

b. On scene channels, primary and secondary.

c. Call signs of aircraft assigned high altitude communications relay duties.

d. Other information.

6. Reports

a. OSC reports to SMC.

b. Parent activity reports to SMC at end of day's operations: sorties, hours flown, and further recommendations.

344 Alerting Ships at Sea and En Route Aircraft

A. Frequently the most immediate help available to a distressed ship or aircraft is provided by ships or aircraft already in the vicinity.

B. Ships can best be alerted by a maritime coastal radio station (CRS). Normally, the RCC originates a message to all ships and sends it to a CRS for broadcast. The RCC should include instructions on whether to use the alarm signal, and whether to issue the broadcast as a distress broadcast or as an urgent marine broadcast. The CRS should then use the procedures in international radio regulations.

1. An urgent broadcast should be used during the Alert phase.

2. A distress broadcast should be used during the Distress phase when the distressed unit may not be able to transmit a distress alert, or when a distressed unit has sent a distress alert not acknowledged by assisting units. The alarm signal should be used before an initial distress broadcast and, judiciously, for subsequent distress traffic.

3. When the incident is in waters usually traversed by ocean-going merchant ships, 500 kHz should he used for emergency broadcasts; 2182 kHz should be used when the incident is within 300 miles of shore and 156.8 MHz (channel 16) when the incident is within 30 miles of shore. Incidents within 300 miles of shore may require broadcasts on all three frequencies.

4. In exceptional circumstances, the SMC may direct an additional broadcast on another frequency (e.g., 2638 kHz or 2738 kHz) after broadcast on 500 kHz, 2182 kHz, or 156.8 MHz. Local factors, such as ship-to-ship and ship-to-shore frequencies in use by fishing or pleasure craft in the area of the incident, determine additional frequencies to be used.

5. The SAR Coordinator may alert small craft listening to the above frequencies by contacting marine operators, commercial radio broadcast stations, and the National Weather Service (NWS). They should be asked to include the missing craft information in their regular marine news or weather broadcasts, asking anyone who has information to contact the controlling RCC.

6. If a need exists to alert surface craft for an

extended time, a Notice to Mariners should be issued in a coastal area and a Navy Hydro message for ocean areas.

C. En route aircraft on IFR flight plans can be informed of emergency situations in their vicinity by ARTCC, which is aware of and able to communicate with aircraft available to assist. Under some circumstances en route aircraft might be alerted by aircraft towers or approach control facilities, usually when incidents occur in the vicinity of these facilities. Alerting of aircraft should be done during the Alert or Distress phases, when en route aircraft may intercept and escort distressed craft, locate survivors transmitting on aeronautical emergency frequencies, or sight the incident. SAR coordinators should consult with aeronautical authorities in advance to determine the best method of alerting en route aircraft in their area.

345 Medico Messages

A. Maritime and overseas SAR coordinators often become involved with medical emergencies at sea. Medico messages request or transmit medical advice from and to a ship.

B. Each medico message is a potential SAR mission. Medico messages may be addressed to SAR coordinators from ships at sea. Replies to such messages must indicate the medical facility which provided the advice, to avoid the impression that the SAR Coordinator is prescribing medical treatment.

C. Medico messages should be prefixed "DHMEDICO" to tell communications personnel to handle them as medico messages. However, fishing vessels and small craft will probably not know about this procedure. Personnel who might be involved with such traffic should be alert for incoming medico messages that can be identified as medico only by the text.

D. Further information on radio medical advice to ships at sea is contained in Defense Mapping Agency Hydrographic Topographic Center publications 117A and 117B, Radio Navigational Aids.

CHAPTER 4. AWARENESS AND INITIAL ACTION

400 GENERAL

When the SAR system first becomes aware of an emergency or potential emergency, the information collected and the initial action taken are critical to SAR success. Information must be gathered and evaluated to determine the nature of the distress, the appropriate emergency phase classification, and what action should be taken.

410 AWARENESS STAGE

The first receipt of information by the SAR system of an actual or potential SAR incident initiates the Awareness Stage. Persons or craft in distress may report a problem, nearby personnel may observe an incident, or an uncertainty may exist due to lack of communication or to non-arrival. If the SAR facility receiving the information is an operational facility, and the situation warrants, the facility should take immediate action to respond to the incident and should report to the RCC simultaneously.

411 Receipt and Recording of Information

The receiving and recording of information should not delay other SAR response. Communications should be maintained with a person or craft reporting an emergency, and they should be kept advised of action being taken. Shifting frequencies should be avoided. When a frequency shift is necessary, positive communication should be established on the second frequency before leaving the first. For incidents reported by telephone, the name and telephone number of the caller should be recorded in case additional information is needed later.

412 SAR Incident Data

Whenever possible, SAR incident data should be collected from the reporting source, with the most important information gathered first in case communication is lost. If, while information is being gathered, the need for an immediate response is indicated, SRUs should be dispatched. In addition, see Chapter 8 for specifics of Land SAR. The following information is desirable:

A. Type of incident and nature of the emergency.

B. Location and time of the incident.

1. Planning and action depend on establishing, as accurately as possible, the location of the incident. The person accepting the information should verify location information:

    a. If the location given used a coordinate system (latitude and longitude), ask how the position was determined (i.e. bearing, ranges, or LORAN C lines including the stations and rates).

    b. If the position is a known geographical location, obtain bearings to other known objects in the immediate area, or a description of the reference object(s).

2. The time at which the incident took place, or when the person or craft was last seen or known to be in a verifiable location, affects search planning, especially datum computation.

C. Target description.

1. A thorough description of the primary target and any secondary targets is necessary. This information is used for search planning, search briefing, and, for secondary targets, contingency planning and searching. In most search planning, target type and size is a primary input in computing probable location and search area.

2. Primary target information should include a description of the distressed craft or person and any radio equipment, including names and call signs. Secondary target information is emergency or survival equipment that might be used such as rafts, mirrors, flares, whistles, or electronic signaling equipment.

D. Number and condition of people involved.

E. Assistance desired, to ensure that appropriate personnel and SRUs are dispatched and properly briefed.

F. Weather information on scene, to assist in deciding type and immediacy of response.

G. Reporting party information. If the source is other than the distressed craft or person, the name, radio call sign or phone number, location, and assistance capability should be obtained.

413 Incident Processing Forms

RCCs and RSCs should complete information processing forms for each reported incident to ensure that important information is not overlooked. The form is a checklist of essential information needed and action to be taken, based on the reported type of incident, and should be filed in the SAR case folder. To ensure rapid relay of incident data, SAR facilities should maintain an incident processing form identical to the one used by their RCC or RSC. Sample incident processing checklists are included in Vol. II, Chapter 1. If the form is maintained in a word processor or management information system, it may be transmitted by electronic mail.

420 INITIAL ACTION STAGE

The Initial Action Stage is the period in which the SAR system begins response, although some activities such as evaluation, may begin during the preceding Awareness Stage and continue through Planning and Operations Stages until the case is over. Initial action may include SMC designation, incident evluation, emergency phase classification, SAR facilities alert, and communications searches.

430 SMC DESIGNATION

A. The RCC should assume or assign the SMC function early in the case. The SMC is often automatically assigned by prearrangement. For simple cases, the SMC is normally the lowest organizational level that can efficiently handle the case. More complicated cases may require specific SMC assignment by RCC.

B. The SMC function may be transferred between units or persons. Complications or the need to acquire larger or additional facilities may make it necessary to transfer SMC to a unit that can more readily coordinate the case, or a capable unit closer to the scene. Changes in a case may also warrant transfer to a lower organization level.

440 INCIDENT EVALUATION

Evaluation of the incident is the first SMC responsibility. Information, judgment, and experience are necessary to place the incident in one of the Emergency Phase classifications discussed in paragraphs 450-453, and to determine the urgency and extent of SAR response.

441 Type of Incident and Severity

A. Information needed for evaluation includes the type of craft involved and the nature and apparent severity of the incident.

B. A marine vessel SAR incident is considered probable or actual when:

1. A distress condition, such as fire, sinking, or collision, is reported.

2. An electronic distress signal is transmitted, or a visual or audio distress signal is used.

3. A vessel is overdue, is unreported, or misses a position report. SRUs usually are not dispatched until after a careful evaluation of factors such as the estimated length of the voyage, fuel and food endurance, type of craft, operator experience and habits, and weather and sea conditions. Each incident must be judged individually.

C. An aircraft SAR incident is considered probable or actual when:

1. An aircraft requests assistance or transmits a distress signal.

2. Aircraft ditching, crash, or forced landing is actual or imminent.

3. The crew is about to abandon, or has abandoned the aircraft.

4. Unlawful aircraft interference is known or believed.

5. The aircraft is overdue and one of the following conditions exists:

a. If the aircraft is on an IFR flight plan, neither communications nor radar contact can be established and 30 minutes have passed since its ETA over a reporting point or at a clearance limit.

b. If the aircraft is on a VFR flight plan, communications cannot be established and it fails to arrive 30 minutes after its ETA.

c. If the aircraft is not on a flight plan, a reliable source reports it 1 hour overdue at its destination.

d. If cleared to land, the aircraft fails to land within 5 minutes of ETA and communications have not been reestablished.

e. If, in certain areas of the United States, the aircraft is not in compliance with special reporting and flight-following service criteria established by FAA FSSs. Commonly these are areas where critical survival factors make earlier activation of the SAR system desirable. FAA publications should be consulted for details of these special services, and liaison maintained with FAA Regional and Area authorities.

D. A submersible water craft incident is considered probable or actual when:

1. For Navy submarines, the operating authority declares an emergency phase. The two phases an emergency are EVENT SUBMISS, the initial search stage, and EVENT SUBSUNK, the full-scale search. Specialized Navy SAR organization and facilities are established for Navy submarines.

2. For civilian submersibles

a. A submersible fails to surface promptly following a known accident, or an accident report has been received from any source.

b. There is suspicion that a submersible has suffered a casualty and requires assistance.

c. Air or power supply is known to be exhausted.

d. When it is overdue-fails to surface within 20 minutes of scheduled surfacing time, or fails to make a scheduled report, while submerged, within 20 minutes of the scheduled reporting time.

442 Location of Incident

A. An accurate determination of the distress location is essential for reducing search time. To have a good starting point for search planning, the SMC should confirm the reported location.

B. If communications have been established with a distressed craft, always assume they may be quickly lost. While still in contact, the SMC should ask for position information. Immediate effect should be made to resolve conflicting position reports. Whenever possible, the SMC should obtain the data the craft used for plotting its position and replot it.

1. Positions given in relation to uncharted or locally named landmarks should be scrutinized. The SMC should make certain that everyone involved is referring to the same object. Not only are landmarks with names such as "Bird Rock" common to many areas, but the same name may even be used for different objects in the same areas.

2. Bearings and ranges should be plotted, and the distressed craft's position confirmed by asking for other known information about the area. If distances are estimated, for objects beyond 4 nautical miles the tendency is to underestimate and the greater the actual distance the larger the error in estimation. {1}

3. Soundings should be acquired from marine craft to cross check between reported and charted soundings.

4. On scene weather may help the SMC determine the incident location. Useful weather information includes:

a. Wind direction and velocity.

b. Prevailing weather, such as rain, snow, or fog.

c. Wave height and direction.

d. Barometer readings.

e. Air and sea temperature.

f. Time of the observation.

g. Sudden weather changes, such as rapid clearing, squall lines, changes in temperature, or cloud cover.

C. If communications are lost with the distressed craft, the SMC should calculate the most probable position, using information gathered to that point. If information is conflicting or sketchy, the SMC must make assumptions about the craft's location. The accuracy of these assumptions depends on the data collected and SMC ability to analyze the information.

D. When evaluating reports of flare sightings, the SMC should determine the location of the flare by carefully questioning the informant and analyzing the data.

1. The location of each informant at the time of the sighting should be plotted.

2. The characteristics of the flare, such as color, intensity, duration, and trajectory should be obtained.

3. Preferably, cross bearings from more than one sighting should be used for plotting the position of the flare. To obtain a line of position (LOP) from an informant, the angle of the sighting relative to a known bearing should be requested. If the informant does not have a compass, the angle could be determined by relation to a geographic feature such as the shore line, a ridge line, or a straight road.

4. If only one sighting is available, obtain an LOP from the informant as described in the previous paragraph and estimate distance to the target. This estimate should be based on a description of the flare, its observed height, the height of the eye of the informant, and the visibility. If the information is limited, determine the maximum distance the flare could be seen and extend the search area appropriately.

5. Since the military is the major user of flares, an immediate check of operating area events should be made following a flare sighting.

E. Establishing overdue craft location is an elimination process.

The craft's float or flight plan is particularly helpful. Once departure and non-arrival are confirmed, probable locations along the route should be checked. Communication searches can either locate the craft or eliminate areas that would otherwise need to be physically searched. An SMC may also dispatch SRUs to check specific locations or to overfly the likely route. If the overdue craft is not located, the SMC then decides whether or not to search other areas.

443 Urgency of Response

A. The nature of the incident and the rate at which the situation may worsen usually determine the urgency of response. The SAR system should provide prompt and effective assistance to all incidents, particularly those that need rapid response.

B. The time to begin searching may depend on the amount of daylight remaining. Since the chances of survival diminish with time, a few hours of searching during remaining daylight may be more productive than waiting until the next day for a full-scale search effort. Influencing factors are the number of SRUs available and the seriousness of the incident. For a known distress, an SRU, preferably the quickest response SRU, should be immediately dispatched to confirm the distress position.

C. SAR incidents are time-critical

1. Survival times vary with local conditions, such as terrain, climate, ability and endurance of survivors, and emergency survival equipment and SRUs available.

2. It should be assumed that all survivors are incapacitated, capable of surviving only a short time, under great stress, experiencing shock and requiring emergency medical care. Normally able-bodied, logical-thinking persons may be, as survivors, unable to accomplish simple tasks or to assist in their own rescue. Some may be calm and rational, some hysterical, and others temporarily stunned and bewildered. This last group will generally be passive and easily led during the first 24 hours after the incident. As

shock wears off, most regain active attitudes. Those who remain passive die unless quickly rescued. This behavior, commonly known as "disaster syndrome", is characterized by an attitude of "I am not here and this is not happening to me."

3. The probability of the target remaining within the search area decreases with time. Floating targets drift or people may hike out. If the target is mobile, the size of the search area must increase with time. Delay may dramatically increase search area size, possibly beyond what available SRUs can cover. For survivors adrift in fast water currents, the best chance of locating them is soon after they have gone adrift, while the search area is still small.

D. Environmental factors may severely limit available rescue time. Survivor life expectancy varies with the type of clothing worn, the clothing's wetness, survivor activity, initial body temperature, physical condition, thirst, exhaustion, hunger, psychological stress, and will-to-live. Many individuals exceed normal life expectancies or tolerance times. The following are guidelines, not absolute factors, for search planning and suspension.

1. Exposure to the chilling effects of cold air, wind, or water can result in hypothermia, the abnormal lowering of internal body temperature. The rate of body heat loss increases as air and water temperatures decrease. Death from hypothermia occurs over four times more often in water than on land. If a survivor is immersed in water having a temperature of less than 92 degrees F (33 degrees C), hypothermia may occur.

a. The warmest ocean water that can be expected at any time of year is 84 degrees F (29 degrees C). Approximately one-third of the earth's oceans have water temperatures above 66 degrees F (19 degrees C). United States Defense Mapping Agency NAVOCEANO publication, NOPUB 225, Atlas of Sea Surface Temperatures, can be used to determine water temperatures for the Pacific, Atlantic, and Indian oceans for any month of the year. Figure 4-1 displays predicted calm-water survival time (defined as the time required to cool to 30 degrees C, 86 degrees F) lightly-clothed, non-exercising humans in cold water. The graph shows a line for the average expectancy and a broad zone that indicates the large amount of individual variability associated with different

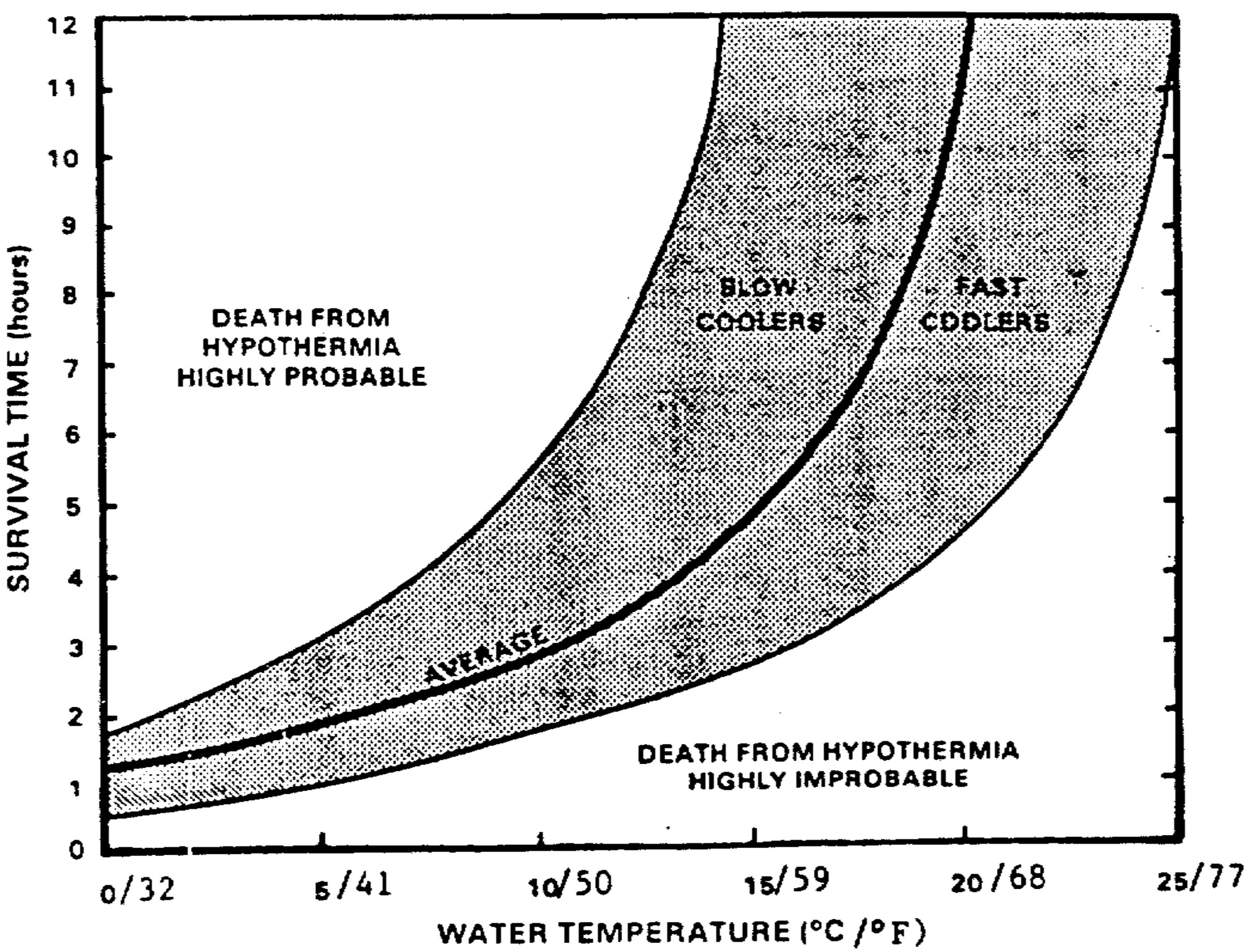


Figure 4–1. Water Chill Without Antiexposure Suit[2]

Figure 4-1. Water Chill Without Antiexposure Suit {2} body size, build, fatness, physical fitness, and state of health. The zone would include approximately 95 percent of the variation expected for adult and teenage humans under the conditions specified. Factors that make a person a slower cooler are: high body weight, heavy clothing, use of survival clothing, or the use of a huddling or other protective behavior. Factors that make a person a faster cooler are: low body weight, children, light clothing, or exercising such as persons without PFDs having to swim. The zone would be shifted downward by physical activity (e.g. swimming) and upward slightly for heavy clothing and/or protective behaviors (e.g. huddling with other survivors or adopting a fetal position in the water). Specialized insulated protective clothing (e.g. survival suits, wet suits, etc.) are capable of increasing survival time from 2 to 10 times (or more) the basic duration shown here. In the zone where death from hypothermia is highly improbable cold water greatly facilitates death from drowning, often in the first 10 to 15 minutes, particularly for those not wearing flotation devices. {2} However, cardiopulmonary resuscitation (CPR) still should be performed, particularly if immersion has not exceeded 60 minutes.

b. Wind is an additional factor for exposed survivors, as body heat loss accelerates with increasing wind velocity. Figure 4-2, Equivalent Temperature curves, shows the effects of various wind speed and air temperature combinations and indicates the equivalent temperature on dry skin in still air. These curves emphasize the necessity for shelter of survivors exposed to severe cold. In temperatures below 0 degrees F (-18 degrees C) survivors become easily fatigued.

2. Heat stress and dehydration are dangers in hot climates, particularly desert areas. The most severe form of heat stress is heat stroke, when body temperature rises because of the collapse of the temperature control mechanism. If the body temperature rises above 107 degrees F (42 degrees C) for sustained periods, death usually occurs. Dehydration is a critical factor both in hot climates and in sea survival; a person without water will die in a few days. A combination of high temperatures and lack of water will quickly aggravate heat stress and dehydration. The life expectancy of survivors in a desert environment is shown in Figure 4-3. In high humidity areas, the water needs of the body are about one-half those in deserts at equal temperatures.

3. The presence of certain animal life may increase hazards and reduce expected survival time. The SMC should be aware of what animals may be in the search area and where to acquire specialized medical help quickly.

S

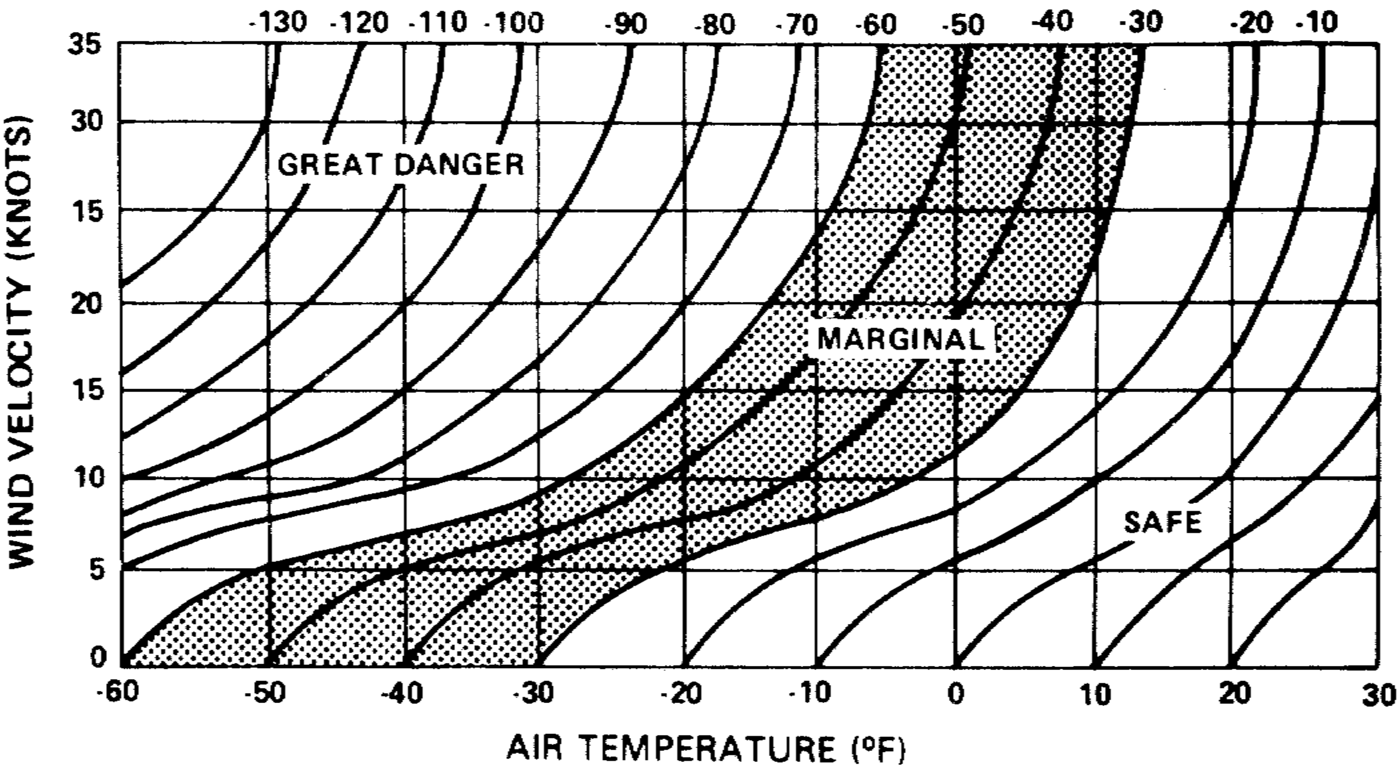


Figure 4–2. Wind Chill Graph – Equivilant Temperature Curves

Figure 4-2. Wind Chill Graph - Equivalent Temperature Curves

SHADE AIR TEMPERATURE (degrees F)   SHADE AIR TEMPERATURE (degrees F)

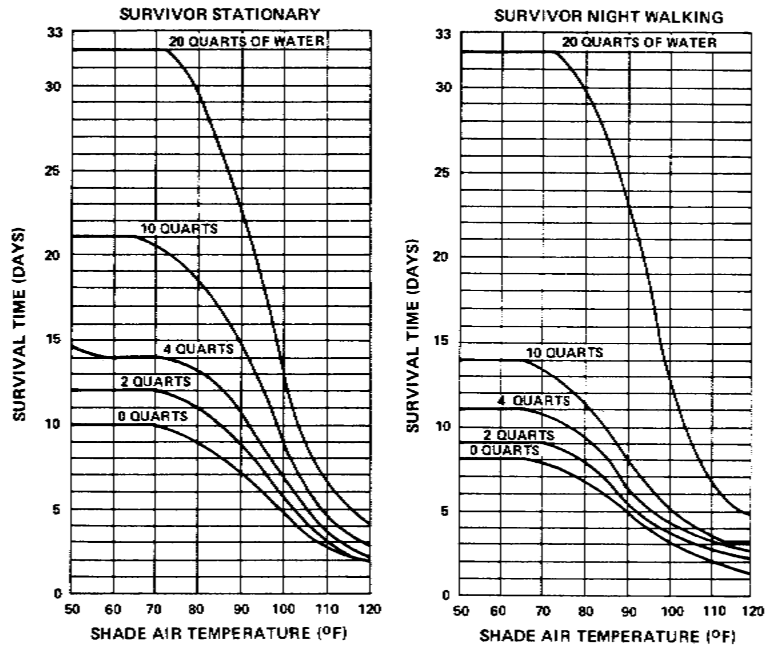


Figure 4-3. Expected Desert Survival

Figure 4-3. Expected Desert Survival

E. Signaling equipment available to survivors influences the urgency of SAR response and the methods used in various SAR stages. SMCs should use the appropriate resources to take advantage of survivor signaling capabilities.

444 Terrain

The terrain may determine the type of search pattern needed and the SRU selected. Highly maneuverable aircraft effective at high altitudes ma be required in rugged mountain areas. Helicopters may not be able to operate in the thin air and turbulence associated with mountain contour searches. The survival kit carried by the distressed craft and the hoist devices available also influence decision-making. Dense foliage may hamper visual and electronic searches and require a greater number of aircraft and ground SRUs, and closer search track spacing. The presence of electrical power lines, towers, and bridges should be considered when planning search altitudes and areas. Prominent landmarks can be used as boundaries and checkpoints for laying out overland air and ground search areas. Some aircraft may have poor navigation equipment, and some members of ground parties may be inexperienced outdoors and more effective when using readily recognizable boundaries. The type of rescue team used after the distress site has been located is also terrain dependent. Local law enforcement authorities, forest service personnel, mountain rescue clubs, ski clubs, or pararescuemen may be required.

445 Weather

A. Weather may limit SAR missions. Not only are search targets more difficult to detect, but SRUs operate less efficiently in turbulence or rough seas. Knowledge of weather conditions and prudent judgment will increase the likelihood of a mission success and SRU safety.

B. If existing weather will not allow a search without unduly endangering additional lives, the search should be delayed. If weather is good but forecast to deteriorate, rapid action is necessary, possibly in lieu of detailed planning.

C. Wind, visibility, and cloud cover influence search sweep width. Accurate search planning is influenced by accurate weather information.

D. SRU safety should be of concern to the SMC. Low ceilings and restricted visibility are particularly hazardous to aircraft. If the search is to be conducted where few navigation aids and poor visibility exist, the SMC may suspend search operations or limit the number of SRUs. OSCs may suspend the search to ensure SRU safety.

E. For overdue craft, the weather at the departure point and the destination, and along the likely track, should be evaluated for the effect it may have had on the craft. Other factors are:

1. The en route and forecast weather information that was available to the crew of the missing craft.

2. Any marked changes in wind or sea currents that might have resulted in navigation errors, or any areas of marked pressure changes that might have caused aircraft altimeter errors.

3. Any areas of low ceiling, poor visibility, precipitation, thunderstorms, frontal activity, turbulence, or icing that the craft may have attempted to circumnavigate, or that may have exceeded craft or operator capabilities.

4. The weather in the area where the missing craft is presumed to be located.

446 Other Considerations

A. Mission Risks. SAR personnel are responsible for taking whatever action they can to save life at any time and place where facilities are available and can be effectively used. All reasonable action should be taken to locate distressed persons, determine their status, and effect their rescue. However, SAR response should be commensurate with the perceived possibility of saving life or property. The risks inherent in any SAR response must be carefully weighed against the mission's chances for success, that is, the saving of life or, to lesser extent, property. Conducting prolonged SAR after the probability of survival has approached zero is normally not warranted.

B. Facilities Available. SMCs must be constantly aware of the status of all available facilities. Lack of SAR resources can be caused by expiration of crew mission time, need for SRU maintenance, or involvement in another mission. A system for monitoring the status of all primary and secondary SAR facilities should be available to each SMC.

C. Re-evaluation of Initial Incident Data. The SMC should remain constantly alert to new developments affecting conclusions and assumptions. When time is critical, SRUs are often immediately dispatched when a probable distress position is determined, often on incomplete information. Therefore, SMCs should, to ensure search in the proper area, corroborate information used to establish the distress location. Since trauma and shock can distort factual observation and memory, accounts by on scene witnesses should be verified. Independent witness reports, SRU observations, current charts and tables, and radio logs are also helpful.

450 EMERGENCY PHASES

Declaration of emergency phases indicates the seriousness of the incident, dictating certain actions. Emergency phase may be assigned by an aircraft pilot or a surface craft master/operator, an ATC or FSS, a SAR facility initiating SAR action, an RCC, or an agency exercising operational control over the craft. When an RCC receives initial information, an incident may already have been classified, or the RCC controller may have to classify the incident. The RCC controller should not hesitate to upgrade a classification received from another source when the situation is more serious than the assigned emergency phase classification indicates. RCC controllers should not downgrade a classification unless it was assigned by a subordinate SAR facility and the RCC assumes SMC.

451 Uncertainty Phase

An Emergency phase is said to exist when there is knowledge of a situation that may need to be monitored, or to have more information gathered, but that does not require moving of resources. When there is doubt about the safety of a craft or person, or they are overdue, the situation should be investigated and information gathered. A preliminary communications search (PRECOM) may begin in this phase.

452 Alert Phase

An Alert phase exists when a craft or person has difficulty and may need assistance, but is not in immediate danger or in need of immediate response. Apprehension is usually associated with the Alert phase. SRUs could be launched, but there is no threat requiring immediate action. For overdues, Alert occurs when there is continued lack of information concerning progress or position. Units should begin or continue communications searches, and possibly dispatch SRUs to investigate high-probability locations or overfly the craft's intended route.

453 Distress Phase

The Distress phase exists when a craft or person is threatened by grave or imminent danger requiring immediate response to the distress scene. For overdues, distress exists when communications searches and other forms of investigation have not succeeded, and search planning and execution are needed.

454 FAA Emergency Phases

FAA emergency phase differ from the above SAR emergency phases. The FAA uses "Information Request" (INREQ) and "Alert Notice" (ALNOT) to indicate emergency conditions over land. INREQ, corresponding to the SAR Uncertainty phase, is a message request for aircraft information to FSSs along the aircraft's planned route. ALNOT, corresponding to the SAR Alert phase, is an alerting message containing all known aircraft data and addressed to the appropriate RCC and all aeronautical facilities within 50 miles of the aircraft's planned route. Both INREQs and ALNOTs must be answered within 60 minutes. In oceanic airspace, the emergency phase terms used by the FAA are the same as those used for SAR, but in coastal areas either terminology may be used in reporting aircraft emergencies be to RCCs. Appropriate FAA facilities will clarify any confusion.

460 SAR FACILITIES INITIAL ACTION

A. After the initial report of an incident is evaluated and assigned an emergency phase, the SMC usually has one of three possible actions:

1. Dispatch SRUs immediately, or request other facilities to take immediate action.

2. Alert SAR facilities of a possible mission but do not dispatch SRUs immediately.

3. Investigate further either the validity of the incident or the degree of SAR system support needed.

B. SRU selection is determined by case evaluation, SRU availability and distance from scene, and their capability of providing rapid and effective SAR services:

1. Aircraft normally provide better search platforms because they can cover an area more quickly and effectively.

2. Helicopters may provide the quickest form of assistance when recovery and transport to a medical facility are needed.

3. Boats and land vehicles can provide quick response close to their geographical location, and normally have more survivor space and unique SAR capabilities.

470 COMMUNICATION SEARCHES

SMCs conduct communication searches when facts are needed to supplement initially reported information. SRU movement to check potential areas of craft location may be necessary. Communication searches continue efforts to contact the craft, determine whether the craft is overdue or simply unreported, better define the search area, and obtain more information for determining subsequent SAR action. The two types of communication searches are the preliminary communication search (PRECOM) and the extended communication search (EXCOM). They are usually conducted sequentially.

471 PRECOM

A. PRECOM search contacts major facilities where the craft might be or might have been seen, and is normally conducted during the Uncertainty phase. PRECOM establishes limits for the area to be covered during EXCOM or physical search efforts, and should be conducted as quickly as possible. Each facility should be contacted only once, and the SMC briefed when PRECOM is completed.

B. PRECOM efforts for marine craft will vary depending on the type of craft.

1. Contacts may include the following:

    a. All dedicated SAR facilities in the area for any information in radio logs and records.

    b. Bridge and lock tenders.

    c. Local harbor patrols, harbor masters, and dockmasters.

    d. Marinas, yacht clubs, and other waterside facilities, such as ice and fuel supplies, chandleries, repair yards, fishing concerns, and vessel agents.

    e. Tug companies and fishing vessels.

    f. Local police, pilot boats, customs and immigration authorities.

    g. Relatives and friends.

2. If the missing craft is known to have a radio aboard, appropriate facilities should attempt contact. Marine operators in areas being searched should be asked to check their logs for information on the search objective. Public correspondence marine operators (MAROP) should be asked to attempt at least one contact.

3. When a vessel is overdue from a long sea voyage, SAR officials in other countries may be asked to assist through their RCCs, Navy, or other military channels. Other courses, such a AMVER, Naval Intelligence Operations Center, Lloyd's, or International Telecommunications Union (ITU), could be queried. United States Embassy or consular officials may also be contacted directly for assistance, with the Department of State an information addressee on messages.

C. PRECOM for aircraft is usually begun by the FAA and conducted by the responsible ARTCC for IFR aircraft and by the responsible FSS for VFR aircraft. When an aircraft not on a flight plan is reported overdue, the RCC should begin an EXCOM immediately, while at the same time requesting the appropriate flight-following facility to start a PRECOM. Aircraft PRECOM usually includes:

1. Contacting the departure airport to confirm departure and non-return. The inquiry verifies flight plan data, weather briefing the pilot received, and any other available facts.

2. Contacting the destination and alternate airports to confirm that the aircraft has not arrived. Physical ramp checks are requested of all uncontrolled airports.

3. Requesting aircraft along or near the route to attempt radio contact;and

4. Contacting airfields, aeronautical radio stations, aeronautical aids to navigation stations, and radar and DF nets within areas through which the aircraft may have flown.

472 EXCOM

A. EXCOM search, normally conducted after the PRECOM, contacts all possible sources of information on the missing craft, and normally occurs during the Alert phase. It may include asking organizations or persons to physically check harbors, marinas, or airport ramps. EXCOM continues until either the target is located or the search is suspended.

B. Facilities checked during PRECOM, and additional facilities that might provide leads, should be checked at least every 24 hours, and preferably every 8 to 12 hours. Choice of facilities contacted usually is left to the discretion of the command conducting the EXCOM. However, the SMC should have a listing of these facilities, and should monitor EXCOM SITREPs to ensure thorough area coverage. EXCOM for an aircraft is begun by FSSs and monitored by the RCC. Since there are numerous facilities which may be checked, EXCOM takes time. If the check is begun at night or on a weekend, it may be necessary to wait for normal working hours to contact many sources.

C. All facilities and persons contacted during EXCOM, including marine operators and the CGAUX, should be asked to maintain a lookout for the objective during their normal operations and to notify the nearest SAR unit if sighted. A definite time limit should be set for the watch in case facilities are overlooked and not de-alerted after the target has been located or the search suspended. If information is still desired after this period, another EXCOM should be initiated.

D. Local press, radio and television should be contacted during this phase to give out information on the missing craft and request assistance of the public. EXCOM for an aircraft is begun by FSSs and monitored by the RCC.

CHAPTER 5. SEARCH PLANNING

500 SEARCH PLANNING

Search planning is necessary when the location of a distress is not known, or significant time has passed since the search object's position was last known. The SMC is responsible for developing and updating an effective search plan. The plan may involve a single SRU or many SRUs searching for several days.

501 Overview

A. Search planning consists of determining datum (the most probable location of the search object, corrected for drift) and search area, developing an attainable search plan, selecting search patterns, planning on scene coordination, transmitting the search plan to OSC/SRUs, and reviewing the search plan. Many factors influence the movement of the search object. The SMC judges the impact of these factors to determine the region to search and methods to use, evaluates the number and capabilities of available SRUs, and determines whether compromise between search area size and search effectiveness is necessary. The methods described in this chapter are based on historical information and mathematical theory, and represent generally accepted techniques for search planning. Though effective tools, they do not in themselves guarantee success; that depends on planner ability and judgment, and SRU effectiveness.

B. For inland cases, search area is normally dependent on the environment. Natural boundaries, injuries, and other hard-to-quantify factors affecting movement are important in search area decisions. The experience and judgment of the SMC is a key factor. For a more detailed discussion, refer to Chapter 8.

502 Methods

A. Methods used in search planning depend on incident complexity and available planning capabilities. For complex incidents, sophisticated computer programs can aid in data analysis, and are preferred if initial information is incomplete or conflicting, many variables exist, or searching continues for more than one day. For less complex cases, or if computer aids are not available, a manual method can be used.

B. All search planning methods use the same types of information. The manual method is presented in detail in this chapter to show the planning process. Volume II contains manual method work forms, with examples. The computations require knowledge of vectors and simple algebra. A scientific-function electronic calculator is helpful.

C. Computer-Aided Search Planning (CASP) is a computer program available at Coast Guard RCCs. It can be used in most search planning and is most useful in cases too complex for the manual method. Maritime cases with more than 24 hours of target drift and cases, inland or maritime, with two or more successive searches can benefit significantly from CASP.

1. Advantages offered by CASP are that the program:

   a. Accepts more available case data than is possible in a manual solution. The SMC can evaluate many possible scenarios with a range of incident times, positions, targets, situations, and environmental factors. The manual method averages data to estimate target location.

   b. Uses computer simulation to graphically depict the range of possible target locations, and areas most likely to contain the target. When more than one search is needed, CASP can use previous search results in estimating the probable target location for the next search.

   c. Calculates the Probability of Success (POS), a measure of search effectiveness, for each search and for cumulative searches. POS is the probability the search object is in the search area and that it will be located. It is always less than or equal to Probability of Detection (POD), discussed later in this chapter, and is often significantly lower than POD, particularly in complex cases involving several days of searching. Used primarily in computer search planning, POS is seldom calculated in a manual solution. CASP uses POS with SRU information to determine optimal allocation of search effort, enabling the SMC to decide where to deploy SRUs for maximum effectiveness.

2. For drift calculations CASP uses average historical and forecast environmental data or on scene data. Actual on scene data should always be used when available, because relatively minor differences in information can greatly affect predicted datum. Even well-established currents can vary in location, direction, and intensity, and weather forecasts are sometimes inaccurate. OSCs should report observed drift and wind data to the SMC to update CASP inputs.

3. To improve CASP reliability and accuracy, successful and unsuccessful SAR missions are compared with CASP predictions. Copies of SITREPs, planning worksheets, and other information potentially useful in validating CASP should be sent to:

   Commandant (G-NRS)
U.S. Coast Guard
2100 2nd Street, S.W.
Washington, DC 20593-0001

D. Other SAR planning models, such as the Navy's NAVSAR package, are available for determining search area and resource allocation. Before use is made of such tools, their limitations and proper application should be determined.

510 DATUM

The most probable location of the search object, corrected for movement over time, is known as datum. Determining datum begins with the reported position of the incident. Unless a distressed craft or individual is immobilized, as in a boat grounding or debilitating physical injury, the actual position of target during the search may be substantially different from the initial position. Therefore, possible movement of the search object should be counted for when calculating datum. Datum should be recomputed periodically as drift forces continue to affect the position of the target. Recomputed datums are usually labeled sequentially (e.g., Datum1, Datum2, Datum3), with time of calculation noted.

511 Initial Position

The location where the distress occurred is called the initial position. To compute datum, the time and location of the search object's last reliable position are first considered. This will determine the type of datum to be computed. One of three situations usually exists, based on the initial information obtained:

A. Position Known. The incident is witnessed or reported by radar net, DF net, another craft, or the distressed craft itself, or position is computed from a previously reliable position. If the position of the incident is known, drift is determined and datum computed.

B. Track Known. The intended track is known but the position along the track is unknown, or a single line of position, such as a DF bearing, is obtained. If only the proposed track is known, a datum line, a known proposed track corrected for drift, can be established.

1. The proposed track is first plotted, and a series of DR positions are computed for estimated progress along the track. The DR positions at each end of the track and turning points along the track are used. If the track legs are long, intermediate positions should be computed.

2. A DR position is recommended for every 5 degrees of latitude or longitude for aircraft, at least each 24 hours on the track of a marine craft, and at least every 4 hours on the track of lost persons in inland areas.

3. Each DR position is considered as a known position and drift is computed for each position up to a common single time. Thus, a series of datum points is developed. All datum points are sequentially connected by straight lines to form a datum line.

C. General Area Known. Neither the position nor the intended track is known, but the general area the target was probably in, such as a lake, a military exercise area, or an offshore fishing ground, is known. In this case, a datum area is developed. Datum area computations depend on many factors, such as fuel endurance, natural boundaries, and known or suspected areas of occupancy. Datum area computations may be reasonably exact, or only a best guess.

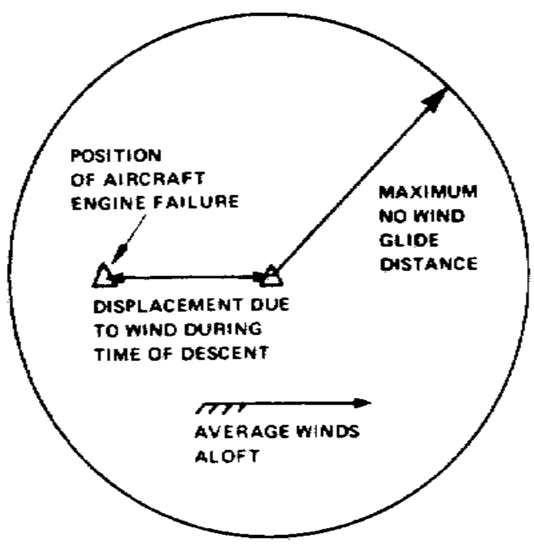


Figure 5-1. Aircraft Glide Area

Figure 5-1. Aircraft Glide Area

1. The aircraft glide area shown in Figure 5-1 is a datum area, since the aircraft has an equal likelihood of being anywhere within that area. A maximum possibility area can be developed using hours of fuel on board, wind speed and direction, glide ratio, and time of departure. A vector representing wind speed and direction is added to the departure point. The SMC then determines the distance the aircraft could cruise from the time of departure to the end of fuel endurance, to which the possible glide distance is added. The SMC uses this as a radius for the datum area. A similar approach can be used for marine craft with fuel endurance in hours, maximum range at cruising speed, and water drift forces. Figure 5-2 shows the general method used to find a maximum possibility area.

2. Datum areas are usually large when the search object endurance is great or many unknown factors exist. Extensive detective work may be necessary to reduce this size to a reasonable initial position, or the SMC may have to outline the datum area based on other hypotheses. For instance, an aircraft may be reported missing while flying in a defined operating area or along a flight planned route, a fishing vessel may have gone to particular fishing grounds, a private aircraft or pleasure boat operating area may be

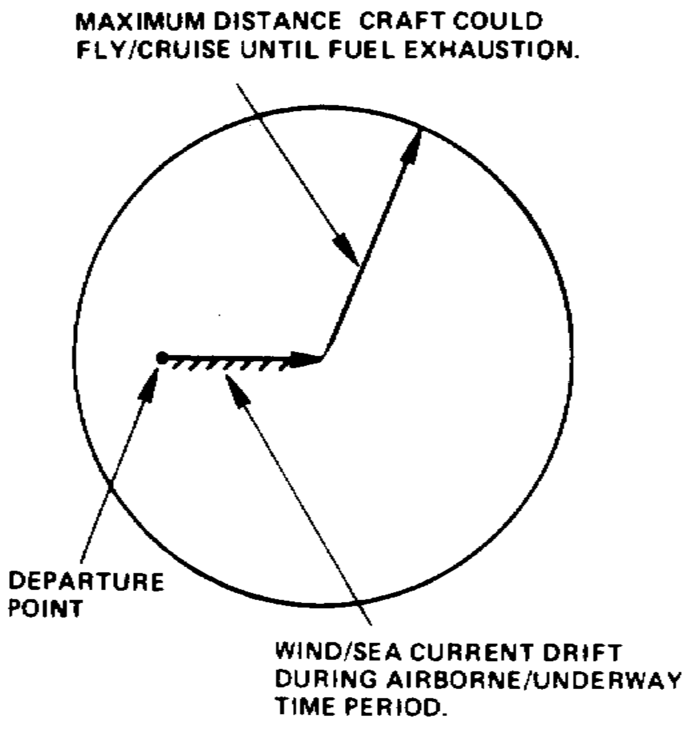


Figure 5–2. Maximum Area of Possibility

Figure 5-2. Maximum Area of Possibility

known, or a yacht is on an extended coastal or ocean cruise. The datum area may be readily apparent. In other cases, the area can be narrowed by communications checks and deduction; if not, large general areas may have to be searched.

512 Computation of Datum

A. Drift is movement of a search object caused by external forces. Datum is calculated by determining which drift forces will affect the search object, selecting the most appropriate ones, and calculating a vector for each. The vectors are then added to the initial position to determine datum. Drift forces should be calculated using the time between the last known position and a time selected by the SMC. This time of datum is normally chosen to coincide with the daily maximum search effort, using midsearch time or the first SRU arrival time.

B. The SMC should determine which environmental forces affected the search object during and after the incident:

1. For marine incidents, currents and winds.

2. For aircraft, primarily wind.

3. For lost persons, terrain and meteorological conditions.

C. The SMC should attempt to quantify each force affecting drift, which is best done by vector, with bearing and length of the vector representing target direction and speed respectively. Since objects that float or fly are more affected by environmental forces, it is easier to quantify their possible movement. Lost persons, while affected by the environment, may choose or not choose to move, or may move unpredictably.

D. Surface drift forces that act on the target are plotted as shown in Figure 5-3. Since all drift elements are acting simultaneously on the object, the path is along the resultant vector. Lengths of vectors are measured in units of distance. Drift speed information is converted to distance covered in a given time period. To determine force vectors:

1. Determine speed of the environmental force.

2. Convert force speed to object speed.

3. Multiply object speed by duration of drift to determine vector length.

4. Determine force direction.

5. Convert force direction to object direction.

6. Add all object vectors to derive the resultant motion vector of the object.

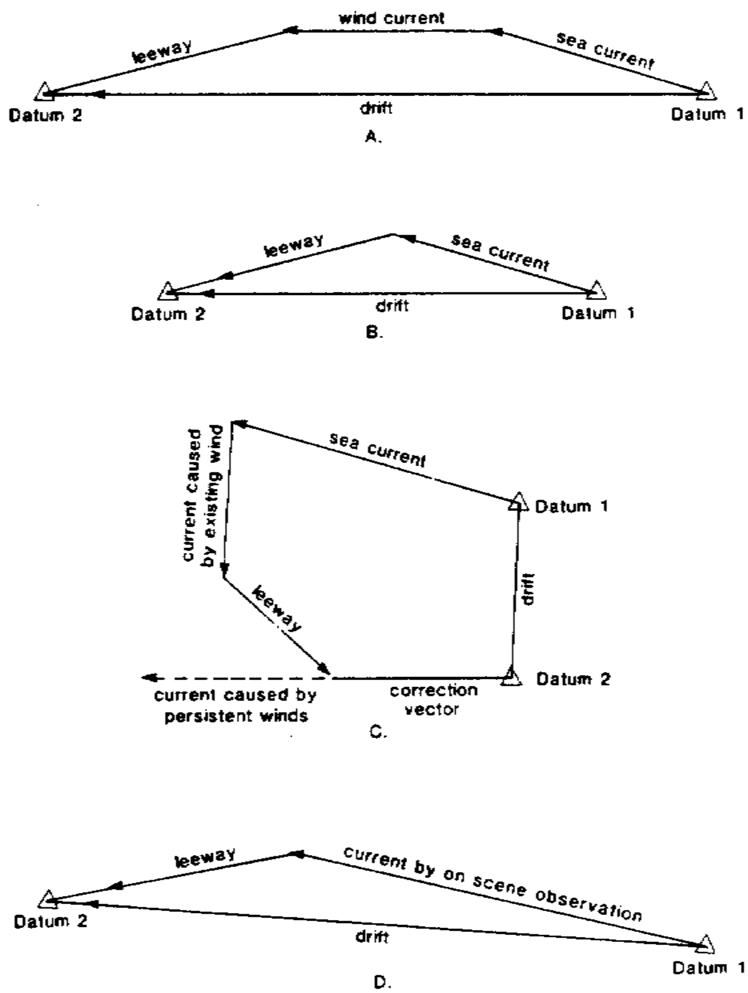


Figure 5-3. Vector Plots of Surface Drift Forces

Figure 5-3. Vector Plots of Surface Drift Forces

513 Aerospace Drift (Da)

A. Aircraft Glide, the maximum ground distance that an aircraft could cover during descent, should be determined if the position and altitude of an aircraft engine failure are known and crew bailout is doubtful. Aircraft glide ratio and rate of descent should be obtained from the parent agency or aircraft performance manual. The SMC can then determine maximum ground distance covered during descent and establish the possible area of impact after adjusting for wind (see Figure 5-1). A circle is constructed around the corrected last known position, using maximum no-wind glide distance as the radius. The enclosed area will be the maximum possible area for the aircraft datum.

B. Parachute Drift (dp) is the combination of parachute glide ratio and displacement due to winds aloft. Opening altitude, parachute type, and glide ratio, as well as average winds aloft and terrain height, should be considered when computing dp.

1. Most U.S. military parachutes automatically deploy at 14,000 feet, while Canadian Defence Force parachutes deploy at 16,400 feet. Some aircraft which operate regularly over mountains set automatic opening devices for 2,000 feet above the highest mountain peak in the operating area. The parent agency should be contacted to determine specific parachute characteristics.

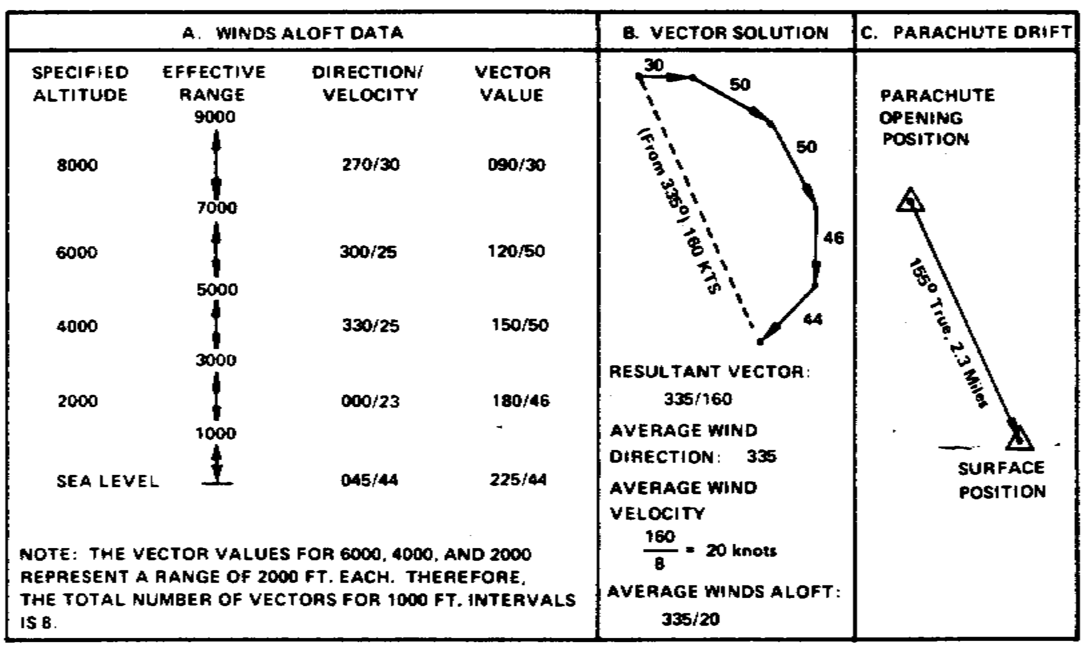
2. If parachute opening altitude is not available, SMCs should assume:

    a. Military parachutes open at 14,000 feet, or at bailout altitude if below 14,000 feet.

    b. Civilian parachutes open at bailout altitude, or if below 14,000 feet, at ATC-assigned altitude.

    For situations mandating descent, such as engine failure, calculations should make allowance for loss of altitude before bailout. Parent agency policy on minimum engine restart altitude

(PARACHUTE OPENED AT 8000 FEET OVER OCEAN)



(PARACHUTE OPENED AT 8000 FEET OVER OCEAN)

Figure 5–4. Average Winds Aloft Example

Figure 5-4. Average Winds Aloft Example

TABLE 5-1. Parachute Drift Distance (Zero Glide Ratio)
(Distance in miles of landing positions downwind from position of parachute opening)

	Wind in Knots						
Parachute-Opening Height	10	20	30	40	50	60	70
30,000 ft. (9,000m)	3.7	7.4	11.1	14.7	18.4	22.1	25.8
20,000 ft. (6,000m)	2.7	5.3	8.0	10.7	13.3	16.0	18.7
14,000 ft. (4,300m)	1.9	3.8	5.7	7.7	9.5	11.4	13.3
10,000 ft. (3,050m)	1.4	2.8	4.2	5.7	7.0	8.3	9.7
8,000 ft. (2,400m)	1.2	2.3	3.5	4.6	5.8	6.9	8.1
6,000 ft. (1,800m)	.9	1.7	2.6	3.5	4.4	5.2	6.1
4,000 ft. (1,200m)	.6	1.2	1.8	2.4	3.0	3.5	4.1
2,000 ft. (600m)	.3	.6	.9	1.2	1.5	1.8	2.1

should be determined and the assumption made that the crew rode the aircraft to that altitude before bailout. If high-performance military aircraft were known to be out of control (spin, mid-air collision, etc.) prior to bailout, the minimum safe bailout altitude should be obtained from the parent agency and used for computations if the actual bailout altitude is unknown.

3. Winds aloft are usually given in true headings, representing the direction winds blow from. Data on average winds aloft between parachute opening altitude and the surface should be obtained. If wind information is available only for certain altitudes, a vector solution is used to obtain an average. The solution assumes the wind is constant above and below a reported wind to a point midway between it and the next altitude for which a wind report is available. Figure 5-4 shows a vector solution to a winds-aloft problem where bailout and parachute opening altitude are 8,000 feet and landing is at sea level. Wind values for 2,000, 4,000, and 6,000 feet are used twice for winds from 7,000 to 5,000 feet, to 3,000 feet, and to 1,000 feet, respectively. Values for 8,000 feet and sea level are used once since each represents only 1,000 feet of altitude. For consistency, downwind vectors are recommended in plotting. Next, parachute drift due to average wind is determined, using the parachute drift distance given in Table 5-1. The value for 8,000 feet and 20 knots is 2.3 miles, which is plotted to determine surface position, as shown in Figure 5-4C. SMCs should interpolate, as necessary, to obtain average wind speeds when using Table 5-1.

4. If the parachute opens over terrain, adjustments for the terrain height should be made. Table 5-1 would be entered with terrain altitude and interpolated for the average wind velocity. The difference between the two values is the drift distance.

5. Glide area for a parachute with a known glide ratio is determined similar to aircraft glide area. The surface position is computed assuming the parachute has no glide ratio. Next, altitude difference between parachute opening and the terrain is determined, and the no-wind glide distance computed by multiplying glide ratio by altitude difference. A circle is drawn around the surface position with radius equal to glide distance. The enclosed area is the possible landing area.

514 Maritime Drift

A. Leeway (LW) is the movement through water caused by winds blowing against the exposed surfaces of the search object. The pushing force of the wind is countered by water drag on the underwater surface of the object. Most marine craft have a portion of the hull and superstructure (sail area) exposed above the water. The more sail area the search object has, the greater the wind force on the object. Completely submerged objects and persons floating in the water are assumed to have no leeway. The SMC should get information on the physical characteristics of the search object to determine the amount of leeway.

1. Leeway speed can be estimated using the graph in Figure 5-5, which provides for wind speeds (U) up to 40 knots. For more precise values, the following formulas may be used for wind speeds up to 40 knots:

Type of Craft	Leeway Speed
Light displacement cabin cruisers, outboards, rubber rafts, etc. (without drogue)	0.07U + 0.04*
Large cabin cruisers	0.05U
Light displacement cabin cruisers, outboards, rubber rafts, etc. (with drogue)	0.05U - 0.12*
Medium displacement sailboats, fishing vessels such as trawlers, trollers, tuna boats, etc.	0.04U
Heavy displacement deep draft sailing vessels	0.03U
Surfboards	0.02U

*Note: Do not use for values of U below 5 knots. Use Figure 5-5 instead, if applicable.

Figure 5-5 and the formula apply to rubber rafts with neither canopies nor ballast systems. Addition of such equipment has varying effects on leeway speeds:

a. Rafts with canopies and ballast pockets have leeway speeds approximately the same as rafts without this equipment.

b. Rafts with canopies have leeway speeds approximately 20 percent faster than rafts without.

c. Rafts with ballast pockets have leeway speeds approximately 20 percent slower than rafts without.

d. Rafts with canopies and a deep ballast system have uncertain leeway speed. Speeds approximately the same as for rafts with drogue may be assumed. The minimum leeway speed is zero for winds of 5 knots or less, and 0.1 knot for winds greater than 5 knots. For a deep ballast raft where the canopy does not deploy, the leeway speed falls to between 3 percent of the wind speed and zero.

2. Leeway direction is subject to large variations. It is usually assumed to be downwind, with diver gence compensated for by extending the search areas to the right and left of downwind.

a. The maximum angles off downwind are 45 degrees for craft with moderate to deep draft, 60 degrees for craft with a relatively shallow draft, and 35 degrees for rubber rafts.

b. Circular rafts with under vater portions symmetrical about a vertical axis through the center of the raft are considered a special category with a maximum leeway angle about 15 degrees either side of downwind. Circular rafts with a deep ballast system fall into this category, while rafts with asymmetrical ballast pockets do not. This category should not be assumed if doubt about raft type exists.

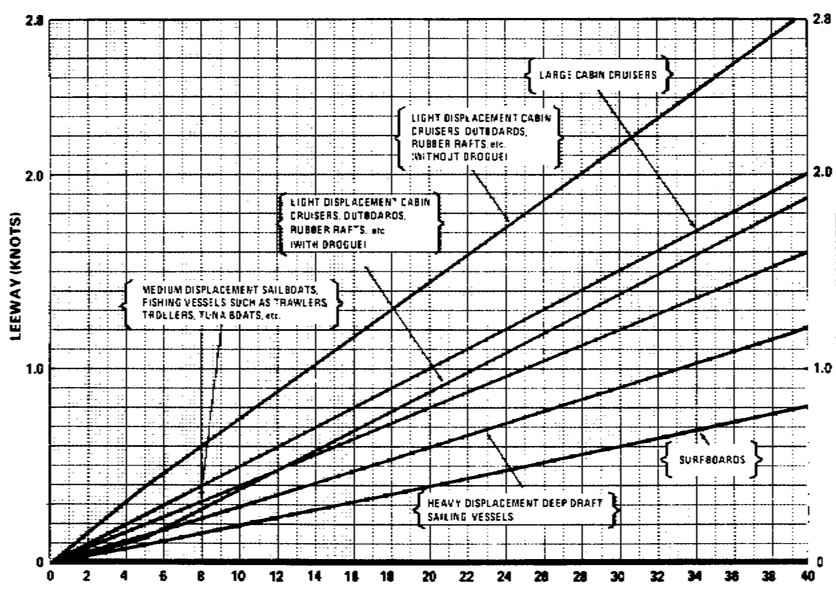


Figure 5-5. Leeway Speed

Figure 5-5. Leeway Speed

B. Sea Current (SC) is the residual current when currents caused by tides and local winds are subtracted from local current. It is the main large-scale flow of ocean waters. Near shore or in shallow waters, sea current is usually less important than the tidal current or the local wind-driven current. The strongest sea currents exist near the edge of the continental shelf and are usually referred to as boundary currents. Sea currents are driven by the energy of large-scale wind systems and the interaction of ocean water masses of different densities.

1. The preferred source of sea current information is the Naval Oceanographic Office Special Publication series 1400. Other sources include Section 1 of the Oceanographic Atlas, the Atlas of Surface Currents, Pilot Charts, and the Defense Mapping Agency. This data is useful for estimating drift of many objects for a long period, but less useful for the drift of one object for a short period.

2. Sea currents are not always steady. Their variability in both speed and direction can be great. Averages should be used with caution.

3. Charts and atlases from which sea current data is obtained are derived from averaging past shipboard observations of drift. In regions dominated by trade winds (persistent winds from the same quadrant 75 percent of the time), observations are biased by a persistent wind current as part of the observed sea current. Unless sea current for these regions is obtained from a better source, such as special current charts based on the average hydrography of the area, the resultant drift vector, illustrated in Figure 5-3A, may not be accurate. For regions of persistent winds:

   a. If winds blow persistently within normal range of direction and speed, find the drift vector by omitting wind current effect from the vector diagram, and using a sea current vector and leeway vector as shown in Figure 5-3B.

   b. If winds blow outside normal range of direction or speed for a period greater than 24 hours during the preceding 48 hours, use a correction vector to subtract the effect of persistent wind from sea current. The correction vector is found by computing the wind-driven current that the persistent wind would cause and reversing its direction. Considering the normal range of persistent wind, the best estimate of median direction and speed should be used. See Figure 5-3C.

C. Wind Current (WC), or wind-driven current, is generated by the wind acting on the water surface over a period of time. As a wind blows over water, it causes horizontal water movement that grows with wind speed and duration.

1. Two methods can be used to calculate the wind current vector.

The first uses Figure 5-6, entering with wind history and forecasts for the incident area. The second uses historical data or local knowledge of wind currents. Wind currents need not be computed for coastal, lake, river, or harbor areas, but should be determined for water depths greater than 100 feet (30 meters) and distances greater than 20 miles (32 kilometers) from shore.

2. Wind observations should be obtained beginning 48 hours before the assumed time the distressed craft began drifting. Accuracy of calculation is less with shorter wind histories. Forecasts should be used through the time period containing datum. On scene wind data should agree with the general circulation shown on area surface weather charts; if it does not, it should be either confirmed or disregarded. Generally, surface winds are directed 20 degrees toward the low pressure side of isobars on surface weather charts.

   a. Wind history is wind speed and direction near datum for the previous 48 hours, divided into 6-hour periods. Period 1 is the most recent 6 hours, period 2 the next most recent, and so on. Because wind observations are often available only at normal synoptic hours (0000Z, 0600Z, 1200Z, and 1800Z), it is best to select the wind interval that begins and ends midway between the synoptic hours bracketing the reported wind time. All other wind intervals also begin and end midway between normal synoptic hours.

   b. For each period, wind speed and direction are determined by using observed wind for the midpoint of the time period. When hourly winds are available, average wind speed over the time period is used. Wind speeds must be averaged vectorially.

3. Wind current computation involves the following considerations:

   a. Wind current should be calculated in 48-hour periods made up of subperiods of 6 hours

	NORTH LATITUDES													
Period	0°N	5°N	10°N	15°N	20°N	25°N	30°N	35°N	40°N	45°N	50°N	55°N	60°N	65°N
1	With sustained winds of 6 hours or more wind current speed will be 5% of wind speed with direction downwind.	185° 0.029	190° 0.028	196° 0.028	200° 0.027	205° 0.027	210° 0.026	214° 0.025	217° 0.024	221° 0.023	224° 0.022	226° 0.021	228° 0.020	230° 0.020
2		203° 0.012	226° 0.012	249° 0.012	271° 0.011	292° 0.011	312° 0.011	332° 0.011	350° 0.010	007° 0.010	022° 0.009	036° 0.009	049° 0.009	059° 0.008
3		219° 0.009	258° 0.009	296° 0.009	333° 0.009	009° 0.008	043° 0.008	076° 0.008	107° 0.008	136° 0.007	162° 0.007	186° 0.007	207° 0.007	224° 0.006
4		235° 0.008	289° 0.008	342° 0.008	035° 0.007	085° 0.007	134° 0.007	180° 0.007	223° 0.006	264° 0.006	301° 0.006	334° 0.006	003° 0.006	028° 0.005
5		250° 0.007	320° 0.007	029° 0.007	096° 0.006	162° 0.006	224° 0.006	283° 0.006	339° 0.006	031° 0.005	079° 0.005	121° 0.005	159° 0.005	192° 0.004
6		266° 0.006	352° 0.006	076° 0.006	158° 0.006	238° 0.006	314° 0.005	027° 0.005	095° 0.005	159° 0.004	217° 0.004	269° 0.004	315° 0.004	355° 0.004
7		282° 0.006	023° 0.006	123° 0.006	220° 0.005	314° 0.005	044° 0.005	130° 0.005	211° 0.004	286° 0.004	355° 0.004	056° 0.004	111° 0.003	158° 0.003
8		298° 0.005	054° 0.005	169° 0.005	281° 0.005	030° 0.005	134° 0.004	233° 0.004	327° 0.004	053° 0.004	132° 0.003	204° 0.003	267° 0.003	321° 0.003

Note. In each time period, the upper number shows the relationship between wind direction and current direction, and the lower number shows the relationship between wind speed and current speed.

Figure 5-6A. Wind Current – North Latitudes

Figure 5-6A. Wind Current - North Latitudes

	SOUTH LATITUDES													
Period	0°	5°S	10°S	15°S	20°S	25°S	30°S	35°S	40°S	45°S	50°S	55°S	60°S	65°S
1	With sustained winds of 6 hours or more wind current speed will be 5% of wind speed with direction downwind.	175° 0.029	170° 0.028	164° 0.028	160° 0.027	155° 0.027	150° 0.026	146° 0.025	143° 0.024	139° 0.023	136° 0.022	134° 0.021	132° 0.020	130° 0.020
2		157° 0.012	134° 0.012	111° 0.012	089° 0.011	068° 0.011	048° 0.011	028° 0.011	010° 0.010	353° 0.010	338° 0.009	324° 0.009	311° 0.009	301° 0.008
3		141° 0.009	102° 0.009	064° 0.009	027° 0.009	351° 0.008	317° 0.008	284° 0.008	253° 0.008	224° 0.007	198° 0.007	174° 0.007	153° 0.007	136° 0.006
4		125° 0.008	071° 0.008	018° 0.008	325° 0.007	275° 0.007	226° 0.007	180° 0.007	137° 0.006	096° 0.006	059° 0.006	026° 0.006	357° 0.006	332° 0.005
5		110° 0.007	040° 0.007	331° 0.007	264° 0.006	198° 0.006	136° 0.006	077° 0.006	021° 0.006	329° 0.005	281° 0.005	239° 0.005	201° 0.005	168° 0.004
6		094° 0.006	008° 0.006	284° 0.006	202° 0.006	122° 0.006	046° 0.005	333° 0.005	265° 0.005	201° 0.004	143° 0.004	091° 0.004	045° 0.004	005° 0.004
7		078° 0.006	337° 0.006	237° 0.006	140° 0.005	046° 0.005	316° 0.005	230° 0.005	149° 0.004	074° 0.004	005° 0.004	304° 0.004	249° 0.003	202° 0.003
8		062° 0.005	306° 0.005	191° 0.005	079° 0.005	330° 0.005	226° 0.004	127° 0.004	033° 0.004	307° 0.004	228° 0.003	156° 0.003	093° 0.003	039° 0.003

Figure 5-6B. Wind Current – South Latitudes

Figure 5-6B. Wind Current - South Latitudes

or less. The first period should begin at the time of datum and move backward for eight 6-hour periods.

b. The contribution that winds from each subperiod make should be determined and then added. The column in Figure 5-6A or 5-6B with the latitude closest to the position where local wind current is calculated (do not interpolate) is selected.

c. For each time period in Figure 5-6A, the lower number shows the relationship between wind speed and current speed, and the upper number shows the relationship between wind direction and current direction. The current speed of each period is found by multiplying wind speed by the lower number. The current direction for each period is determined by adding the upper number to the direction from which the wind blew. These contributions from each time period are added vectorially to obtain local wind current at the desired place and time.

D. Tidal Current (TC) is found in coastal waters, and changes direction and velocity as the tide changes. The effect of the tide on currents in any area may be found by consulting current tables and charts, or by seeking local knowledge. Calculating wind and sea currents close to land masses is normally not possible. Therefore, drift computations depend on tidal current and leeway.

1. With reversing currents that abruptly change direction approximately 180 degrees, the effect in one direction is normally greater than in the other, causing a net drift in one direction.

2. With rotary tidal currents, an object will move in a generally elliptical direction.

3. The cumulative effect of tidal current and leeway may move the target into the influence of different tidal conditions or to where sea current takes effect. Consideration may shift from tidal to sea current in the later stages of a SAR case. Intermediate datums should be computed for small periods of time to account for different influences.

4. Nearby land masses may also affect tidal current. Inlets will channel and release a current, often in a different direction at the inlet mouth. When an object drifts near the mouth of a bay or inlet, manuals can be used to see whether tidal current data has changed.

E. Other water currents affecting search objects are usually difficult to calculate.

1. Lake Current (LC) information usually comes from local knowledge, charts, tables, or computer models. A current in a

large lake can vary with season, weather, or time of day.

2. River Current (RC) information can usually be obtained from published data, local knowledge, or direct observation. Current data is published for most large rivers. The National Ocean Survey and the Army Corps of Engineers are the primary sources of information or river currents. In areas where a river discharges into the ocean, tidal current can affect river current upstream, and river current can affect tidal and sea currents. If offshore current is present, the SMC should not expect the river discharge to fan out symmetrically, but should expect displacement in the direction of the offshore current, as shown in Figure 5-7. Local colleges or universities may be a source of specific knowledge regarding this interface.

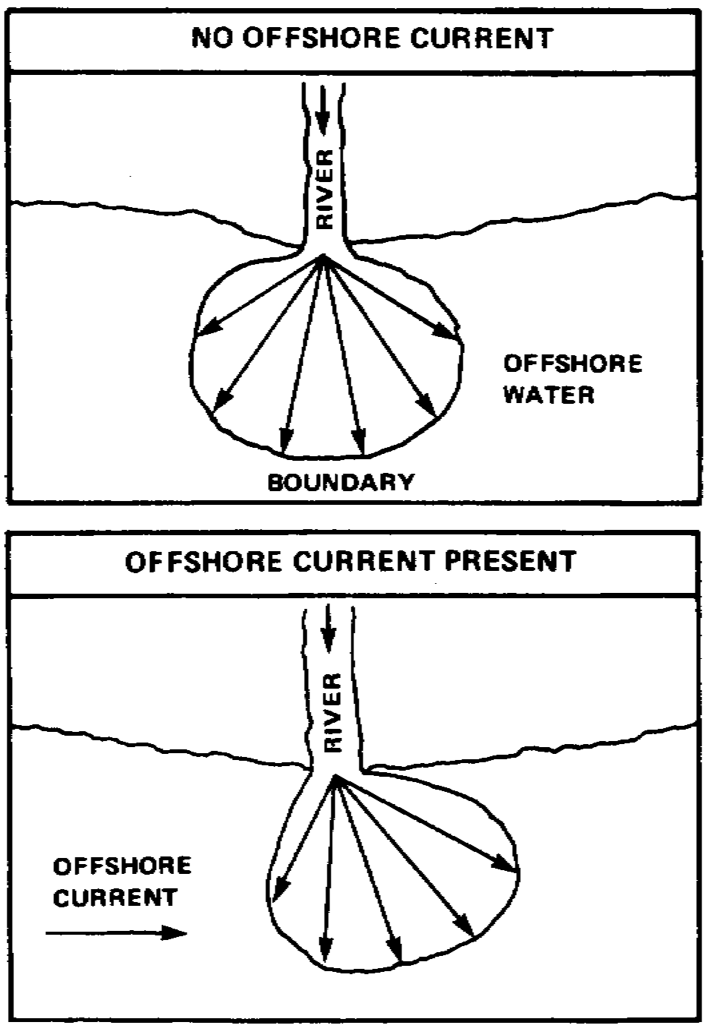


Figure 5–7. River Currents

Figure 5-7. River Currents

3. Bottom Current (BC) should be considered in underwater incidents. Bottom current is usually not strong enough to move a sunken object, including a body. However, if current exceeds 4 to 5 knots, as in a rain-swollen river, the sunken target may tumble along the bottom. Bottom current information can be obtained from the Defense Mapping Agency Oceanographic Atlas for certain harbor, coastal, and ocean areas. Also, Defense Mapping Agency or Naval Fleet Weather Centers may be able to provide special analysis services for underwater and bottom currents. For bottom currents in harbor areas the Army corps of Engineers should be consulted.

4. Swell/Wave Currents (SWC) may, in the absence of winds, affect rafts and other small marine craft. Because SWC speed is slight, this drift force is usually disregarded. However, it may be useful for determining probable direction of target movement.

5. Surf Current (SUC) is considered only for coastal surf areas and is more of a factor in rescue or salvage than in search planning. Surf current will move the object perpendicular to the line of breakers toward the shore. The object will also be displaced in the direction of any along-shore current.

F. Total Water Current (TWC) is the vector sum of currents affecting the search object. The best information on total water current is usually obtained from a Datum Marker Buoy (DMB).

1. DMBs and sonobuoys are droppable floating beacons transmitting a signal on UHF frequencies. The buoy drifts with surface currents, but shows no leeway. Each DMB used on scene should operate on a different frequency to preclude confusion over DMB origin.

2. With minimal current, first-day DMB observations may be questionable because of SRU navigational error. The average over 2 to 3 days can reduce the effect of such error. DMBs should be inserted or relocated as accurately as navigational systems permit.

3. Information on currents obtained by a DMB should be used with caution. It provides information only while in the water and represents a total water current (sea current and wind-driven current) valid only during the time of deployment and for the water area through which it traveled. Even so, it is probably a more accurate representation of current than that previously calculated from historical and statistical data. If there is a wide disparity between DMB and planning information, the SMC should consider adjusting search areas and/or datum.

4. To preclude diversion from planned search patterns, SRUs should relocate DMBs only at the beginning or end of search.

5. Other on scene observations can improve the accuracy of drift estimates. Ships and stations near the incident can be asked for recent wind and local current observations, but these should also be used with caution.

515 Enclosed and Coastal Waters

A. Datums in enclosed and coastal waters are derived by adding force vectors for the incident area. Typically, the applicable forces are leeway and water current.

B. Leeway direction is considered as directly downwind. The reciprocal of the average wind direction between the incident and datum determines the direction of the leeway vector. Leeway speed is calculated using the leeway graph or formulas in paragraph 514.A.

C. Two currents normally encountered in coastal environments are tidal and wind-driven currents. However, other currents should be included in calculations if their effect is significant.

1. After leeway, tidal currents cause the greatest drift for most objects. Procedures for determining tidal current vectors are discussed in Vol. II, Chapter 2, and the appropriate tidal current manual.

2. Wind current, normally present where wind and a long enough fetch generate the force, is difficult to quantify. The tidal current manual for the East Coast of the United States has a wind current table based on historical data. Most other areas have no data. Whether to compute a wind current depends on SMC local knowledge and the environmental parameters. Wind current for enclosed and coastal areas, including water depths less than 100 feet and distances closer than 20 miles from shore, is not normally calculated because of variability and short fetch distances. On some larger or deeper lakes, such as the Great Lakes, wind current can be determined

with reasonable accuracy.

516 Minimax Solution

A. When one or more of the drift variables cannot be accurately determined, the minimax solution can be used. It is usually used in ocean search planning when drift time or speed of the object is unknown.

B. Many situations, particularly target uncertainty, may require a minimax calculation. The SMC may be unsure whether survivors are still aboard a vessel or have abandoned it, and ships, rafts, and persons in the water have varying drift rates and divergence factors. Doubt about injuries will complicate determining the distance people could move.

C. The SMC should select the variable with the greatest impact on drift and solve for datum using the possible extremes, such as the faster speed of an unballasted raft and the slower speed of a half-swamped boat. This establishes the maximum and minimum drifts. Datum minimax is half way between these points, ensuring that the most probable position is closest to the center of the search area. See Figure 5-8.

D. A minimax solution might be used if there is any doubt about the following information:

1. For aircraft:

    a. Altitude of parachute opening.

    b. Point along a DR track or planned route where the aircraft went down.

2. For inland persons:

    a. Distance a lost child could travel.

    b. Whether travel-inhibiting injuries have occurred.

3. For maritime situations:

    a. Time a craft has been adrift.

    b. Time local winds shifted.

    c. Direction or speed of a drifting object.

    d. Only known factor is the direction of a flare sighting.

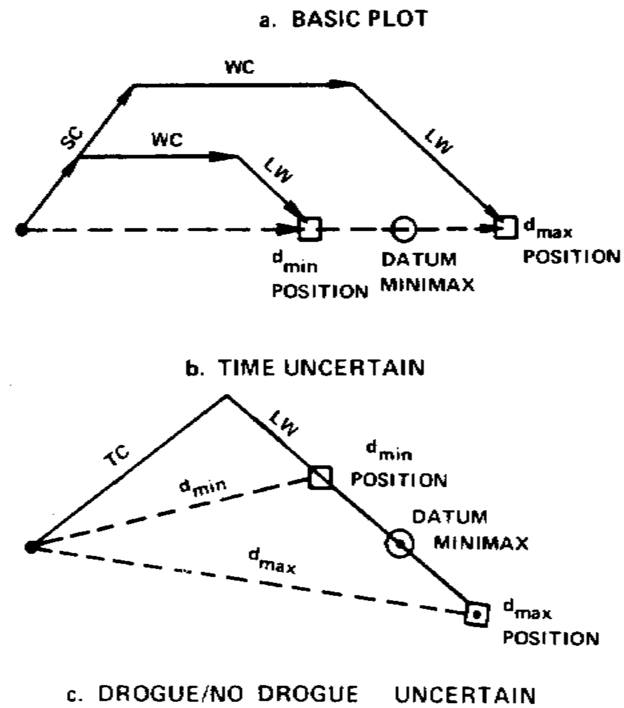


Figure 5–8. Minimax Plotting

Figure 5-8. Minimax Plotting

520 SEARCH AREA

A. The search area is the geographic area determined by the SMC as most likely to contain the search object. The amount of error inherent in the drift calculations and the navigational capabilities of the distressed craft and SRU are used to calculate a search radius (R), centered about datum, for the search area. The radius is normally limited by the maximum distance the search object could travel after the incident.

B. For areas such as large lakes, rivers, sounds, bays, or other coastal areas, the search area may depend on physical restrictions and time required to respond.

1. When response times are short, the SMC may use a standard radius, adjusted for physical surroundings. In areas where a search can begin in less than 6 hours, a radius of 6 nautical miles is usually large enough to include most targets.

2. Expanding the area based on drift calculations may place a large part of the area ashore or move datum into the ocean. If the SMC determines the target probably has moved into open ocean, and the standard radius may not apply, additional planning may be needed.

C. For open-ocean incidents, mathematical methods exist to determine R because drift determination is more quantifiable. The method described in the following paragraph is used primarily for air and water craft, but could also be used for inland or coastal region planning. See Vol. II, Chapter 3 for further search area calculation information.

521 Total Probable Error

A. Total Probable Error (E) is a mathematical tool for determining search area based on the probable errors in estimation of drift (De), initial position of the incident (X), and navigational capability of the SRU (Y).

B. Total Drift Error (De) accounts for errors in estimating drift and is used when determining E. It is the arithmetic sum of the individual drift errors from the time of the incident until datum.

1. Individual Drift Error (de) should be computed for each datum and is assumed to be three-tenths of total drift. Errors less than one mile are disregarded. When the first datum is computed, De equals de on the first search plan. However, as the mission progresses, De becomes de1, plus de2, etc.

2. Drift Errors for datum minimax calculations are determined by graphical or algebraic solutions.

   a. In the graphical solution, de is found for both dmin and dmax by multiplying their distances by the drift error confidence factor (CF) of 0.3, as shown in Figure 5-9. Using the dmin position as a center, and the minimum de as a radius, a circle is drawn. Using the dmax position as a center, and the maximum de as a radius, another circle is drawn. A third circle is drawn tangent to the other two circles with the center located on a straight line connecting the dmin position and dmax position. This circle's radius is the minimax drift error (de minimax), used as De on the first search plan. See Figure 5-9. Three circles need not actually be drawn; once the dmin position and dmax position have been determined, the problem can be laid off on an extended line joining the two positions.

   b. The algebraic method obtains de minimax by first plotting minimum and maximum datums. The distance between the two is added to de min and de max, and divided in half to derive de minimax.

   de minimax = (Distance + de min + de max)/2

$$d_e\text{minimax} = (\text{Distance} + d_e\text{min} + d_e\text{max})/2$$

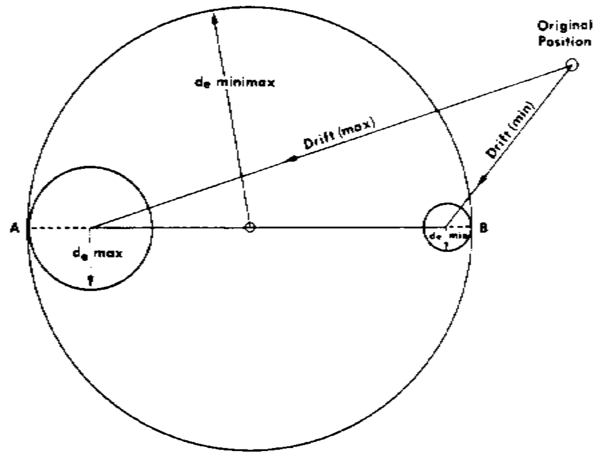


Figure 5–9. Drift Error by Minimax

Figure 5-9. Drift Error by Minimax

TABLE 5-2. Navigational Fix Errors

Means of Navigation	Fix Errors (NM)
NAVSAT	0.5 NM
Radar	1 NM
Visual Fix (3 lines)*	1 NM
Celestial Fix (3 lines)*	2 NM
Marine Radio Beacon	4 NM (3 beacon fix)
LORAN C	1 NM
OMEGA	4 NM
INS	0.5 NM per flight hour without position update
VOR	± 3 degrees arc and 3 percent of distance or 0.5 NM radius, whichever is greater
TACAN	± 3 degrees arc and 3 percent of distance or 0.5 NM radius, whichever is greater

*Should be evaluated upward according to circumstances.

C. Initial Position Error (X) is the assumed error of the initial position based on navigational accuracy of the distressed craft or the position fixing accuracy of the radio DF net, radar net, SOFAR net, etc., reporting the initial position.

1. If information on the means of navigation used by the distressed craft is available, the navigational

fix errors (Fixe) listed in Table 5-2 may be assumed for positions reported as navigation fixes (X=Fixe). If the means of navigation on the distressed craft is unknown, the SMC should assign error on the following basis:

a. 5 NM for ships, military submarines, and aircraft with more two engines.

b. 10 NM for twin-engine aircraft.

c. 15 NM for boats, submersibles, and single-engine aircraft.

2. If the position is determined from an FCC direction-finding network, the fix error corresponds to the assigned classification of the fix as follows:

Navigational Fix Errors

Class of Fix	Fix Error
A	20 NM
B	40 NM
C	60 NM

TABLE 5-3. Dead Reckoning Errors

Type of Craft	DRe
Ship	5 percent of the DR distance
Submarine (military)	5 percent of the DR distance
Aircraft (more than 2 engines)	5 percent of the DR distance
Aircraft (twin-engine)	10 percent of the DR distance
Aircraft (single-engine)	15 percent of the DR distance
Submersible	15 percent of the DR distance
Boat	15 percent of the DR distance

3. When the initially reported position is based on dead reckoning (DR), an additional error is assumed for the distance traveled since the last fix. The initial position error is the sum of the fix error and DR error (DRe). Table 5-3 gives DRe which may be assumed for various types of craft.

D. SRU Error (Y) based on errors in SRU navigation accuracy, should be considered by the SMC. Since SRUs maintain frequent fixes, usually only Fixe is used. However, if an SRU uses DR navigation in the search area, the SMC should be advised. The SMC then uses both Fixe and

DRe to determine SRU error (Y = Fixe + DRe).

E. Total Probable Error (E) is calculated using one of the following formulas:

1. E = X2+Y2 for the initial 4 hours of a mission when drift can be disregarded, and in most inland missions.

2. E = De2+X2+Y2 when drift forces are relevant.

F. Recalculation of E is necessary when one of the following happens:

1. The drift changes. A target in water continually drifts. The SMC periodically recomputes datum, leading to a change in De. To illustrate, suppose a surface position is the initially reported position. Drift and drift error are zero. When datum is computed 4 hours later, d1 = 16 miles, and de1 = 4.8 miles, making De = de1 = 4.8 miles. Six hours later datum 2 is computed with d2 = 24 miles and de2 = 7.2 miles, making De = de1 + de2 = 4.8 + 7.2 = 12 miles. The process is continued throughout the mission.

2. The SRUs change. The SMC recomputes E each time the SRU is changed if the Fixe(Y) changes.

3. The initial position changes. Once errors in the initial position are computed, they usually are not changed unless later information shows initial assumptions to be in error.

522 Search Radius

The search radius (R) is the radius of a circle centered on a datum, having a length equal to E plus an additional safety length to help ensure that the target is in the search area. For ground and underwater searches, R is measured in yards. On other searches, R is measured in nautical miles. R is usually increased after successive searches to increase the chance of the target being in the search area. Table 5-4 lists Safety Factors (fs) used sequentially to gradually enlarge the search area.

TABLE 5-4. Search Radius Safety Factors

Search	fs
1st	1.1
2nd	1.6
3rd	2.0
4th	2.3
5th	2.5
Subsequent Searches	2.5

Search radius is defined as R1 for the first search, R2 for the second, etc. R is computed by multiplying E by the appropriate fs, i.e., R = E x fs.

523 Search Area Development

A. Theoretically, the best search area is a circle centered on datum. However, few search patterns are adaptable to circular search areas. For most patterns, a square or rectangular search area is more The ends of the area are squared off with tangent lines as illustrated in Figure 5-12. Figure 5-13, a datum line search expansion, shows development of the next search area enlargement, assuming the datum line is not stationary.practical. Circular areas are simply boxed in as shown by Figure 5-10.

B. For a search with little or no drift, search area is constructed around a stationary datum. If the target is not found, the area may be expanded for subsequent searches. Therefore, the area around datum, which continues to be the most probable location, is searched repeatedly.

C. For maritime incidents, datum will normally move during the search, as Figure 5-11 illustrates. The enlargement of the search area for a moving datum is the same as for a stationary datum, but the area is centered on a new datum so that the water surface is re-searched where survivors are most likely to be.

D. A search area along a datum line is set up by first developing a search radius for each datum along the trackline. Each datum is circled, using its search radius. Tangent lines are then drawn from circle to circle to establish search area boundaries.

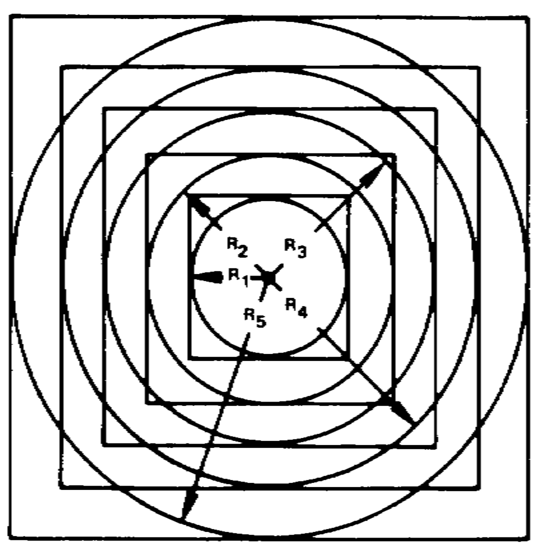


Figure 5-10. Search Areas – Stationary Datum Point

Figure 5-10. Search Areas - Stationary Datum Point

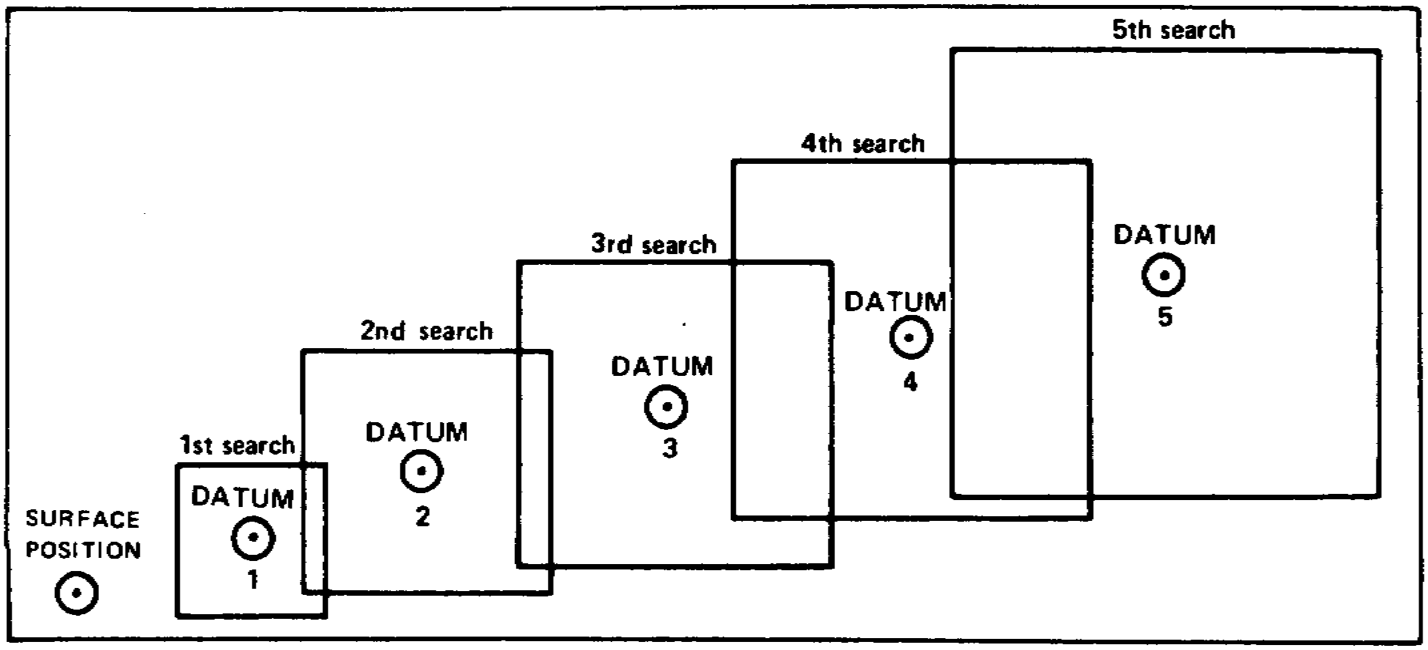


Figure 5-11. Search Areas – Moving Datum Point

Figure 5-11. Search Areas - Moving Datum Point

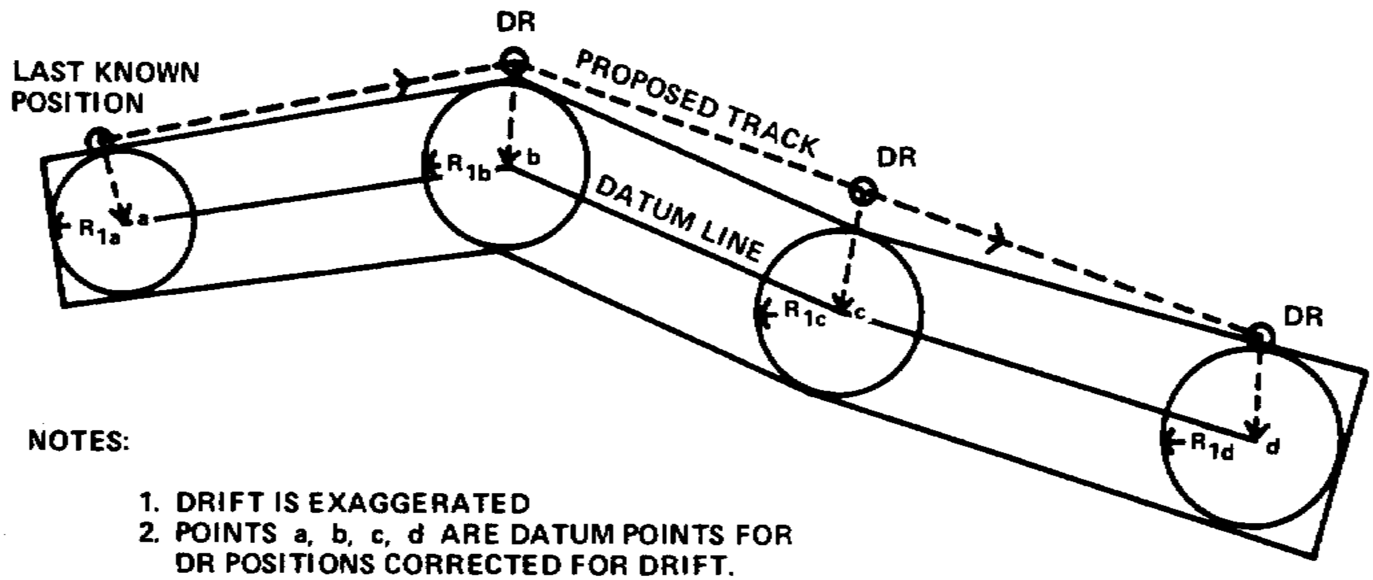


Figure 5–12. Search Areas – Datum Line

Figure 5-12. Search Areas - Datum Line

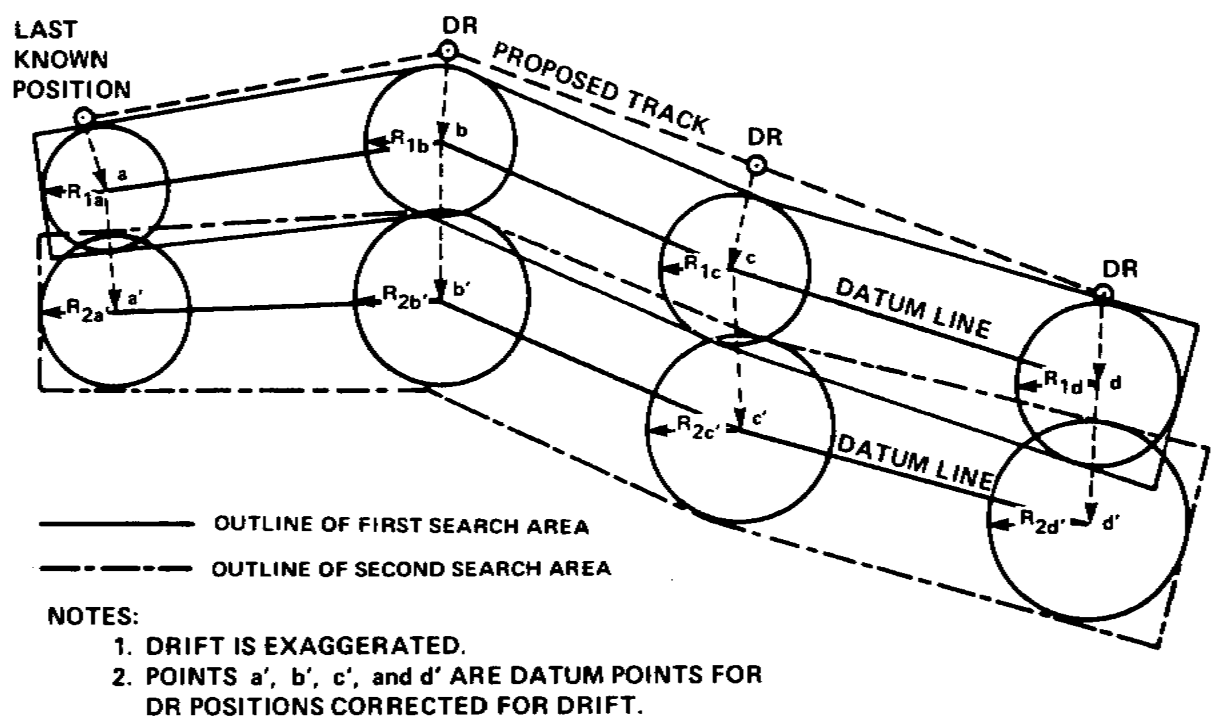


Figure 5–13. Search Areas Expansion – Datum Line

Figure 5-13. Search Areas Expansion - Datum Line

E. When only a datum area exists, search areas are developed differently:

1. If the area is small, a search radius is computed as before and added to the radius of the datum area.

2. If the datum area is a reasonable size for searching and probably contains the target, it can be used as the first search area. An example is a military aircraft disappearing in a prescribed operating area. When the datum area is based on reports of low flying or crashed aircraft, planners should avoid the tendency to excessively limit the size of the search area around the reported site. A radius of 15 miles from the observation

point 30-50 miles in the aircraft direction of flight, and a 5-15 mile radius from the reported position of a crash, are usually preferred.

3. If the original datum area is too large for search by available SRUs, the area should be reduced. Information obtained during the SAR effort may aid in determining what portion of the area to eliminate.

4. As with point and line datums, drift may be considered in datum areas. For small or medium-size areas, drift can be plotted using a single point, relocating the area for drift, and keeping the original orientation, size, and shape of the area. If the area is so large that positions have different drifts, it may be necessary to calculate drift for each section. Subsequent displaced areas will not keep their original shape.

F. After each search, a reevaluation should determine whether the next search should cover the same area, an expanded area, or a different area. Generally, at least one re-search is desirable.

524 Repeated Expansion Concept

The Repeated Expansion concept is used for successive enlargement of search areas and is suitable when approximate target datum is known. It involves up to five successive searches with each search centered on the datum. As the target is most likely to be near the datum and least likely to be at the outer edges of the fifth search area, the concentrated effort is at the most likely target position, while the search area is expanded by using the search radius safety factors. After five searches, an area equal in size to the first search area has been searched five times while the outer edge of the fifth search has been searched once, resulting in a high cumulative Probability of Detection (POD) at the center (see paragraph 537).

530 SEARCH PLAN VARIABLES

The goal of search planning is to cover as much of the search area as possible with a reasonable POD. Area coverage is a function of the number, speed, and endurance of SRUs used. POD is the measure of desired search results prior to a search, or the search results actually obtained, and is a function of sweep width and track spacing. The planner should balance these variables.

531 Number of SRUs

A. An optimal search plan should be developed assuming that sufficient and suitable SRUs are available. Every effort should be made to obtain necessary SRUs.

B. The first SRUs dispatched are usually alert SRUs, and are normally sent to datum or on a trackline search. Backup and standby

SRUs are dispatched next. Supplementary SRUs may be requested from other activities.

C. If sufficient SRUs are not available, compromises should be made to develop an attainable search plan. These compromises may involve reduction of the search area, increased track spacing, or the use of less desirable SRUs.

532 Search Time Available

A. The amount of search time available (T) is of paramount importance. Since survival rates normally decrease with time, the SMC is always working against the clock. Limited time available for search may require a rapid search rate at the expense of area searched or POD. Two major controlling factors for computing search time available are SRU endurance and amount of daylight available.

B. Search Endurance of the individual SRUs is normally more critical for aircraft. To calculate on scene endurance for an SRU, total mission endurance should be determined, contacting the parent agency if necessary. Time needed for transit to and from the assigned search area is deducted from total endurance, to obtain on scene endurance. Search endurance can be assumed to be 85 percent of on scene endurance, allowing 15 percent for identifying targets.

1. Generally, diversion to identify a target will have no appreciable effect on area coverage as long as the SRU "fixes" the location and time of departure from the search pattern and returns to the same point to resume search within a reasonable time.

2. When SRUs operate far from home base, they can sometimes be deployed to an advance base so more time will be available for searching, and less time will be spent en route to and from the search area.

C. Sunset is the usual cut-off point for visual searches. Every time the SRU diverts, available daylight is reduced. Visibility, an entering argument for calculating sweep width, changes after sunset. Also, search target detectability changes. Searching after sunset is restricted to visual detection aids or electronic detection, dictating changes in track spacing to obtain desired POD.

533 SRU Ground Speed

SRU ground speed (V) is important when calculating attainable area size. The faster the SRU, the larger the area covered. However, speed may adversely affect endurance and search effectiveness.

534 Track Spacing

A. Track spacing (S) is the distance between two adjacent parallel search legs. It directly influences target detectability. See Figure 5-14.

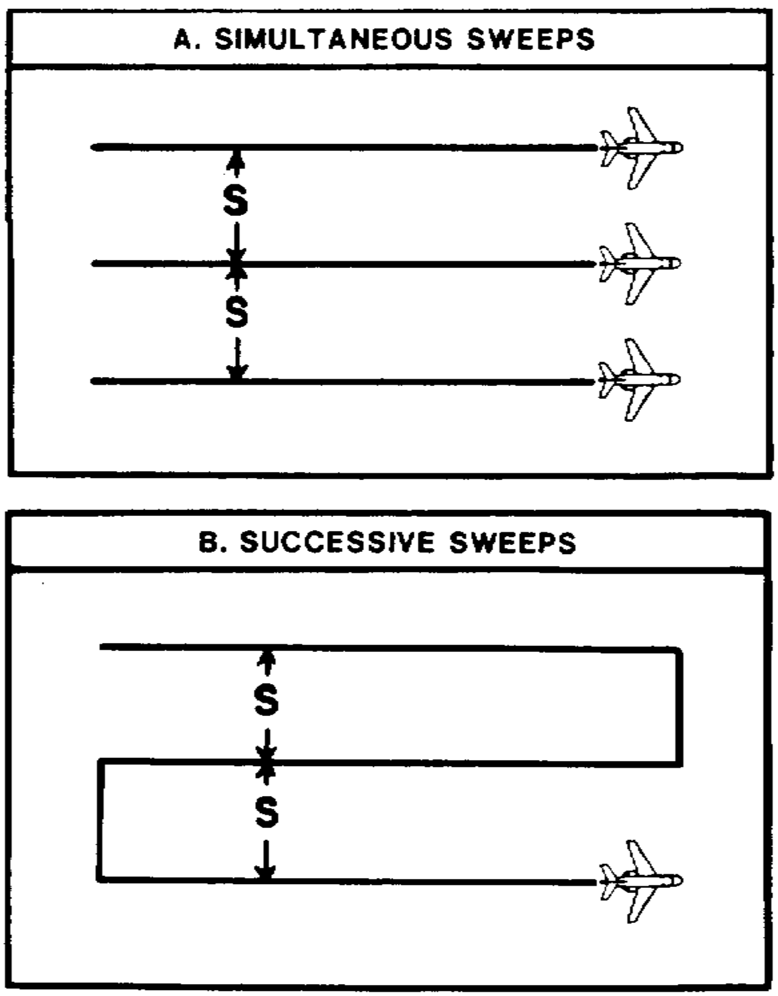


Figure 5–14. Track Spacing

Figure 5-14. Track Spacing

B. POD can be increased by decreasing track spacing, but decreased track spacing means that more time is needed to search an area with the same number of SRUs. If extra time is not available, the search area may need to be reduced. Conversely, search area can be expanded by increasing track spacing, but this will decrease POD. Unless an optimum number of SRUs is available, the SMC must choose between the amount of area to be covered and the POD desired. See Figure 5-15.

C. The practical limits of SRU turning radii and navigational accuracy limit how much track spacing can be reduced. Optimum track spacing yields maximum POD during the time available, consistent with the economical use of available SRUs.

535 Sweep Width

A. Sweep width (W) is the distance on both sides of the SRU where the probability of detecting a target outside of the sweep width is equal to the probability of missing a target inside that distance. It is a measure of detection capability based on target characteristics, weather, and other factors. Sweep width is less than twice the maximum detection range, which is the farthest range at which the target can be detected. See Figure 5-16. It is usually expressed in yards for underwater and ground searches, and in nautical miles for other types of searches. Use of the sweep width concept in any search allows solution of otherwise unworkable problems.

B. Sweep width varies with the type of search conducted. Visual searching is used most often. However, sensor searches can be far more efficient than visual and should be considered when it is known, or even suspected, that the distressed craft or persons may be more readily detected by electronic or other nonvisual means.

1. Sensors include radio, radar, magnetic, voltage, radioactive, infrared, ultraviolet, electro-optical, and other electromagnetic signal sensing equipment. Most common in SAR applications are radio and radar, with infrared becoming increasingly available. Detection range information may be available from parent agencies, operating commands, manufacturers, or operators. Chapter 6 has additional information on use of electronic equipment for searches.

2. Each SAR agency should test its specific equipment to develop accurate estimates of sensor sweep width. Output power, reflective capabilities, antennae heights, environmental ambient noise and clutter levels, and other factors that affect the quality of sensor receiving and transmitting may affect sweep width.

Parameter Change	Requires/Permits				
	POD	S	No. of Search Units	Size of Search Area	Search Duration
Increase POD Decrease POD	N/A N/A	Decrease Increase	Increase Decrease	Decrease Increase	Increase Decrease
Increase S Decrease S	Decrease Increase	N/A N/A	Decrease Increase	Increase Decrease	Decrease Increase
Increase No. of Search Units Decrease No. of Search Units	Increase Decrease	Decrease Increase	N/A N/A	Increase Decrease	Decrease Increase
Increase Search Area Size Decrease Search Area Size	Decrease Increase	Increase Decrease	Increase Decrease	N/A N/A	Increase Decrease
Increase Search Duration Decrease Search Duration	Increase Decrease	Decrease Increase	Decrease Increase	Increase Decrease	N/A N/A

Figure 5-15. Relationship Between Track Spacing and Other Search Planning Parameters

Figure 5-15. Relationship Between Track Spacing and Other Search Planning Parameters

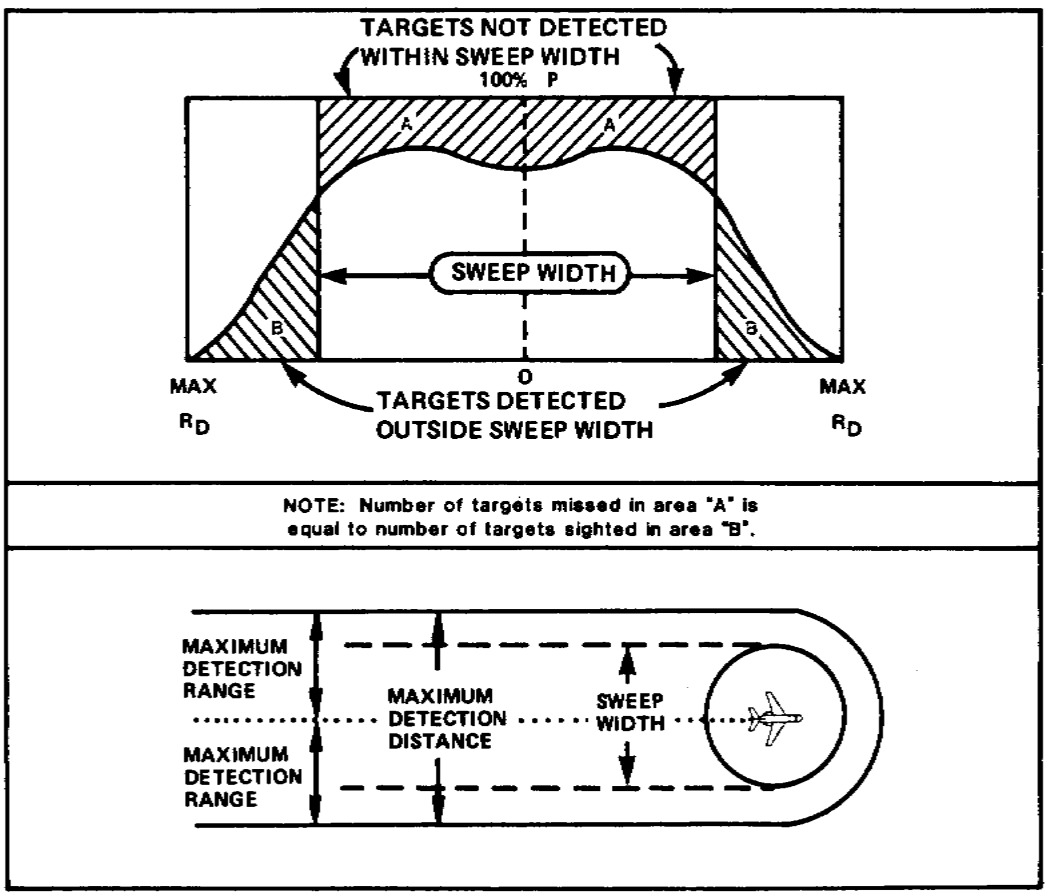


Figure 5-16. Sweep Width

Figure 5-16. Sweep Width

C. Visual sweep widths are determined by choosing an uncorrected sweep width based on type of search object and SRU altitude and correcting it for environmental conditions, speed, and fatigue. For maritime SAR, sweep width corrected (W) = sweep width uncorrected (Wa) x weather correction (fw) x fatigue correction (ff) x speed correction (fy). For inland searches, see Chapter 8. Sweep width tables are available in Appendix D and in Vol. II, Chapter 4. Factors affecting sweep width are:

1. Target characteristics. The target size, shape, distance from the SRU, color contrast and brightness contrast, movement, and duration of exposure to an observer must be considered.

2. Meteorological Visibility. The maximum range at which large unlighted objects such as land masses can be seen constitutes meteorological visibility. Reduced visibility results in reduced detectability and sweep width.

3. Terrain/Sea Conditions. Normally, the more level the terrain, the more effective the search can be. Trees, rock outcroppings, and other surface irregularities decrease search effectiveness, as will whitecaps, wind streaks, foam streaks, breaking seas, swell systems, salt spray, and sun reflections over water. Overwater sweep width decreases as wind speed and significant wave height increase.

4. Cloud Cover. Visual seep widths may be reduced 10 to 20 percent by cloud cover above the SRU due to reduced surface illumination.

5. Search Altitude. As altitude decreases, the search target passes more rapidly through the field of vision because of angular acceleration. This effect is most pronounced at altitudes below 500 feet. If a large number of targets are in the area, a low altitude is preferable to reduce diversions for identifying sightings. Also, low altitude favors target identification because scanners are more familiar with objects viewed from low angles. For maritime searches, the daylight lower limit is 200 feet for all search conditions, and altitude usually does not exceed 3000 feet even under good search conditions. For land searches, scanner efficiency decreases rapidly as altitude increases from 200 feet up to 2000 feet, and more slowly as it increases above 2000 feet. See Table 5-5 for recommended search altitudes.

TABLE 5-5. Recommended Visual Search Altitudes

Search Target	Terrain	Recommended Altitudes (ft)
Person, cars, light aircraft crashes	Moderate terrain	200 to 500
Trucks, large aircraft	Moderate terrain	400 to 1000
Persons, one-person rafts, surfboards, light aircraft crashes	Water or flat terrain	200 to 500
Small to medium-sized boats, liferafts, trucks, aircraft	Water or flat terrain	1000 to 3000
Distress signals	Night-all terrain	1500 to 2000

6. Search Speed. At low altitudes, higher speed causes blurring of targets at close ranges and decreases exposure time to the scanner. At altitudes above 500 feet, search speed of traditional SRUs has no significant influence on overwater sweep widths. The increase in area searched more than compensates for the small reduction in sweep width at higher search speeds.

7. Visual Distress Signaling Devices (VDSDs). When estimating sweep widths for VDSDs, such as pyrotechnics, dye markers, tracer bullets, or signal mirrors, use either twice the range at which survivors can be expected to detect the SRU, or the value given in Tables 5-6, 5-6a, 5-7, 5-7a or 5-7b, whichever is smaller.

a. Daylight Detection Aids. Effectiveness of daylight aids is marginal due to the difficulty in achieving target contrast in a sunlit environment. Estimated sweep widths for various daylight detection aids are given in Tables 5-6 and 5-6a. Hand held orange smoke detectability varies by type of SRU, and also by time on task for surface SRUs. Estimated sweep widths for hand held orange smoke are given in Table 5-6a for winds 10 knots or less. For winds over 10 knots the smoke tends to dissipate and sweep width degrades to less than 2 nautical miles.

b. Night Detection Aids. If it is known, or suspected, that survivors can make a night signal, night visual searches should be conducted.

TABLE 5-6. Visual Sweep Width Estimate for Daylight Detection Aids

Device	Estimated Sweep Width (NM)	SRU Type
Red/orange balloon	0.5	Air or surface
Orange flight suit	0.5	Air
Red hand flare (500 candlepower)	0.5	Air or surface
Day/night flare	0.5	Air or surface
Red pen gun flare	0.75	Air or surface
Red reflective paulin	2.0	Air or surface
Tracer bullets	2.0	Air or surface
Green dye marker*	2.0	Air
Red/orange flag (waving) (3 ft x 3 ft)	2.5	Air or surface
Sun signal mirror	5.0	Air or surface
White parachute	5.0	Air or surface
Red meteor (star) or parachute flare (10,000 candlepower)*	6.0	Air or surface

*Greatly reduced in heavy seas

Table 5-6a. Visual Sweep Width Estimates for Hand Held Orange Smoke {1}

SRU Type	Time on Task (hr) < 3	Time on Task (hr) þ 3
Small boat (41' UTB)	4.6	2.8
Vessel (90' WPB)	6.9	5.0
Air*	7.7	

*Sweep width based on test results involving helicopters only.

Searches during the early stages potentially yield a high POD. Cloud cover, wind, and obscurations to visibility have less detrimental effects on night detection aids. Even a flashlight may be seen. On clear nights, pyrotechnics have been sighted in excess of 40 nautical miles. Sweep width should be based on the most likely VDSD to be used, and limited to slightly less than twice the estimated range at which survivors can detect the SRU. Estimated sweep widths for night detection aids are given in Table 5-7, 5-7a and 5-7b. Hand held red flare detectability varies by type of SRU, and also by time on task for surface SRUs. Estimated sweep widths for hand held red flares are given in Table 5-7a. Life ring and life jacket strobe light detectablility varies by type of SRU and time on task, and also by wind speed for surface SRUs. Estimated sweep widths for life ring/life jacket white strobes (50,000 peak candlepower) are given in Table 5-7b.

Table 5-7. Visual Sweep Width Estimates for Night Detection Aids

Device	Estimated Sweep Width (NM)	SRU Type
Strobe (2,000 candlepower peak)	0.5	Air or surface
Cyalume personnel marker light	1.0	Air or surface
Electric flashing SOS lantern or hand flashlight	3.0	Air or surface
Tracer bullets	4.0	Air or surface
Red Very signals	8.0	Air or surface
Aircraft marine markers	8.0	Air or surface
Red pen gun flare	8.0	Air or surface
Red meteor (star) or parachute flare (10,000 candlepower)	10.0 or twice limit of survivor/ SRU visibility	Air or surface

Table 5-7a. Visual Sweep Width Estimates for Hand Held Red Flare (500 candlepower) {1}

SRU Type	Time on Task (hr) < 3	þ 3
Small boat (41' UTB)	10.7	10.2
Vessel (90' WPB)	13.0	12.6
Air*	15.4	

*Sweep width based on test results involving helicopters only.

Table 5-7b. Visual Sweep Width Estimates for Life ring/Life jacket White Strobe (50,000 peak candlepower) {1}

	Time on Task (hr) <3			þ3		
	Wind Speed (kts)					
SRU Type	<10	10-15	>15*	<10	10-15	>15*
Surface	3.9	2.6	1.3	2.1	1.1	0.5

SRU Type	Time on Task (hr) <1	þ1
Air**	4.4	3.9

*Values for this category were extrapolated from test data.
**Based on test results with helicopters only.

8. Position of the Sun. The sun's position relative to SRU and target can significantly influence target appearance. Detectability, however, is not necessarily better or worse in any particular direction relative to the sun.

9. Fatigue. Degradation of detection performance during a search can be significant. The sweep widths given in Appendix D and Volume II are adjusted for a normal amount of crew fatigue. If search crews are excessively fatigued, sweep width should be further reduced by 10 percent.

D. EPIRB/ELT Sweep Widths

1. The detection range data obtained from various sources may be tabulated as maximum, average, or minimum ranges:

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

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

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

2. The following guidelines, listed in order of preference, are recommended for developing an EPIRB/ELT sweep width:

a. When minimum detection range is known: W = (1.7) x (minimum detection range).

b. When average detection range is known: W = (1.5) x (average detection range).

c. When maximum detection range is known: W = (1.0) x (maximum detection range).

d. When no detection range is known: W = (0.5) x (horizon range), using horizon range table (Table 5-8).

3. If search aircraft VHF/UHF antennas are located on top of the aircraft or in the tail, the sweep widths determined by these rules should be reduced by 25 percent.

4. Sweep width should be cut in half if searching in mountainous regions.

E. Radar Sweep Widths

1. Radar is primarily used for maritime search. Most aircraft radars available for SAR would be unlikely to detect typical search objects on land except for metal wreckage or vehicles in open desert or tundra. Sweep width depends on the type of radar, height of eye to the horizon, environmental clutter and noise, radar cross section of the target, radar beam refraction due to atmospherics, and sensor operator ability.

2. This section provides sweep widths for a limited range of target types and sea conditions. For other targets and sea conditions, the manufacturer's detection performance estimates should be used when available. Manufacturers should have completed extensive testing of their products and may be able to provide detection capabilities for particular targets and specified environmental conditions. If this information is not available, the SMC may ask radar operators for estimates of sweep width based on operational experience. An experienced radar operator familiar with the assigned radar should be able to offer fairly accurate estimates of effective (not maximum) detection range. Radar operators should be told that the effective detection range is the range at which they believe the target will certainly be detected under prevailing conditions. Sweep width can be calculated as about twice this estimate of effective range. Sweep width estimates for small fiberglass or wooden craft that may be capsized are based on the assumption that the target has no engine or significant metal equipment exposed.

3. The Douglas scale (see Table 5-9) is a series of numbers from 0 to 9 to indicate sea condition, and was used in the development of the radar sweep width tables. Douglas sea states over 3 are not used because little data has been collected under these conditions, and most radars show excessive sea return (clutter) above sea state 3.

TABLE 5-9. Douglas Sea State

Douglas Sea State	Description	Wave Height
O	Calm	--------
1	Smooth	0 - 1 foot
2	Slight	1 - 3 feet
3	Moderate	3 - 5 feet
4	Rough	5 - 8 feet
5	Very Rough	8 - 12 feet
6	High	12 - 20 feet
7	Very High	20 - 40 feet
8	Precipitous	over 40 feet
9	Confused	--------

4. For Surface Vessel Radar (SVR), the following sweep widths can be used, based upon data from AN/SPS-64(V) and AN/SPS-66 radars:

Table 5-8. Height of Eye vs. Horizon Range

< Not Included >

TABLE 5-10. Sweep Widths for Surface Vessel Radar (NM)

Target Type	Douglas Sea State	Sweep Width (NM)) Surface Vessel Radar System AN/SPS-64(V)	AN/SPS-66
Small (20 feet or less) fiberglass boats, without radar reflector or engine/metal equipment	0 to 1 2 to 3	1.4 1.1	0.8 0
Small (20 feet or less) fiberglass boats, with radar reflector or engine/metal equipment	0 to 1 2 to 3	5.0 1.6	2.0 0.4
Medium to large vessels (40 feet or over) with significant amounts of reflective material	0 to 2	13	9.5

a. For intermediate-size targets in sea states below 3, the information from the SVR table must be interpolated. For sea states greater than 3, sweep width should be estimated on the basis of sea state and target characteristics.

b. When windy conditions cause heavy sea clutter, SVR search patterns oriented with major search legs in the crosswind direction and crosslegs in the downwind direction provide the best radar coverage. However, sea conditions may inhibit searching in this manner.

5. Sweep widths for Forward-Looking Airborne Radar (FLAR) can be calculated using the values in Tables 5-11 and 5-11a.

a. Sweep widths for small targets in sea state 3 or higher decrease rapidly to zero.

b. Detection range is more often limited by either clutter or signal-to-noise ratio than by horizon distance.

c. AN/APS-127 searches should be conducted at lower altitudes whenever flight operations permit, particularly when seas are greater than two feet, because higher altitudes tend to enhance sea return.

d. The AN/APS-127 provides a useful detection capability for life rafts when the 10NM scale is used. The 20NM range scale may degrade detection capability at each range interval but the doubling of the range scale leads to a greater sweep width. Either the 10 or 20NM range scale is effective against 24 to 43 foot boats.

6. Sweep widths for Side-Looking Airborne Radar (SLAR), based on tests of the AN/APS-94D SLAR systems, are given in Table 5-12.

a. Sweep widths are based on altitudes of 2,500 to 4,000 feet for targets under 40 feet long, and 8,000 feet for targets over 40 feet long, with range scales no greater than 27 NM.

b. SLAR is usually capable of searching large areas to either side of the aircraft and includes a film or video record of the search for extended analysis.

c. Search legs should be aligned upwind and downwind so that the radar signal is aimed crosswind at all times. This tactic allows the largest possible area to be searched without contending with heavy upwind sea clutter.

d. When time and resources are sufficient to conduct multiple searches of an area, search tracks for the second search should be offset from the first search to compensate for the blind zone adjacent to aircraft ground track. The commence search point (CSP) for the second search is offset a distance equal to the blind zone width.

TABLE 5-11. Sweep Widths for Forward-Looking Airborne Radar (AN/APS-133, AN/APN-215)

Target Type	Douglas Sea State	Sweep Width (NM) Radar System AN/APS-133 MAP-1 and MAP-2 Modes	AN/APN-215 SEARCH-1 and SEARCH-2 Modes
Small (20 feet or less) fiberglass boats, without radar reflector or engine/ metal equipment	0 to 1 2	7 2	4 2
Small (20 feet or less) fiberglass boats, with radar reflector or engine/ metal equipment	0 to 1 2	8 3	6 3
Medium to large (40 to 100 feet) targets with significant amounts of reflective material	0 to 1 2 to 3	40 4	40 4
Metal targets longer than 100 feet	0 to 1 2 to 3	>50 16	>50 16

TABLE 5-11a. Sweep Widths for Forward-Looking Airborne Radar (AN/APS-127) {2}

Target Type	Range Scale (NM)	Search Altitudes (FT)	Significant Wave (FT)	Sweep Width (NM)
6 to 10 person life rafts	10	500 to 4500	<2	5.4
			2 to 5	1.8
			>5	nil
24 to 43 foot boats	10	500 to 1000	<2	12.8
			2 to 5	10.8
			6 to 10*	6.3
			>10*	3.1
		1100 to 2400*	<2	11.2
			2 to 5	9.2
			6 to 10	4.7
			>10	2.3
		2500 to 5000	<2	8.5
			2 to 5	7.2
			6 to 10*	3.5
			>10*	1.5
6 to 10 person life rafts	20	500 to 4500	<2	7.0
			2 to 5*	1.8
			>6*	nil
24 to 30 foot boats	20	500 to 4000	<2	14.1
			2 to 5*	7.0
			6 to 10*	4.9
			>10*	2.4
31 to 43 foot boats	20	500 to 4000	<2	24.9
			2 to 5*	15.3
			6 to 10*	7.0
			>10*	3.5

*Values for this category were extrapolated from test data.

TABLE 5-12. Sweep Widths For Side-Looking Airborne Radar

Target Type	Sweep Width (NM) Douglas Sea State O to 1	Douglas Sea State 2 to 3
Fiberglass or wooden boats, 20 feet or less, without radar reflector or engine/ metal equipment	16	<6
Fiberglass or wooden boats, 20 feet or less, with radar reflector or engine/metal equipment	21	6
Life rafts, 4 to 10 persons without radar reflectors	12	<5
Targets, 40 to 100 feet, with significant metal equipment	47	24
Metal targets longer than 100 feet	57	54

F. Forward-Looking Infrared Radar (FLIR) Sweep Widths. Recommended search altitudes and sweep width information for use with FLIR are given in Table 5-13.

TABLE 5-13. Altitudes and Sweep Widths For Forward-Looking Infrared Radar

Target Type	Altitudes (FT) Recommended Range of Altitude	Preferred Altitude
Persons in the water	200 to 500	None determined
Vessels and life rafts	500 to 1500	1000

	Sweep Width (NM) Douglas Sea State 0 to 1	Douglas Sea State 2
Persons in the water	0.3	0
Small boats and life rafts	1.5	0.5

Sweep widths should be approximated, using the operator's best estimate of effective detection ranges for other target types and field of view/scan width limits. Operators should be told the effective detection range is the range at which they believe the target will certainly be detected under prevailing conditions. Sweep width should not exceed the effective azimuthal coverage of the FLIR system in use, regardless of target size. Figure 5-17 illustrates a means of estimating sweep width.

G. Multisensor Sweep Widths

1. Environmental parameters limit all types of search methods. Multisensor searching, both sensor and combinations of sensor and visual, can be used to mitigate environmental limitations. Table 5-14 outlines various ways in which radar, infrared, and visual searches can be combined to complement each other and possibly overcome some environmental conditions.

2. Sweep width tables for various combinations of search sensors, based on the type of conditions, type of target, and sensors used, are presented in Vol. II, Chapter 4.

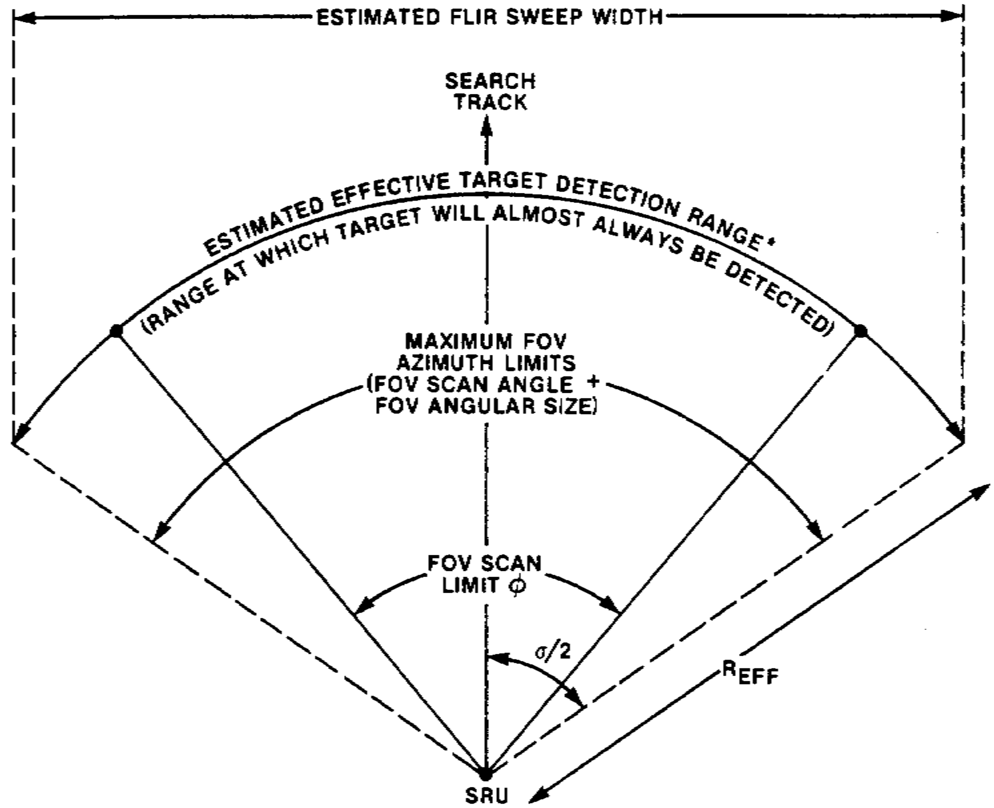
3. Combined sensor searches should be planned so that sensor capabilities complement each other. Search patterns and track spacing should be selected on the basis of the effectiveness of the different SRU sensors available. The most effective sensor should be favored and controllable parameters, such as speed and altitude, should be selected to maximize the performance of the most capable sensor.

4. Multisensor searches are normally assigned only if they provide the maximum sweep width possible with the available personnel. Scanners should not be manning sensors ineffective for the search conditions if they might be used as visual scanners.

5. Visual searching may supplement sensor coverage by filling in blind zones created by antenna configuration and physical or operational limitations of the electronic equipment.

536 Coverage Factor (C)

Coverage Factor (C) is a measure of search effectiveness or quality. It is used as an entering argument when calculating POD. In SAR action



*FOR PREVAILING ENVIRONMENTAL CONDITIONS

NOTE: THE MAXIMUM FIELD OF VIEW (FOV) AZIMUTH LIMIT SHOULD BE USED ONLY IF COMPLETE AREA COVERAGE CAN BE ACHIEVED WITHIN THE EFFECTIVE TARGET DETECTION RANGE. OTHERWISE, A NARROWER FOV SCAN LIMIT SHOULD BE USED IN CALCULATING SWEEP WIDTH.

EXAMPLE CALCULATION

ϕ = FOV SCAN LIMIT (ANGLE THROUGH WHICH FLIR CAMERA SCANS)	= 60°
σ = MAXIMUM FOV AZIMUTH LIMITS (FOV SCAN ANGLE + FOV ANGULAR SIZE)	= 90°
R_{EFF} = ESTIMATED EFFECTIVE TARGET DETECTION RANGE	= 3 nm
ESTIMATED SWEEP WIDTH = 2 SIN (σ/2) • R_{EFF} = 2 SIN (45°) • 3 nm	= 4.2 nm

Figure 5-17. Estimated FLIR Sweep Width

Figure 5-17. Estimated FLIR Sweep Width

TABLE 5-14. Environmental Limitations and Multisensor Search

Environmental Limitation	Visual	Radar	Infrared
Darkness	Very limited detection capability	Short- and long-range target detection, but no identification	Short-range target detection/ identification of long-range radar targets after closing
Poor visibility (daylight)	Detection and identification to limit of visibility	Short- and long-range target detection, but no identification	May extend limits of visibility when haze limits detection by naked eye
High sea state	Reduced effectiveness, but some ability to distinguish target from whitecaps	Detection of medium/large targets only Many false targets	Short-range target detection/ identification Better than visual search only at night or with high thermal contrast target

messages, C should normally be used rather than POD to indicate the coverage required. The relationship between sweep width and track spacing is:

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

Sweep width and track spacing are measured in the same units (nautical miles or yards), and C is dimensionless. Higher coverage factors indicate more thorough coverage. Coverage factors of 0.5 and 1.0 are compared in Figure 5-18. If coverage cannot be compromised, then additional SRUs should be found, the area decreased, the time increased, or SRU speed increased.

537 Probability of Detection

A. Probability of Detection (POD) is the probability that the search object will be detected provided it is in the area searched. It is a function of coverage and the total number of searches in an area, and describes the effectiveness of a single search or the cumulative effectiveness of multiple searches.

B. For any search of an area, the SMC may specify a desired POD and determine the coverage factor accordingly, or, if there are constraints on C, the SMC may have to settle for an attainable POD.

Maritime search POD can be determined by entering Figure 5-19 with C and using the first search curve. Figure 5-19 is based on the assumptions that search patterns will be executed precisely, sweep width is constant throughout the search, and the search object is in the search area.

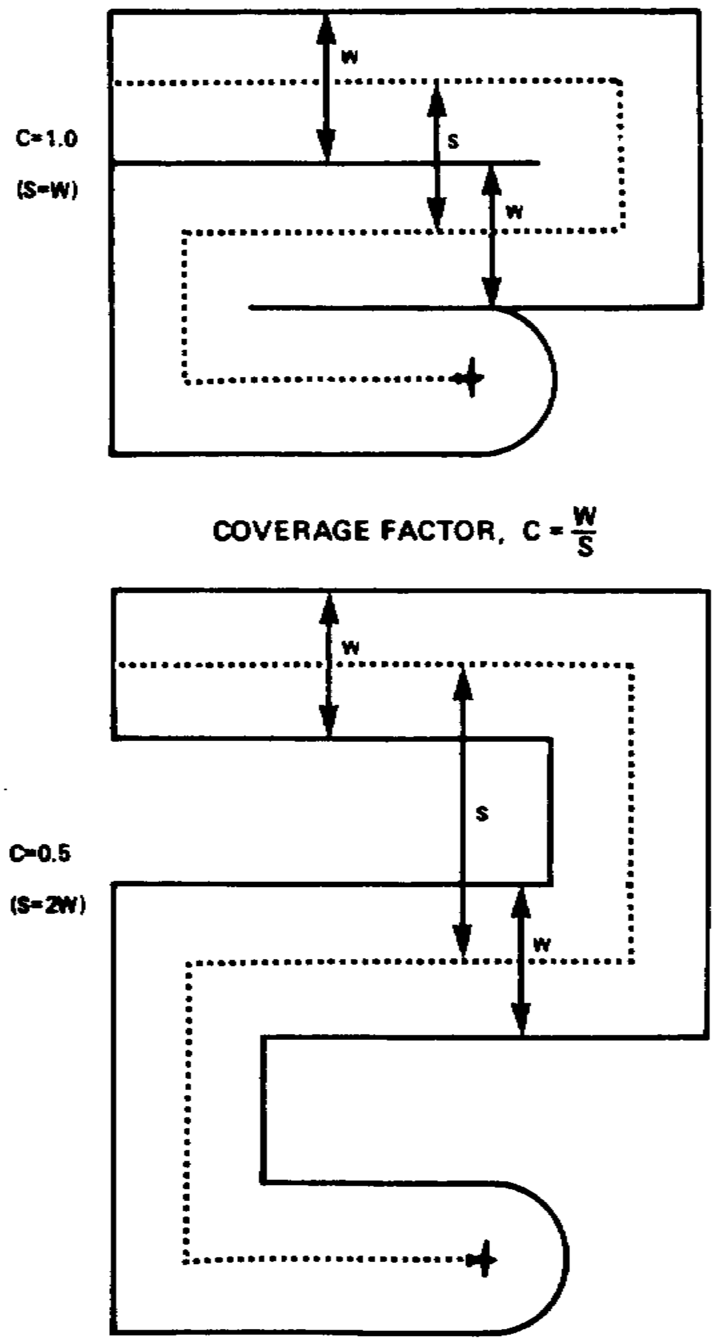


Figure 5-18. Coverage Factors

Figure 5-18. Coverage Factors

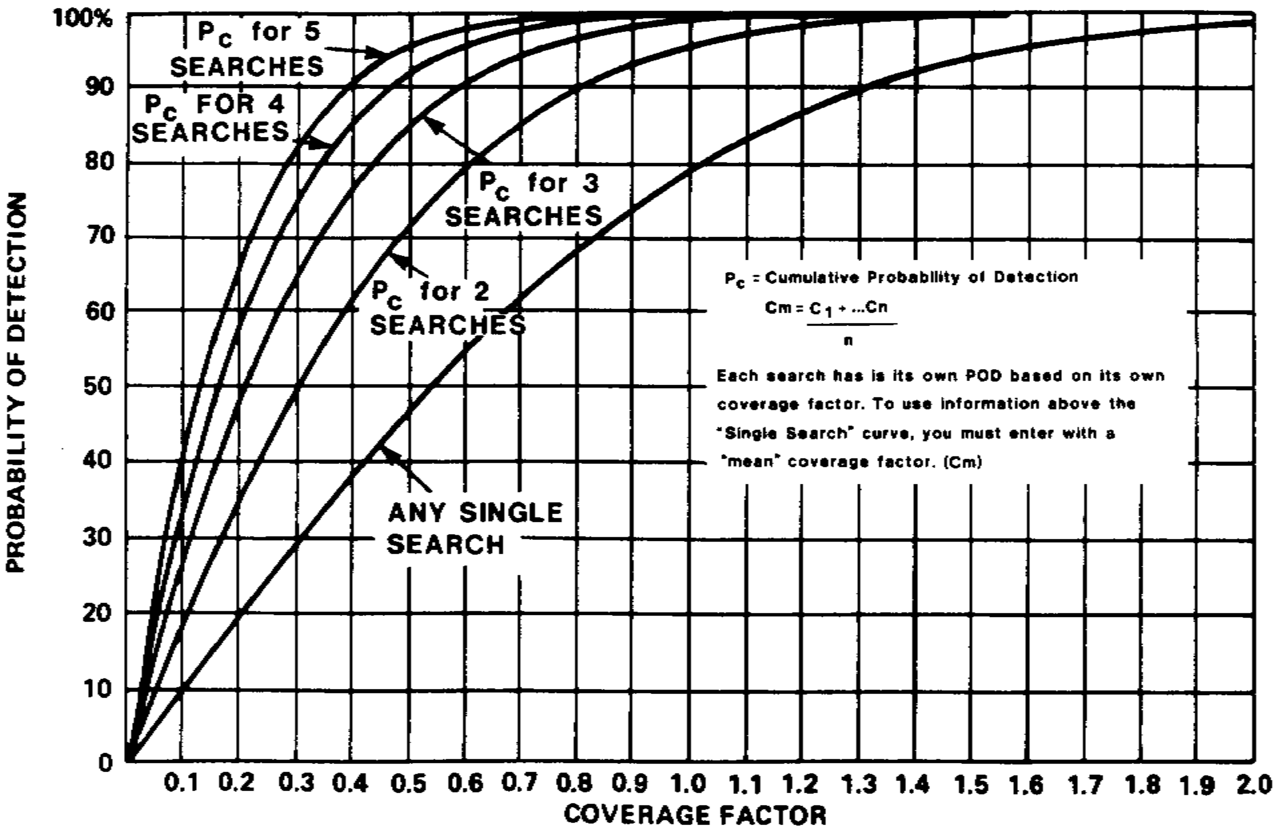


Figure 5-19. Maritime Probability of Detection

C. For an area that has been searched repeatedly, with appropriate corrections made for drift, a Mean Coverage Factor (Cm) is obtained by averaging the individual search coverage factors. Cm is then used with the appropriate search curve of Figure 5-19 to determine the Cumulative POD. For a sixth or subsequent search, the fifth search curve should be used. Cumulative POD should be calculated by the SMC at the conclusion of each search. A high Cumulative POD for successive searches of an area without locating the target may indicate the target was not in or has drifted out of the search area, has sunk, or has changed characteristics and requires a reevaluation of search area and coverage (e.g., primary target changes from a fishing vessel to a liferaft).

D. For searches involving multiple resources, an overall coverage factor is calculated as outlined in paragraph 541.D. This coverage factor is used with the first search curve of Figure 5-19 to determine POD for the total area searched. If the search is unsuccessful, the search area should be expanded, using the search radius safety factors in paragraph 522, and a new overall coverage factor calculated. The POD for that particular search is determined as before, and the Cumulative POD is found by averaging the overall coverage factors and using this average coverage factor with the first search curve of Figure 5-19. The second through fifth search curves are not used because, with each successive expansion, a portion of the total search area is being searched for the first time.

E. Inland search POD is discussed in Chapter 8. Single-search and Cumulative POD are determined directly from Tables 8-1 and 8-2.

540 SEARCH AREA AND SRU ASSIGNMENT

The SMC determines what constraints the search variables place on the optimal search area so the area that can actually be covered may be calculated. This obtainable search area may be subdivided into smaller regions for SRU assignment. If a search is unsuccessful, the SMC should reevaluate all information, modify the search plan, and search again, unless it is determined further effort is unlikely to be successful and search efforts should be suspended.

541 Allocating Effort

A. The assignment of SRUs to achieve maximum search effectiveness can be controlled by varying the rate of search effort. Some situations call for an initial maximum search effort over wide areas. However, a maximum search effort cannot be mounted every time an overdue is first reported, nor can the SMC continue with a lesser effort when preliminary searches fail. The SMC carefully weighs the limitations of time, terrain, weather, navigational aids, search target detectability, suitability of available SRUs, search area size, distance between search area and SRU staging bases, and desired POD. Of all the factors involved, one or more may prove so important that the others become secondary. These controlling factors are considered first in preparing an attainable search plan.

B. When a distress is either known or strongly suspected, the time available for effective search will usually be limited, and a maximum effort search should be completed within this time. It is usually preferable to search an area with many SRUs from the onset when chances for success are highest. First search should be planned to locate survivors rapidly while they are still in a condition to use radio, visual, or other signaling aids, and battery transmission life of locator beacons is good. The following procedure has proven successful:

1. Plot an area large enough to reasonably ensure that the survivors are included.

2. Use track spacing equal to sweep width (C = 1.0).

3. Fix the time by which the search should be completed.

4. Calculate SRU hours required to search the area within the allocated time.

5. Dispatch sufficient SRUs to search the area within the allocated time.

6. If unsuccessful, use the repeated expansion concept and search again.

7. Do not reorient the search or change SRU search assignments, if avoidable, after the search plan has been transmitted to the SRUs. Once a large-scale search is ordered and SRUs dispatched, reorientation of the search area for that search may be difficult and wasteful. Planning should be thorough and adhered to.

8. Resist the temptation to redeploy SRUs whenever new leads or doubtful sightings are reported. After assigned SRUs have been dispatched, additional SRUs should be dispatched to investigate new leads.

C. Overdues can usually be effectively handled by planned buildup of search effort. By using the repeated expansion concept with a small coverage factor, a reasonable buildup of search effort can be combined with an expansion of the search area.

D. If a large-scale search is necessary, it is desirable to optimize effort subject to the constraints imposed by the planning variables. The following is a possible method of reconciling the desired and the attainable:

1. Calculate the optimum rectangular search area (four times the square of the search radius):

   A = 4 x R2

2. For each SRU, calculate available effort as the product of SRU speed, search endurance, and sweep width:

   Z = V x T x W

3. Calculate total available effort, which is the sum of each SRU's available effort:

   Zt = Z1 + Z2 ... + Zn

4. Compare the optimum area to the total available effort to determine track spacing.

   a. If total available effort is greater than the optimum search area, select a coverage factor for each subarea (C = 1.0 is recommended) and determine the track spacing for each SRU:

   S = W/C

   b. If total available effort is less than the optimum search area, calculate a midpoint compromise search area and coverage factor, resulting in a compromise track spacing for each SRU:

   Amc = (A + Zt)/2

   Cmc = Zt/Amc

   Smc = W/Cmc

c. This track spacing may exceed the limits of SRU navigation capability. Therefore, the assigned track spacing should be either the calculated value or the minimum feasible for the assigned SRU, whichever is greater.

5. Calculate attainable coverage factor for each SRU:

$C = W/S$

6. Determine attainable search area for each SRU:

$A = V \times S \times T$

and sum these values to obtain the total attainable search area:

$At = A1 + A2 + ... + An$

where n is the number of available SRUs. This formula does not include additional time for making search pattern turns which, compounded over a full day of search, could be considerable. Therefore, aircraft should be instructed to start turns 15 seconds prior to the computed time of reaching the end of the search leg, which makes the formula sufficiently accurate. Wind and current will also affect search effectiveness.

7. Base POD for the entire search on the overall coverage factor:

$C = Zt/At$

542 Partitioning The Search Area

A. The computed search area is divided into subareas to be searched by SRUs, the number of subareas depending on the number of SRUs available. The size and orientation of the subareas depend on the capabilities of the SRUs and on environmental factors, such as the sun or swell direction. Elongated search areas are better for navigation than small squares.

B. Establishing Individual Search Area Sizes. This is done by means of:

$An = V \times S \times T$. To determine subarea dimensions:

1. The estimated search subarea length (l') will be the smaller of:

a.

b. The distance that could be covered in 30 minutes for fixed-wing aircraft;

c. The distance that could be covered in 20 minutes for helicopters.

2. The estimated width is W' = An/1'.

3. The number of required track spacings is n' = w'/S. This figure is rounded to the nearest even or odd whole number, n. If n is an even number the SRU completes its search pattern on the same side of the search area as it started, but if n is odd the SRU finishes on the opposite side. This factor should be considered if SRU endurance requires that the end search point be as near as possible to a refueling base.

4. The subarea width is then w = n x S, and the length is 1 = An/w.

C. Naming Search Areas. An identification system for use in both small and large search operations is to label overall search areas alphabetically. Search areas used in the first search effort are Alfa areas, Bravo areas in the second search effort, and so forth. Subareas assigned to SRUs are given a numerical identifier. For example, the SMC computes the search area for a first search and divides it into three subareas, A-1, A-2, A-3, for assignment to three different SRUs. If the first search is unsuccessful, the second enlarged subareas become B-1, B-2, and B-3.

D. Describing Search Areas. SRUs must be able to plot the search area on the basis of information received from the SMC. Several standard methods are used to describe search areas:

1. Boundary Method. Any square or rectangular area oriented east-west or north-south can be described by stating the two latitudes and two longitudes. Any inland search area that is bounded by prominent geographical features can be described by stating the boundaries in sequence. For example:

a. D-7 Boundaries 26N to 27N, 64W to 65W.

b. A-1 Boundaries Highway 15 to the south, Lake Merhaven to the west, Runslip River to the north, and Bravado mountain range to the east.

2. Corner Point Method. This can be used for any area (except circular areas) that can be described by stating the latitude and longitude, or geographical features, of each corner, in sequence. For example:

a. E-7 corners 23 15N 74 35W to 23 10N 73 25W to 22 20N 73 25W to 22 25N 74 25W to origin.

b. A-6 corners Stony Tavern to Red River bridge to Gunder Cave to origin.

3. Center Point Method. Convenient for describing all but irregular search areas and quickly transmitted, this method gives latitude and longitude of the center point and the search radius, if circular, or the direction of the major axis and applicable dimensions, if rectangular. For example:

a. 23 15N 74 35W, 12NM.

b. 23 15N 74 35W, 060 degrees true, 144 X 24 NM.

The Boundary Method or Corner Point Method is preferred over the Center Point Method because the latter requires more plotting and makes detection of plotting errors more difficult. Also, if plotted on a chart of different projections from the SMC's (e.g., Lambert Conformal vs Mercator), it results in plots of adjoining areas which do not have the same boundaries or corner points.

4. Track Line Method. Search areas may be described in this method by stating the track and the width of coverage. For example:

C-2 trackline 24 06N 78 55W to 24 50N 75 46W. Width 50 NM.

5. Grid Method. Many areas are divided into grids on local grid maps. Use of these grids permits accurate positioning and small area referencing without transmitting lengthy geographical coordinates. However, all SRUs must have the same grid charts; SRUs could be endangered if there search areas overlap due to use of different grid systems. The grid method is most often used in inland SAR operations. See Chapter 8 and Volume II Appendix D concerning CAP grids.

6. Georef Method. This method may be used to describe square or rectangular areas oriented N-S or E-W that coincide with Georef grids. The Georef method is not normally used. All SRUs involved in a Georef search should possess Georef grids to avoid endangering each other.

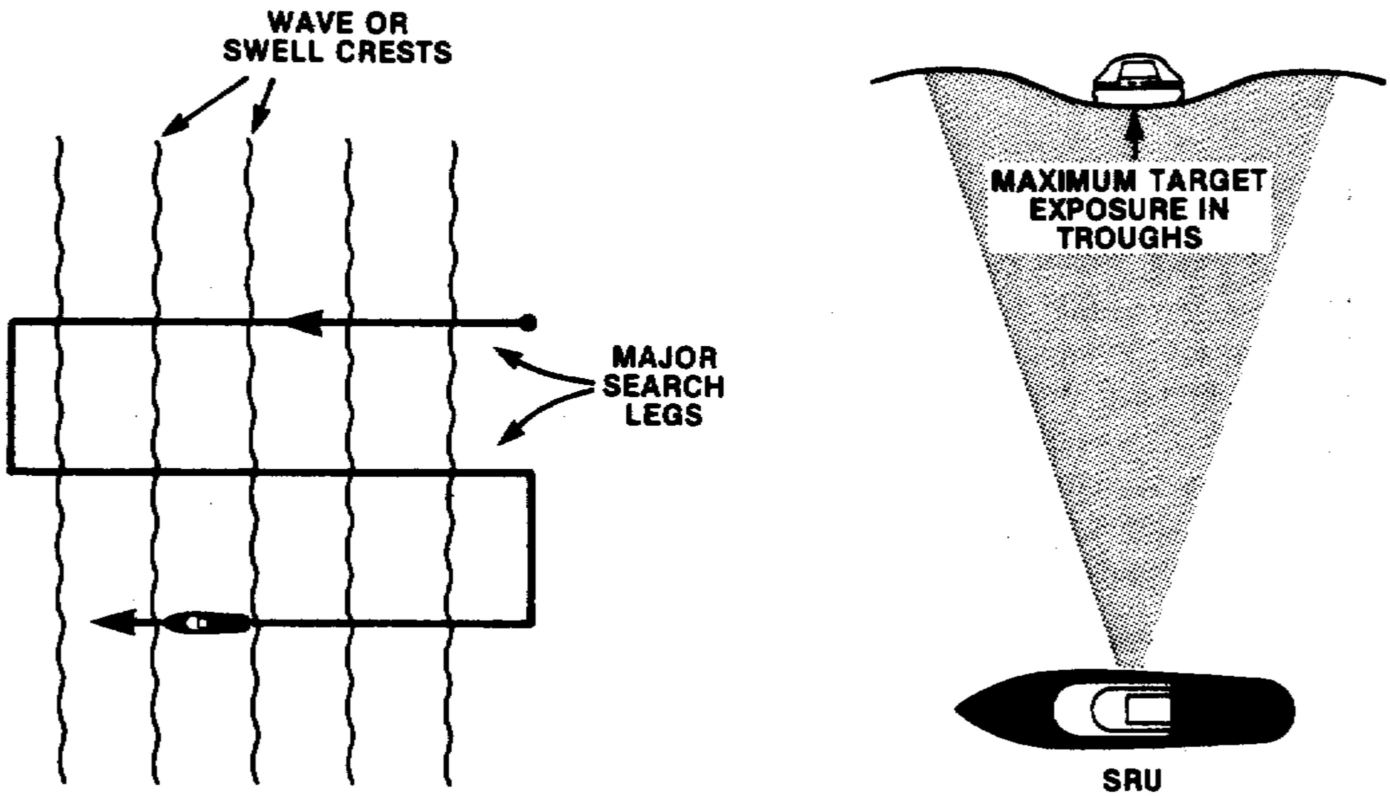


Figure 5-20. Search Leg Orientation

Figure 5-20. Search Leg Orientation

E. Orienting Search Areas Search patterns should be oriented to maximize target exposure to SRUs. This is especially important in any combination of high sea state, low target freeboard, and low searcher height. Under these circumstances, search leg headings perpendicular to the seas or swells, whichever is dominant, prolong the time that objects are visible on the beam as the SRU passes. This search leg orientation is also best for minimizing roll motion of surface SRUs. This technique is illustrated in Figure 5-20.

543 Assigning SRUs to Search Areas

A. After dividing overall search area into subareas, the SMC usually assigns an SRU to each subarea, designates search pattern execution and direction of pattern creep, and assigns search altitudes for aircraft. SRU safety is a most important consideration when search areas are being assigned.

B. Occasionally, the SMC requires the OSC to make various search decisions, such as search pattern selection, track spacing, and individual SRU search area assignments. The SMC normally prescribes the overall search area and decides on subareas for SRUs.

C. When allocating subareas, each SRU should used only for searches for which it is operationally suitable. For example, if only aircraft are available, the following considerations are relevant:

1. Short-range or medium-range aircraft should be used for areas close to a base.

2. Fast, long-range aircraft should be used for more distant areas.

3. Aircraft with poor navigation capability should be used in areas with prominent landmarks, or for searches requiring constant visual reference, as in shoreline searches.

4. During good weather, search areas in coastal waters may be laid out so aircraft can fly search legs perpendicular to the coast line. This allows aircraft without modern navigation equipment to obtain a fix at the land end of each leg. However, terrain clearance must be considered.

D. The SMC normally specifies the commence search point (CSP) which, along with pattern creep and search altitude, is used to maintain lateral and vertical separation. While SRUs should help themselves by using IFF/SIF interrogators, radar, air-to-air TACAN, and visual lookouts, the SMC and OSC also plan for safe separation between SRUs. An example of a separation plan (see Figure 5-21) follows:

1. The SMC first assigns all search patterns to creep north. This will help ensure that the aircraft in areas A-1 and A-2 maintain lateral separation of one search area width from the aircraft in areas A-3 and A-4 (assuming they begin their

search at about the same time).

2. Second, the SMC assigns the CSP as the south west corner. This helps maintain separation between the two aircraft in A-1 and A-2, and between the two aircraft in A-3 and A-4, by a distance equal to the individual search area length (assuming A-1 and A-2 start search at about the same time, A-3 and A-4 start search at about the same time, and SRUs operate at the same speed).

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

4. Air-to-air TACAN channels are assigned to search areas for use by the SRUs. TACAN channel pairing must be 63 channels apart for air-to-air ranging operations. If SRU equipment allows the use of TACAN Y instead of TACAN X channels, interference with shore stations is reduced. The aircraft in A-1 and A-2 and in A-3 and A-4 would be concerned with approaching each other, even with an altitude separation of 500 feet. Therefore, the SMC could pair SRUs in A-1 and A-2 on TACAN channels 20 and 83, and A-3 and A-4 aircraft on channels 30 and 93. If the paired aircraft approach a common boundary simultaneously, they can monitor distance separation.

5. Unless there is a large difference in the commence search times of the two diagonally opposite aircraft, the SMC assumes that adequate lateral and vertical separation will be maintained as long as each aircraft properly executes the assigned search pattern. No SRU should approach another SRU at a distance of less than one track space. The SRU flies the legs nearest the search pattern perimeter at one-half of a track spacing inside its search area boundary.

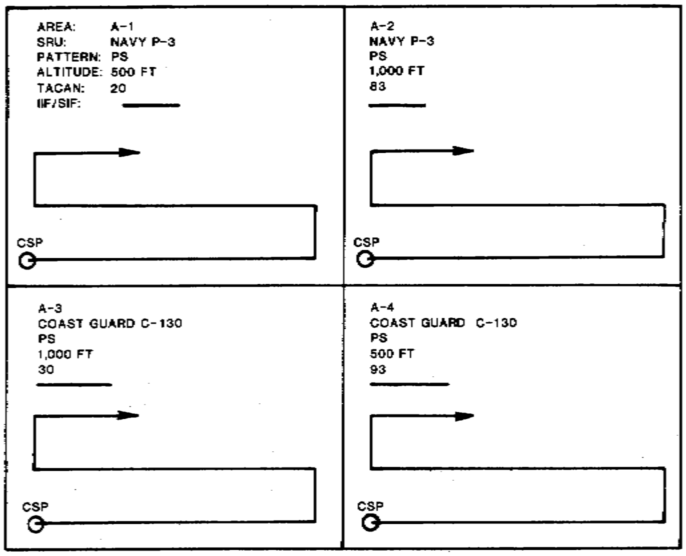


Figure 5-21. Typical Assignments for SRUs

Figure 5-21. Typical Assignments for SRUs

E. Outside the search area, lateral and vertical separation of aircraft is provided either by air traffic control (ATC) agencies under instrument flying rules, or by the aircraft themselves under visual flying rules. Since control of air traffic by ATC in the search area is usually not feasible because of low search altitudes, overall responsibility for maintaining safe separation within the search area rests with the OSC.

550 SEARCH PATTERN SELECTION

To ensure that the search area is uniformly searched, use of standard search patterns allows the SMC to calculate probable search effectiveness. This information is valuable for assigning SRUs, and for planning future searches.

551 Factors in Selection

A. Search pattern selection depends on many factors, including accuracy of datum, search area size, number and capabilities of SRUs, environmental conditions, size of search target, and type of survivor detection aids. While the factors are interrelated, some may be more important than others. The SMC should satisfy the more important factors while meeting others as nearly as possible.

B. The type and number of available SRUs are controlling factors in selection of search patterns. SRU turning diameters, speeds, detection capability, and navigational accuracy have a significant impact on the uniformity of search area coverage and on POD. POD curves are valid only when SRUs follow search pattern tracks accurately.

1. Surface Craft. Navigation accuracy of surface

SRUs is generally not a significant problem as long as LORAN, inertial, SATNAV, OMEGA, or radar navigation aids are available. DR navigation can cause significant errors in search pattern execution, even in coastal areas with visual references. Sea states of three feet or more can also adversely affect the ability of small surface SRUs to execute search patterns accurately.

2. Aircraft. High-speed aircraft are more likely to accumulate turn errors, especially with narrow track spacing, because of their larger turn diameters. Low-speed aircraft are more sensitive to wind because the crosswind component will be a higher percentage of search speed. The following should be considered when planning aircraft searches:

a. Aircraft navigation accuracy has improved due to increased use of, and improvements in, navigation computers, area navigation (RNAV), OMEGA, INS, and LORAN C. More sophisticated systems can be coupled to an autopilot, enabling execution of accurate search patterns.

b. When accurate navigation systems are not available, the type of pattern that requires minimum turns and maximum search leg length is usually selected to reduce turning errors and to ease navigation. For high-speed aircraft, patterns and search area assignments that allow turns outside the search area should be considered to allow aircraft to establish themselves on each leg, improving uniformity of area coverage. (Canadian SRUs always turn outside assigned search areas.)

C. Once large-scale search efforts are under way, redeployment of SRUs or changing of assigned search patterns becomes difficult. Careful consideration should be given to selecting patterns and designating SRUs. Unique patterns based on search circumstances may be developed.

552 Search Pattern Nomenclature

A. Commence Search Point (CSP) is the location in the search pattern where the SRU begins searching. Specifying the CSP allows the SRU to efficiently plan the en route track, and ensures that SRUS are separated and that the SRU begins search at the desired point and time.

B. Search Leg is the long leg along the track of any pattern.

C. Crossleg is the connection between two search legs.

D. Creep is the general direction in which an SRU moves through a rectangular or square area, normally the same direction as the crosslegs.

553 Search Pattern Designation

A. A coded system of letters is used to designate search patterns.

The major pattern characteristic is designated by the first letter. The second letter denotes SRU number ("S" is a single-unit search; "M" is a multiunit search). The third letter designates specialized SRU patterns or instructions.

B. Trackline Patterns (T) are used when the intended route of the search object is known. A route search is usually the first search action since it is assumed that the target is near track, and that either it will be easily seen or the survivors will signal. The trackline pattern is a rapid and reasonably thorough coverage of the missing craft's proposed track and area immediately adjacent, such as along a datum line.

1. Trackline Single-Unit Non-Return (TSN) search is made along the track or datum line. The letter "N" in the third position indicates that the pattern makes one or more searches along the track, but the search terminates at the opposite end of track from where it began. See Figure 5 22.

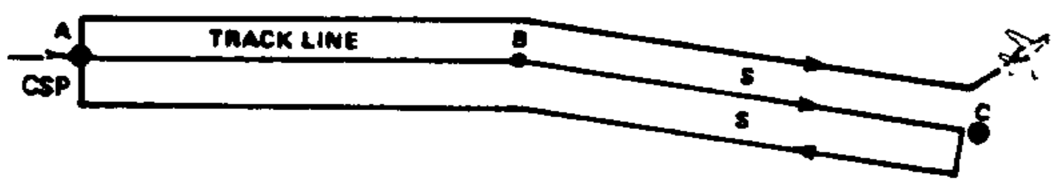


Figure 5–22

Figure 5-22.

2. Trackline Single-Unit Return (TSR) has the CSP offset 1/2 search track spacing from the trackline or datum. The SRU runs up one side and down the other, ending one track space from where it began. See Figure 5-23.

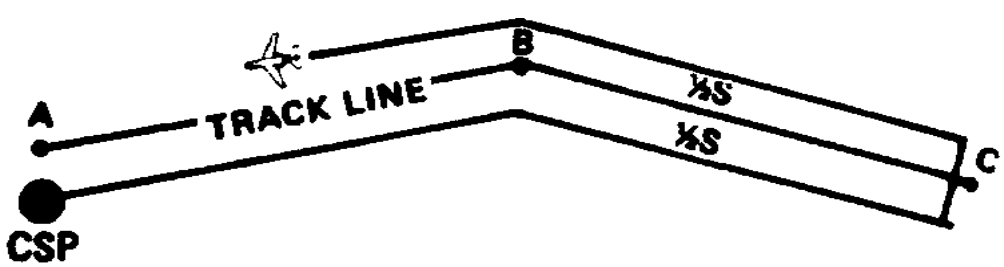


Figure 5–23

Figure 5-23.

3. Trackline Multiunit Return (TMR). Two or more SRUs are used in an abeam formation to afford greater width coverage along track. See Figure 5-24.

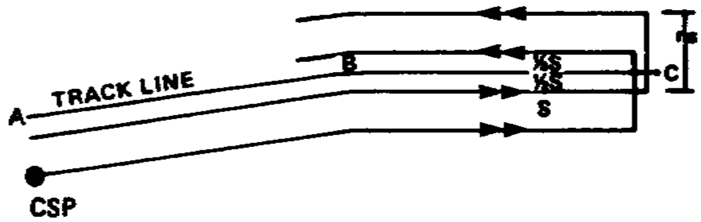


Figure 5-24

Figure 5-24.

4. Trackline Multiunit Non-Return (TMN). This pattern is the same as TMR except search terminates at the opposite end of track from where it began. See Figure 5-25.

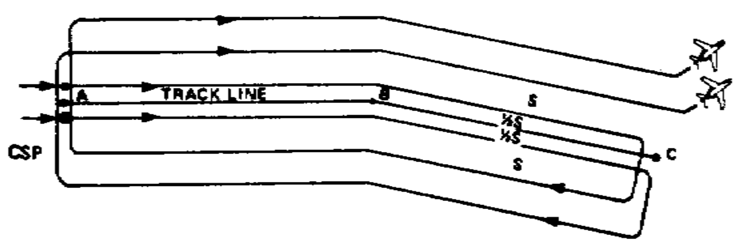


Figure 5-25

Figure 5-25.

C. Parallel Patterns (P) are best adapted to rectangular or square areas and have straight search legs that are usually aligned parallel to the major axis. Parallel patterns are normally used for large, fairly level search areas, where only approximate initial position is known, and when uniform coverage is desired. Special parallel circle patterns are normally used for small underwater areas and have legs of adjacent concentric circles.

1. Parallel Track Single-Unit (PS) is used by single SRUs for searching rectangular areas and is mostly used by fixed-wing aircraft. Search legs are oriented along the major axis, providing longer legs and fewer turns. See Figure 5-26.

2. Parallel Track Multiunit (PM) provides accurate track spacing and fast area coverage, and an increased safety factor for aircraft over water. One SRU is designated as guide and handles navigation, communications, and control. Turns at the end of legs should be executed by signal from the guide. Crosslegs are a distance equal to the track spacing multiplied by the number of SRUs in the team (n). See Figure 5-27. Land SRUs use procedures in Chapter 8.

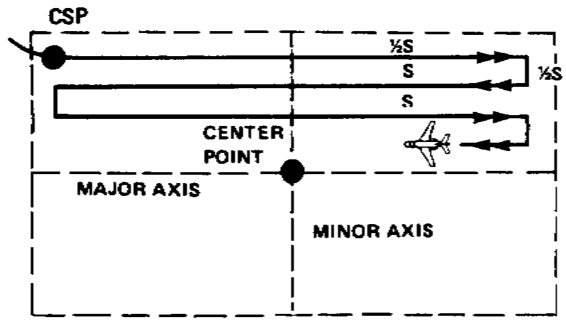


Figure 5–26

Figure 5-26.

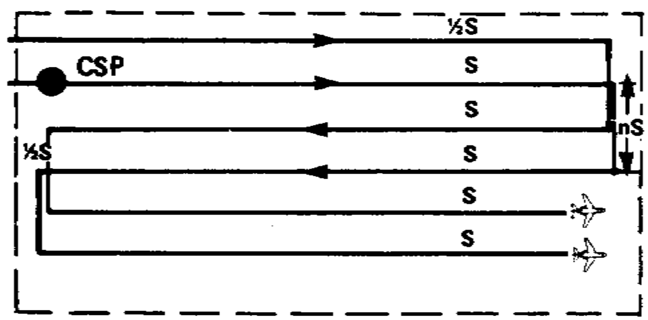


Figure 5–27

Figure 5-27.

3. Parallel Track Multiunit Return (PMR) is used when simultaneous sweep of an area to maximum radius is desired. It provides concentrated coverage of large areas in a minimum time period, and allows the use of aircraft with different speeds in a parallel search pattern. See Figure 5-28.

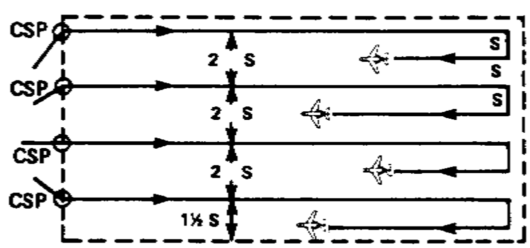


Figure 5–28

Figure 5-28.

4. Parallel Track Multiunit Non-Return (PMN) is similar to the PMR, except that SRUs continue to a destination other than the departure point. It is normally used when en route vessels are available and will alter their tracks to provide

uniform coverage of the search area. See Figure 5-29.

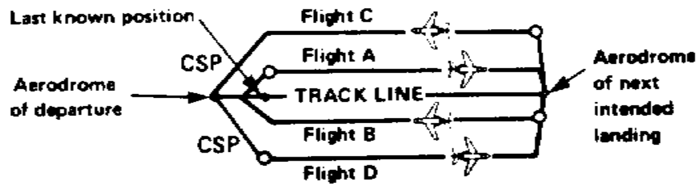


Figure 5-29

Figure 5-29.

5. Parallel Track Single-Unit LORAN (PSL) is one of the most accurate search patterns for searching areas covered by LORAN, OMEGA, or similar navigational systems. The pattern must be oriented so legs flown by the SRU are parallel to a system of LORAN lines, OMEGA lines, and so on. LORAN lines are selected at the track spacing desired. As each leg is flown, the selected line reading is preset on the receiver indicator. The letter "L" in the third position is used to indicate. See Figure 5-30.

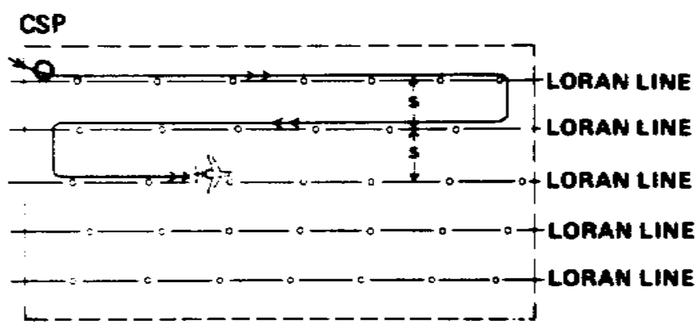


Figure 5-30

Figure 5-30.

6. Parallel Multiunit Circle (PMC) is used by two or more swimmers for underwater search of small areas, generally less than 25 yards in diameter. A line or rope is knotted along its length at distances equal to the track spacing. The line is anchored in the center of the area and swimmers use the knots to maintain uniform spacing, beginning with the innermost knots for one set of circles, then shifting outward to the next set of knots. See Figure 5-31.

7. Parallel Single-Unit Spiral (PSS) is used by a single underwater swimmer for search of small areas, generally less than 25 yards in diameter. The swimmer uses a line coiled on a fixed drum in the center of the area, and swims in ever-increasing spirals, using the line to maintain proper track spacing by keeping it taut. See Figure 5-32.

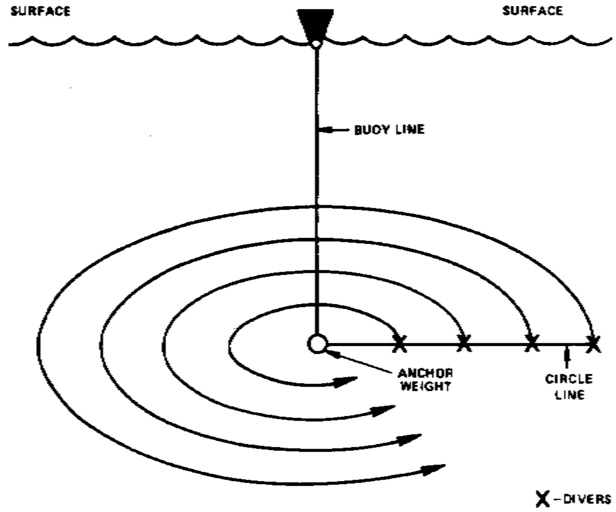


Figure 5-31

Figure 5-31.

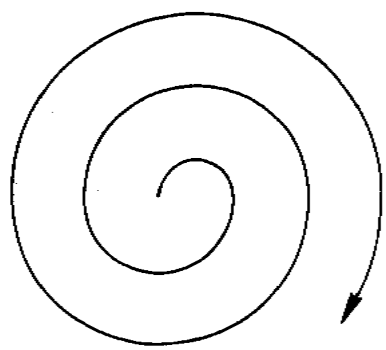


Figure 5-32

Figure 5-32.

D. Creeping Line Patterns (C) are a specialized type of parallel pattern where the direction of creep is along the major axis, unlike the usual parallel (P) pattern. They are used to cover one end of an area first, or to change direction of the search legs where sun glare or swell direction makes this necessary.

1. Creeping Line Single-Unit (CS). The CSP is located 1/2 track spacing inside the corner of the search area. See Figures 5-33.

2. Creeping Line Single-Unit Coordinated (CSC) is used when aircraft and either vessels or boats are available. The aircraft track is planned so that advance of successive legs of the search pattern equals that of the marine craft, and the aircraft passes over the vessel on each leg. This results in a more accurate search pattern, and enables

quick rescue by marine craft once survivors are located. If the vessel is radar equipped, it should assist the aircraft in keeping on course and advise the aircraft when it is 5 miles from the end of each leg and at the time to turn onto a cross leg. Advisories of distance off course are based on an average of several fixes. Whenever the aircraft is within range, visual bearings should be taken and plotted with radar ranges. Coordinated patterns should be started before entering the search area so that full coverage of the area will be assured. See Figure 5-34. See Appendix E for procedures for coordinated patterns.

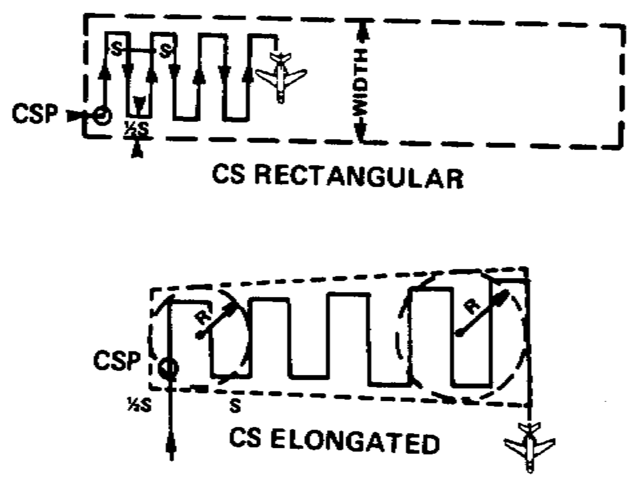


Figure 5-33

Figure 5-33.

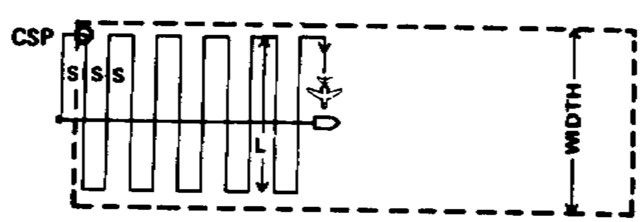


Figure 5-34

Figure 5-34.

E. Square Patterns (S) are used to search a small area when some doubt exists about the distress position. They provide more uniform coverage than a sector search and may be expanded. Square searches are referred to as expanding square searches beginning at datum and expanding outward. If datum is a line instead of a point, the pattern may be changed to an expanding rectangle. The first leg is usually directly into the wind or current to minimize navigation errors. A precise pattern, it requires the full attention of the navigator. If two aircraft (the maximum that should be used) are assigned to the same area, they must fly their individual patterns at different altitudes on tracks which differ by 45 degrees. See Figure 5-35.

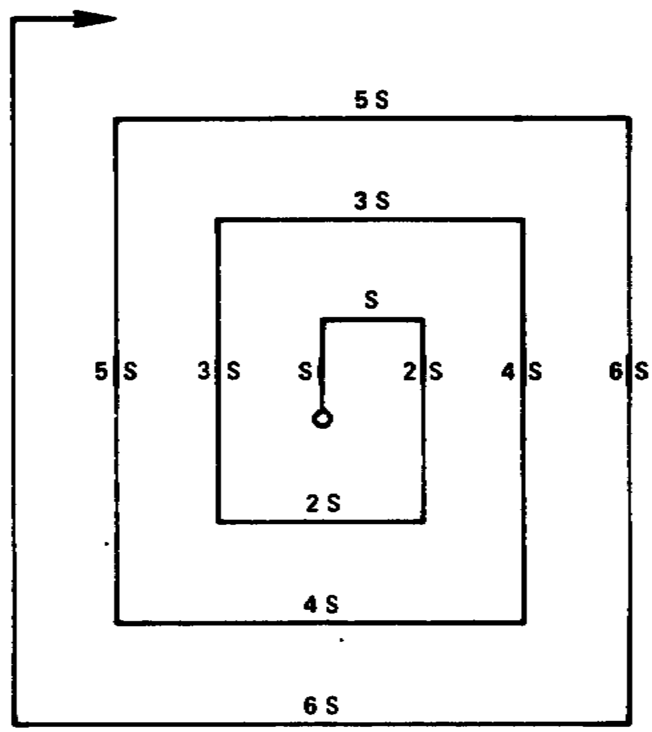


Figure 5-35

Figure 5-35.

F. Sector Patterns (V) are used when the position of a distress is reliable or the area searched is not extensive, and a concentration of effort is desired at datum. The pattern resembles the spokes of a wheel and is used to cover a circular search area. A datum marker, in the center of the area, aids navigation on each leg. Generally, aircraft sector search areas do not have a radius greater than 20 to 30 miles, while marine craft use a maximum radius of 5 miles. Because only a small area is covered, datum should be recomputed on every search to allow for drift. If the search is oriented over a marker, adjustment for total water current (TWC) will occur automatically, and only leeway must be considered. The CSP may be at the perimeter of the pattern or at datum. Each leg is separated by an angle, based on the maximum track spacing and search radius, and connected by a crossleg equal to the maximum track spacing. For standardization, all turns should be made to the right. An average POD for sector patterns can be determined by using the mid-leg track spacing.

1. In Sector Single-Unit (VS) searches, four-sector and six-sector patterns are most commonly used. See Figure 5-36.

   a. The six-sector pattern is easiest since it

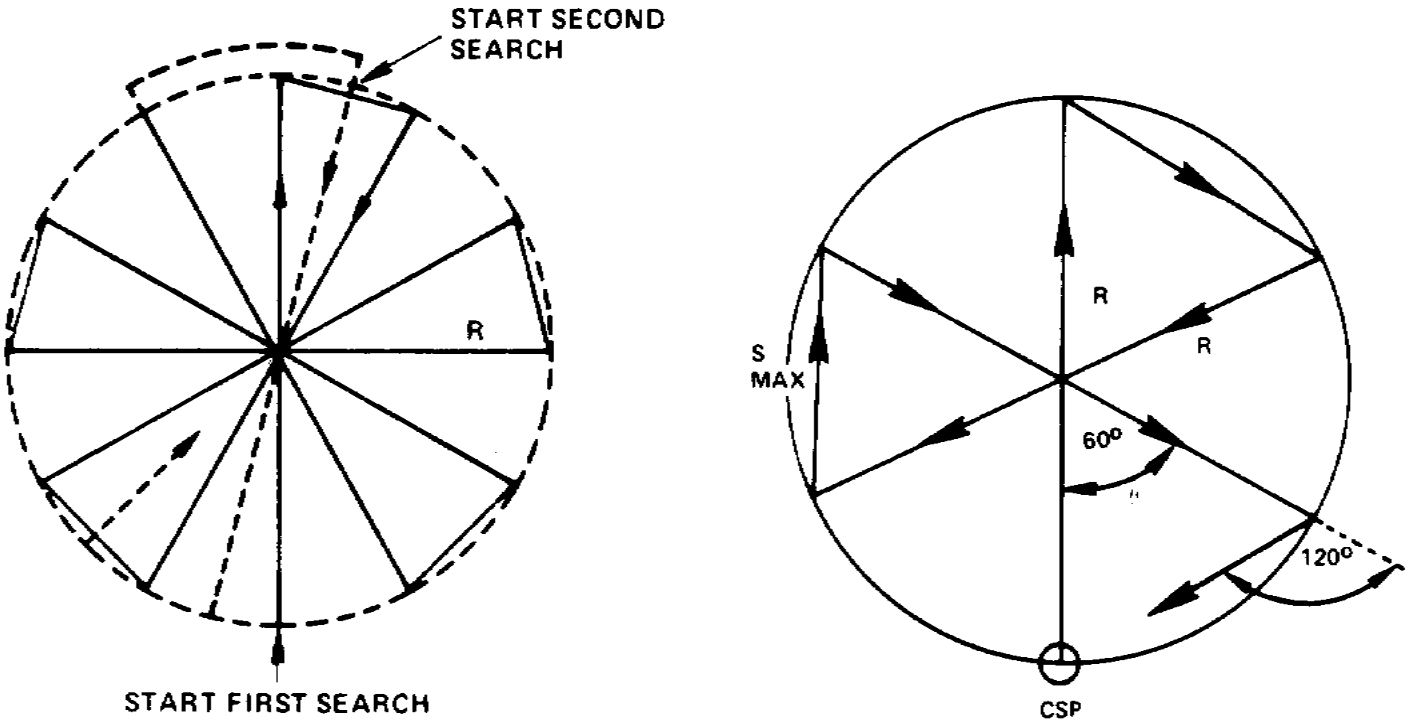


Figure 5-36

Figure 5-36.

divides the circle into three equal triangles with one corner of each triangle at datum. All search legs, crosslegs, and the maximum track spacing are equal to the radius of the circle.

b. The four-sector pattern has 90 degrees between successive radii, and only two search legs (diameters) and one crossleg (equal to 1.4 times search radius) are required to complete the pattern. To obtain complete area coverage, the pattern is rotated 45 degrees after completion of the first pattern, and then run again.

2. Sector Single-Unit Radar (VSR) is used when a radar-equipped marine craft takes station at the center of the pattern and provides radar navigation assistance to one aircraft completing a sector search pattern.

G. Contour Patterns (O) are used for search in mountainous and hilly terrain. They are adaptable to underwater SRUs for searching peaks on the ocean floor. Contour searches are covered in Chapter 8.

H. Flare Patterns (F) are used only at night. Detection of survivors without visual aids is difficult at night. Parachute flares increase the chance of detection only slightly and are effective mostly for large objects in well-defined search areas on flat land or at sea. Parachute flares should be used for searches over land when the urgency is such that the risk of starting ground fires becomes acceptable. They are more useful in sea searches where searchers under parachute flare illumination are less likely to be confused by silhouettes or reflections from objects other than the target. The flares are normally dropped from a fixed-wing aircraft above and ahead of the SRU. The most effective SRUs for flare patterns are, in order, vessels, helicopters, and fixed-wing aircraft.

1. Flare Single-Unit (FS) is conducted by a single vessel or helicopter with an aircraft dropping flares. See Figure 5-37.

    a. For ships, the aircraft should drop the flares upwind of the vessel, off the starboard or port bow. Flare burnout should occur on the opposite quarter of the vessel. Illumination may be on one or both sides of the SRU.

    b. For helicopters, the search pattern should be flown into the wind or downwind at a minimum altitude of 500 feet. Favorable visual meteorological conditions should exist. The flares should be dropped at the 2 o'clock or 10 o'clock positions at a height which permits flare burn out at or below helicopter altitude. Illumination should be continuous because alternating between light and darkness disorients helicopter pilots. With consideration for wind strength, the pattern should be planned so that the fixed-wing aircraft drops a new flare just before the old burns out. The helicopter pilot should be able to see the flare or flare-dropping aircraft when the flare is dropped.

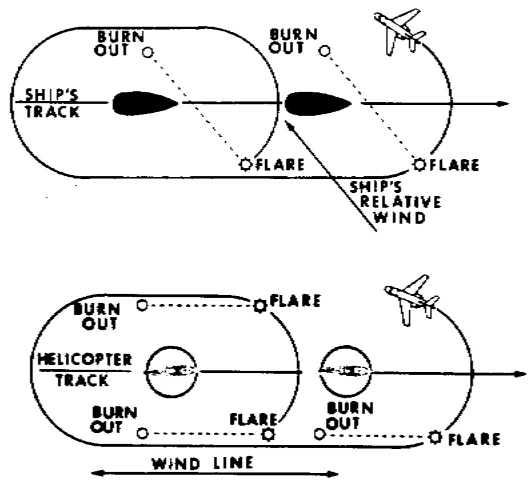


Figure 5-37

Figure 5-37.

2. Flare Multiunit (FM) is similar to the Parallel Track Multiunit Non-Return pattern. The vessels form abeam with spacing between ships depending on size of target and local conditions. The search legs are oriented into the wind. The aircraft flies a racetrack pattern over the formation, and between vessels, dropping a set of flares upwind so that they are over the formation during the middle of the burning period. The aircraft drops a new set as the previous set burns out. See Figure 5-38.

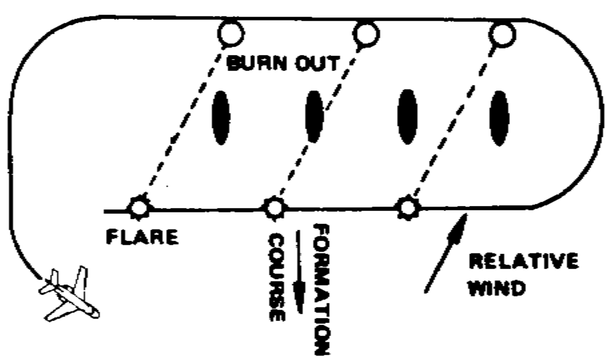


Figure 5-38

Figure 5-38.

I. Homing Patterns (H) are used to locate emergency transmitters or other radio or electronic emissions from survivors or distressed craft when the detected signal is too weak for homing equipment to receive, or the SRU does not have homing equipment. See para 642.C.2.

J. Drift Compensation During a Search. If the target and SRU are in motion, it may be necessary to consider the relative motion plot of the SRU with respect to the target, especially in high current areas. Failure to account for target motion may cause the target to drift out of the search area before the search is completed. Even if the target remains in the search area, the pattern relative to the target may be so distorted that POD is greatly reduced.

1. While it is possible to compensate any search pattern for drift, in practice compensation is normally applied to parallel path (PS/CS) searches. To determine whether compensation is needed, planners ascertain expected velocity of target drift (v) during the next search, maximum dimensions (length (l) and width (w)) of the search area, and search speed (V) and track spacing (S) to be used.

    a. If the value of (v x l)/(V x S) is less than 0.1, compensation for drift is not necessary. Otherwise, orient the search area so that the major axis is parallel to target drift direction, and investigate further the problem further.

    b. If the value of (v x w)/(V x S) is less than 0.1, no compensation is necessary. Otherwise, patterns for drift compensation should be considered.

2. Patterns accounting for search target motion are:

    a. Parallelogram Pattern (Pd). In these patterns the search legs are parallel to target expected motion. The perimeter of the area relative to the earth can be found by moving the downcreep side of the uncompensated area the distance the target is expected to drift during the search of that area. For multi-SRU searches, the total area should be divided into adjacent areas which join only along sides parallel to the search legs (see Figure 5-39). All SRUs should creep in the same direction with altitude separation provided for aircraft SRUs. Each area should be compensated to account for differences expected in drift rate between subareas.

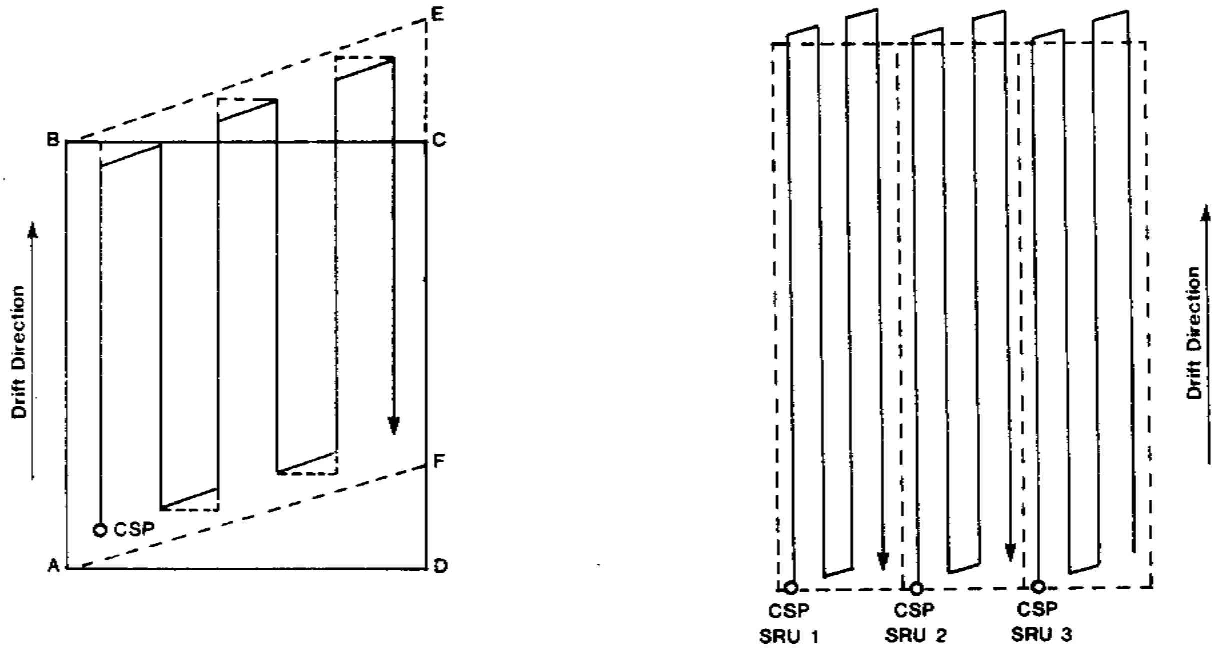


Figure 5-39. Parallelogram Search Patterns

Figure 5-39. Parallelogram Search Patterns

b. Cross-Over Barrier Pattern (B). These patterns have search legs perpendicular to the expected relative movement of targets. The three types of barriers -- depending on relationships of search speed, search leg length, and target speed -- are advancing, stationary, and retreating barriers (see Figure 5-40). Most barrier patterns executed by aircraft will be advancing. If multiple barrier patterns are used, search areas should be joined only along sides parallel to search legs. All SRUs should creep in the same direction, with aircraft given altitude separation. Barrier and parallelogram patterns should never be used in adjacent areas. A barrier pattern is more sensitive than a parallelogram pattern to differences between the computed rate of target drift and target rate of drift.

c. Expanded Area. Circumstances may not permit use of parallelogram or barrier patterns for drift compensation. The search area size and number of SRUs may preclude establishing adjoining search areas. If so, the planner should expand the area and plan a search with non-compensated patterns. The amount and direction(s) of expansion should be consistent with expected target drift. Figure 5-41 illustrates a case of drift direction reasonably well known, but a search area grouping requiring the expanded area technique. In this case, search areas are oriented in the direction of drift. Figure 5-42 illustrates a similar case where the search area cannot be oriented with the drift direction. When the search is completed, the initial area, not the expanded area, is completely covered relative to the search target.

3. When drift compensation is used, SRUs should arrive on scene at assigned times. Delays may occur, but target motion continues and its effect on area coverage relative to the target should be considered. In some cases the assigned area of a late arrival can be moved downdrift without adversely affecting SRU separation. In other cases, the SMC will need to determine the uncovered area and search it later to ensure coverage. Search area prioritization also reduces the effects of delay or interruption. Areas can be ranked according to probability of containing the target. If this is done in advance, SRUs can be reassigned from areas of lower probability.

554 Search Pattern Summary

Characteristics of the various types of search patterns are summarized in Figure 5-43.

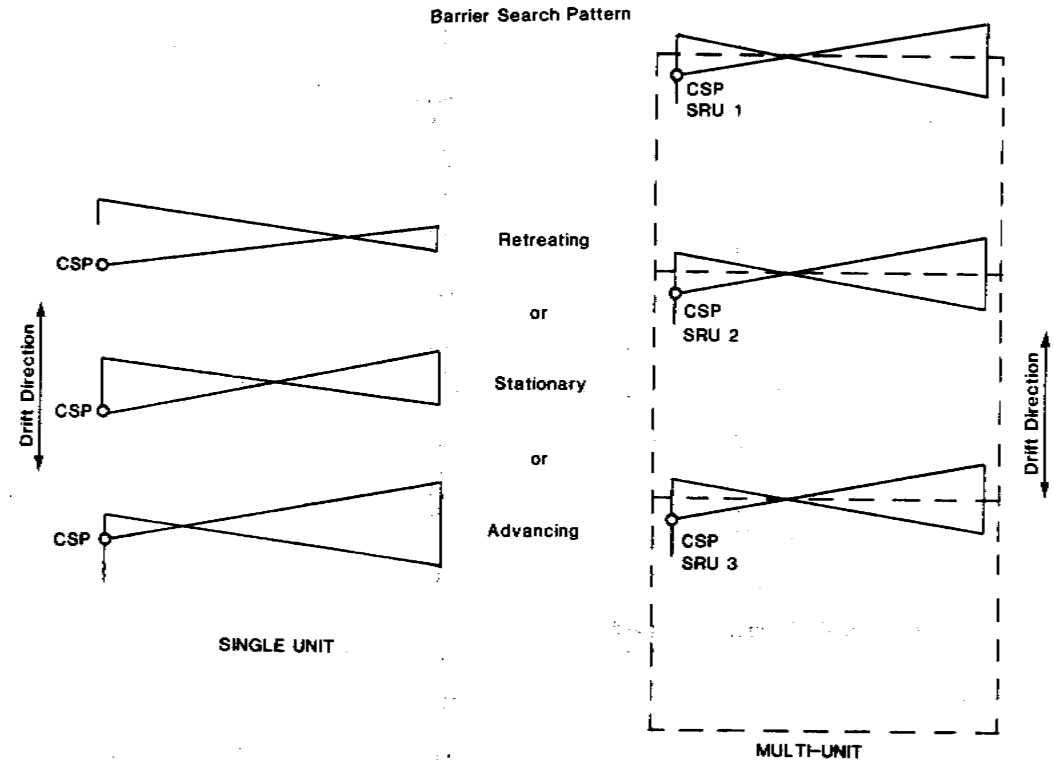


Figure 5-40. Cross-Over Barrier Pattern

Figure 5-40. Cross-Over Barrier Pattern

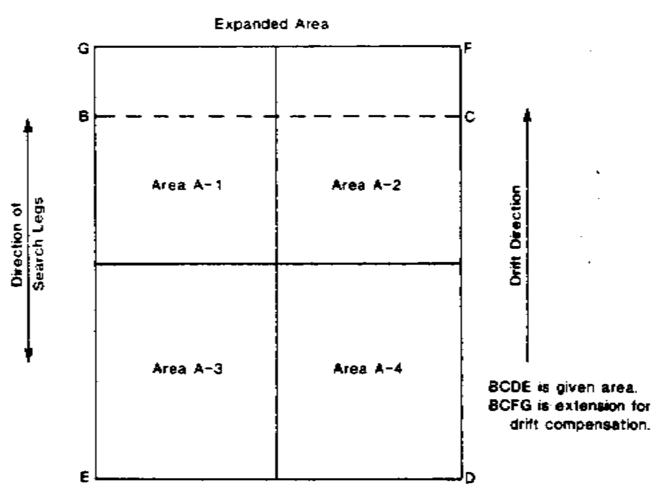


Figure 5-41. Expanded Area, Drift Oriented

Figure 5-41. Expanded Area, Drift Oriented

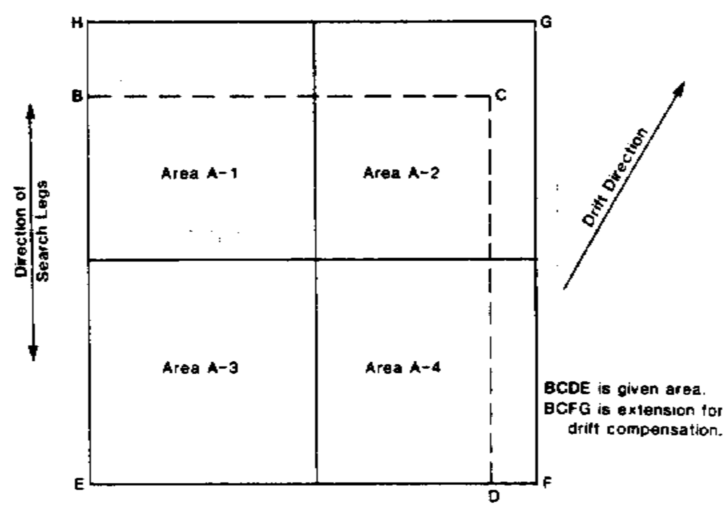


Figure 5-42. Expanded Area

Figure 5-42. Expanded Area

Pattern	Name	SRU required	Remarks
TSR	Trackline single-unit return	1	For search of a trackline or line of position when unit must break off search at same end of track as search originated.
TMR	Trackline multiunit return	2 or more	Same AS TSR except that 2 or more SRUs are used cruising abeam of each other.
TSN	Trackline single-unit nonreturn	1	Same as TSR except that search terminates at opposite end of track from commence search point.
TMN	Trackline multiunit nonreturn	2 or more	Same as TMR except that search terminates at opposite end of track from commence search point.
PS	Parallel track single-unit	1	Search of a large area when position of distress is unknown.
PM	Parallel track multiunit	2 or more	Same as PS except two or more SRUs search abeam of each other a distance S apart.
PMR	Parallel track multiunit return	2 or more	Used for search of long rectangular area where only one track out and back is possible.
PMN	Parallel track multiunit nonreturn	2 or more	Only enroute SRUs or transient craft available for one track through search area.
PSL	Parallel track single-unit Loran line	1	Same as PS except SRU uses Loran lines for greater navigational accuracy on tracks.
PMC	Parallel multiunit circle	2 or more	Underwater pattern only.
PSS	Parallel single-unit spiral	1	Underwater pattern only.
Pd	Parallel drift compensated	1 or more	Used when target motion requires drift compensation.

CS	Creeping line single-unit	1	Distress generally known to be between two points. Wider than trackline patterns.
CSC	Creeping line single-unit coordinated	1 acft + 1 ship	Same as PS except coordinated ship movement used to obtain greater navigational accuracy.
SS	Square single-unit	1	Distress Position known within close limits and search area not extensive.
SM	Square multiunit	2 acft	Same as SS except two SRUs fly at different altitudes on tracks which differ by 45 degrees.
VS	Sector single-unit	1	Distress position known within close limits and search area not extensive.
VSR	Sector single-unit	1 acft + 1 ship	Same as VS except ship controls aircraft by radar.
OS	Contour single-unit	1	Search of mountainous/hilly terrain.
OM	Contour multiunit	2 or more	Search of mountainous/hilly terrain by land search teams.
FS	Flare single-unit	1 acft + 1 ship or 2 acft.	Night visual search only.
FM	Flare multiunit	1 acft + ships	Night visual search only.
HSA	Homing single-unit aural	1	Electronic homing-in use.
HSM	Homing single-unit meter	1	Electronic homing-in use.
HMN	Homing multiunit nonreturn	2 or more	Electronic positioning use.
B	Cross-over Barrier	1 or more	Used when target motion requires drift compensation.

Figure 5-43. Search Pattern Summary

560 PLANNING OF ON SCENE COORDINATION

561 OSC Designation

The SMC should assign the best qualified and most capable SRU as the OSC, regardless of seniority. For maritime incidents a SAR vessel with adequate communications is normally assigned as OSC because of greater on scene endurance.

562 ATC Coordination

A. The SMC must often coordinate with ATC facilities during a mission and should be familiar with ATC procedures. Aircraft are prohibited from flying in instrument meteorological conditions (IMC) in controlled airspace unless flying on an IFR clearance provided by ATC. It is usually not possible to obtain an IFR clearance in uncontrolled airspace, and, as a result, aircraft may operate only if visual separation from other aircraft and obstacles can be maintained. State-owned aircraft flying over open ocean may operate in IMC without an IFR clearance, provided certain criteria are met. The parent agency or the pilot in command should be consulted regarding these operations.

B. The Department of Defense controls many areas that are designated as special use airspace. These include Military Operating Areas (MOAs), Low Level Training Routes, and Restricted Areas over land and Warning Areas over the ocean. If a distress requires SRU operation in these areas, prior coordination with the military command exercising control over the special use airspace is necessary. The names and telephone numbers for the controlling agencies are available in various military Flight Information Publications (FLIPs).

C. SAR Airspace Reservations. The SMC may request ATCs to establish temporary airspace or altitude reservations during SAR operations to prevent non-SAR aircraft from interfering with search operations.

1. Temporary Flight Restrictions (TFRs) are obtainable in domestic airspace, and may be imposed for forest fires, floods, earthquakes, or similar disasters (see Appendix F). The designated area normally is within 5 statute miles of the disaster boundaries and includes altitudes to 2,000 feet above the surface.

   a. No person may operate an aircraft within the area unless:

      (1) Operating under direction of the agency responsible for relief activities.

      (2) Transiting to or from an airport within the area and operating so as not to hamper or endanger relief activities.

(3) Operating under an IFR-ATC clearance.

(4) Operating because VFR flight around or above the area is impracticable due to weather, terrain, or other considerations, with prior notice given to the ATC facility specified in the Notice to Airmen (NOTAM), and provided that en route operation through the area does not hamper or endanger relief activities.

(5) Carrying accredited news representatives, or persons on official business concerning the incident. Prior to entering the area the operator must file with the ATC facility a flight plan including identification of aircraft, communications frequencies, times of entry and exit, and name of news media or purpose of flight.

b. When a temporary flight restriction area is designated, ARTCC issues a NOTAM and specifies the Flight Service Station (FSS) nearest the disaster for air traffic coordination. If the disaster scene is large, the ARTCC will usually assign ATC coordination to the FSS nearest the RCC or disaster control operations base. The assigned FSS coordinates between the SMC and all affected aircraft.

c. For a flight restriction area containing numerous operating SAR aircraft, the SMC should prohibit news media aircraft from the same altitudes as SAR aircraft. If SAR aircraft traffic increases, and the SMC has previously permitted entry by news media aircraft, the OSC should rescind this authorization if their presence creates a hazard. News media aircraft should be instructed to contact the OSC prior to entry, and to remain outside the area if unable to establish communications.

2. SAR Operations Warning Areas can be reserved in either domestic airspace or international airspace, and are usually in uncontrolled airspace. Restraint on aircraft entering the area is voluntary. ARTCC will not routinely issue a NOTAM for this type of reservation. However, the SMC may want to consider requesting a

NOTAM for non-SAR aircraft to remain outside the area.

a. After the SMC has developed the search area, 5 miles should be added to the outer boundaries of the coordinates passed to the ARTCC. The SAR operations warning area will include airspace within the expanded boundaries from the surface normally up to 2,000 feet overland, or 6,000 feet overwater. For international waters, the ceiling should not exceed the base of the Oceanic Control Area (CTA) found in the ICAO air navigation plan for that region.

b. While the SAR operations warning area is in effect, ATC will not route IFR traffic to within 60 miles of the boundaries laterally, or 1,000 feet above the area ceiling.

3. SAR Altitude Reservation is usually controlled airspace, and provides for separation from ATC of controlled aircraft. There is no assurance of separation from aircraft not under ATC control. ATC does not issue a NOTAM for this reservation.

4. When requesting SAR airspace reservation, the SMC should provide ATC with the following:

a. Name and organization of the person making the request.

b. Brief incident description.

c. Estimated time of area reservation.

d. Method of contacting SMC.

e. Description of area by geographic features or coordinates.

f. Nature of operations and altitudes for aircraft SRUs.

g. SAR aircraft staging bases, and whether non-SAR aircraft should be asked to avoid these bases.

h. Whether aircraft carrying news media or persons on official SAR business should operate at altitudes used by SAR aircraft, including special instructions such as radio call signs, frequencies of SAR aircraft, requirement to contact the OSC, specific areas to be avoided, and direction of traffic flow. The SMC notifies ATC when reservations are no longer required.

D. During large-scale missions, or missions remote from adequate communications facilities, the SMC may require an aircraft OSC to establish a high-altitude orbit over the search area for better communications with SRUs and shore stations. The SMC selects a position over the search area, permitting the OSC to establish early radio contact with SAR aircraft approaching from staging bases, and request altitude and orbit distance from the selected position. The aircraft should make the same request on its flight plan.

E. SAR aircraft should use the word "rescue" in their call signs when requesting priority handling or when in a restricted area.

F. The SMC should advise the OSC of authorized non-SAR craft in the area.

563 Reports

The OSC must submit periodic SITREPs as discussed in Chapter 3. If there is only one SRU, the SRU commander submits SITREPs. Normally, the SMC requires SRU arrival time, expected departure time, actual departure time, and similar information to properly schedule relief SRUs. The OSC obtains search results from each departing SRU, and forwards this information to the SMC.

564 Search Action Plan

A. After an attainable search plan is formulated, the search action plan message is developed. The format and use of search action plan messages are discussed in Chapter 3. Although the complete message format is not required for every mission, it is a useful guide for information that should be given to SRUs.

B. The search action plan considers six areas: situation, search areas, execution, coordination required, communications, and required reports.

1. The situation summary is an evaluation of the situation on scene, including the nature of the emergency, last known position of target, search target description, types of detection aids and survival equipment which the survivors may have, present and forecast weather, and SRUs on scene.

2. Search area details include a listing of the search area and subareas that can be searched by SRUs during the allotted time. Search areas should be

described as previously discussed, and air-to-air TACAN channel assignments should be listed.

3. To establish effective communications, the SMC selects primary, secondary, and tertiary control channels, designates on scene, monitor, and press channels, and specifies special communication procedures, radio schedules, or other communication factors concerning search action plan execution. See Chapter 4.

570 SEARCH PLANNING FORMS

To preclude overlooking search planning steps, and to establish a logical sequence for computations, search planning forms and checklists are developed as required. See Volume II.

CHAPTER 6. SEARCH OPERATIONS

600 GENERAL

Search Operations should begin with the least possible delay, starting with SRU briefing and dispatch, and ending when the search objective is located or the search is suspended. Search operations also normally include SRU transit to the search area, SRU arrival and search, distress sighting, on scene relief, and SRU return to base and debriefing.

610 SEARCH BRIEFINGS

SRU participation in a SAR mission begins with search briefings. Briefings should include information obtained from previous search efforts, to ensure up-to-date information and avoid duplication. For a preplanned search effort, SRUs are normally briefed prior to departing. However, for urgent calls, briefings often follow dispatch and are completed via radio. The briefing should include situation and weather information, along with information on search area and patterns, communications, and SRU operations. See Vol. II, Chapter 6, for further information on briefings.

620 SRU DISPATCH

SRU dispatch procedures differ depending on SRU type. Scramble procedures for aircraft SRUs should be coordinated in advance with controlling agencies. Preplanned departure routes can be established with ATC agencies, and designated mission frequencies should be used for briefing information. A large-scale search using many light aircraft will often be staged from a single airport, with the entire mission flown in visual flight conditions. The preferred method is to stage aircraft at a variety of suitable sites, if available. In this case, the SMC should assign both en route and on scene search altitudes, ensuring separation. SAR vessels and land SRUs can often be briefed after departure.

621 Family Member Participation

Presence of family members aboard SRUs should normally be limited because of safety considerations, and the next of kin should be spared the potential emotional impact of landing in a helicopter at the distress site. The presence of family aboard SRUs should be governed by agency directives.

622 SRU En Route

A. SRU preparations en route should be completed prior to arriving on scene. Scanners should be assigned, briefed, and positioned, and a relief/rotation schedule established. Homing, monitor, and on scene communication channels should be tuned and guarded, and navigational charts laid out and readied, including plotting search pattern legs. Smoke floats, drift signals, droppable supplies, and similar devices should also be readied.

B. SRU en route search may sometimes be used to increase the search area and the effectiveness of the search. Figure 6-1 shows en route searching with a mix of search aircraft.

630 SRU ARRIVAL ON SCENE

A. Each SRU should contact the OSC about 15 minutes prior to arrival on scene, giving ETA, limitations on operational capability, search airspeed

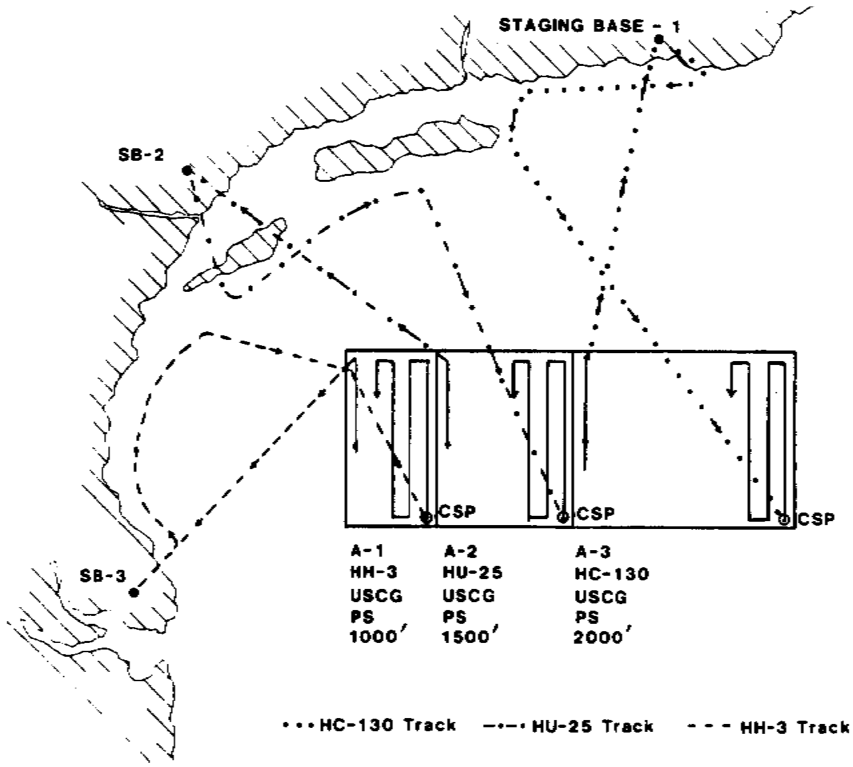


Figure 6-1. En Route Searching

Figure 6-1. En Route Searching

or speed of advance, on scene endurance, intended departure point and time, and whether the vessel navbeacon is tuned and identified.

B. As SRUs arrive, the OSC should provide information on new developments, search targets, search area designation, search pattern(s), recommended common on scene altimeter setting, altitude and track spacing, Commence Search Point (CSP), pertinent communications and navigation information (IFF squawk, air-to-air TACAN channels, etc.), traffic advisories, "operations normal" reporting times, check-in/check-out procedures, and on scene weather.

C. Normally, the SMC will direct the SRU having the most accurate navigation equipment to deploy a Datum Marker Buoy (DMB). The time and position should be closely monitored and reported to the SMC. Datum markers are useful for determining total water current, and serve as a visual or electronic centerpoint for sector searches. An accurate datum can be obtained by applying leeway to the marker position. Subsequent markers should be deployed at the newly computed datum. SMC coordination protects against two DMBs with the same frequency being activated at the same time. However, on an urgent call, in the absence of SMC instructions, the first SRU on scene should deploy a DMB on arrival.

1. Where sea current, tidal current, and wind-driven currents can greatly influence datum calculation, an electronic datum marker should be deployed before beginning the first search leg. Where multiple SRUs are assigned for large area searches, this responsibility should be given to the SRU assigned the search area in which datum is located, assuming the SRU has a highly accurate navigation system. The SRU should report to the OSC on the exact position, time of insertion, expected battery life, and radio frequency of the marker.

2. For sector searches, any type of marking device that can be located visually or electronically may be used as a datum marker. Smoke floats, life ring lights, fishing floats, and Personal Flotation Devices (PFDs) have all been used successfully.

3. Over a desert or water area, datum may be

marked by a fluorescent grenade marker or a smoke/drift signal in daylight, or a strobe light at night.

D. Safety procedures for aircraft are a major concern. If no airspace reservations are provided, aircraft SRUs are responsible for complying with all FAA and ICAO requirements. During large-scale searches, the SMC normally obtains a SAR airspace reservation from ATC. When ATC facilities are unable to provide airspace reservation for search aircraft, the SMC and OSC will normally provide safety and alerting services. All aircraft within the area will maintain their own VFR separation. When instrument meteorological conditions (IMC) exist in the SAR airspace reservation, aircraft should not be assigned for visual searches. In the absence of adequate ATC facilities, aircraft control in the SAR area will often be advisory rather than directive. Unless the OSC has a qualified and experienced air controller to handle air traffic, each aircraft commander should make technical air safety decision.

1. Assigned altitudes. The OSC should monitor the progress of arriving or departing aircraft, and assign altitudes to ensure separation of aircraft and clearance of obstructions. Assigned altitudes may not provide separation between aircraft unless all aircraft have the same altimeter setting. Altimeter settings may be obtained from ground stations or vessels, and are based on prevailing atmospheric pressure. A common setting should be assigned to all aircraft on scene unless the search area is large. "Flight level" is used over ocean areas where sea level barometric pressure is not available. Flight levels provide vertical separation of aircraft because a common altimeter setting of 29.92 is used. They should never be used to assign altitudes for low-level searches.

2. Military Assumes Responsibility for Separation of Aircraft (MARSA). When the SMC and OSC direct search aircraft to specific search altitudes, they must ensure that aircraft do not interfere with each other. The SMC uses search altitudes, CSP, and direction of creep to provide aircraft separation. In addition, the OSC or pilot provides vertical separation during descent and ascent. Participating search aircraft should file flight plans with the phrase "MARSA and safety of flight in search area" noted in the remarks section.

3. Aircraft descent procedures via CSP. When several search areas are involved and a large total area is being searched, all search aircraft should be directed to file for either their CSP or the center point of their assigned search areas. If altitudes below are clear, the aircraft should descend to search altitudes and keep the OSC advised.

4. Cancellation of air search. If visibility in the search area has deteriorated so that flight safety becomes a concern, the OSC should suspend searching and direct arriving aircraft to

return to base.

E. Continuous attention must be given to weather conditions. When each SRU is on its first search leg, it should transmit on scene weather to the OSC, who transmits consolidated information to the SMC. The most important weather factors are winds, water currents, visibility, and cloud coverage; surface SRUs may also report air and water temperatures. These observations should be as accurate as possible; relatively minor differences in direction and speed between forecast winds and actual winds may result in the search object being outside the planned search area.

1. Wind direction may be estimated by observing wind effects on land and water surfaces. On water surfaces, wavelets and whitecaps appear to move into the wind, wave systems move down wind, and windstreaks and foamstreaks align with the wind. On land, flags, clothes hanging on wash lines, tree limbs, dust, and snow align with the wind. Wind direction can also be determined if smoke is present. Care should be taken not to use smoke signals or smoke grenades in areas covered with fuel or combustible vegetation.

2. Water currents can sometimes be estimated by observing water color, kelp streaks, and mud and silt streaks, or by measuring water salinity and temperature. Major currents are normally well defined and their boundaries easily detected by color or temperature changes.

3. The SMC plans searches on the basis of existing and forecast weather. If ceiling and visibility deteriorate below that forecast, the assigned track spacing could result in lower coverage factor and POD even though the full search area will be searched. Therefore, the SMC should provide the OSC with guidance, if weather deteriorates, on whether to maintain specified track spacing, or to compress track spacing to attain the desired POD but in a smaller area.

640 ON SCENE SEARCH

641 Operations

A. Search Techniques

1. SRUs execute assigned search patterns making every effort to locate and to be visible to the search object. A distressed craft has only a limited supply of expendable visual detection aids, and survivors usually do not activate these devices until they either see or hear an SRU. SRUs should use audible signals when searching for survivors in a canopied life raft or similar craft, or when visibility is poor. For night searches, as much lighting as possible should be kept on.

2. During daylight searching the use of a whistle, horn, smoke, or other signaling device by an SRU to make its presence known may cause those in distress to set off detection aids. In using such devices, however, care should be taken not to confuse other SRUs.

3. For night searching SRUs should increase self-illumination by turning on navigation and other lights if this does not detract from the night vision efficiency of scanners.

   a. Turning on aircraft landing lights when established on a new search leg will sometimes assist a survivor in timing the firing of a pyrotechnic signal to ignite ahead of the aircraft, rather than behind or to the side.

   b. During night surface searches for survivors known to be without any type of electronic or luminous detection aid, audio reception becomes important. The survivor might have a police whistle, or may have to rely entirely on voice to attract attention. This situation is most common with a person overboard or a person lost in difficult terrain.

4. SRUs are most effective in audio searching when they are downwind of a sound source. With winds up to 10 knots, the upwind sound range may be only one-fourth of the downwind range. SRUs should concentrate on listening on the upwind side.

5. SRU background noise should be reduced as much as possible during audio search. If possible, marine SRUs should stop engines occasionally to permit low-decibel sounds to be heard.

6. While every search radar and SRU has unique features, capabilities, and limitations, some general radar search guidance applies.

   a. Search leg alignment. Optimum target detection is obtained when the radar signal is aimed downwind or crosswind to minimize clutter. While this is not critical with surface vessel radar where a full 360 degrees of azimuth is usually covered, it is an important factor in airborne radar searches.

b. Display adjustments. Whenever possible while en route to the search area, the SRU should pass within radar detection range of targets of opportunity to enable the radar operator to estimate the expected detection range of the search object under prevailing conditions.

c. Range scale. The radar display range scale should be selected to accommodate no more than the maximum expected detection range for the target, unless the radar must also be used for navigation.

d. Antenna stabilization. When available, antenna stabilization should be used to maintain a consistent surface picture. Some radars have a ground-stabilized display mode which improves detection performance with small targets. Target echoes remain stationary while sea clutter fluctuates, aiding the operator in distinguishing one from the other.

e. Search area atmospheric conditions. Whenever possible, detailed weather information should be obtained to help determine how inversion layers or other atmospheric conditions will be expected to affect radar performance.

f. Search altitude. Generally, altitude should be kept to a minimum considering safety and expected target detection range. Low search altitudes tend to reduce "sea clutter" and minimize the size of the blind zone beneath the aircraft in SLAR searches. Search altitudes of less then 500 feet up to 1000 feet for FLAR, and 2000 to 3000 feet for SLAR, are the most effective search altitudes for small targets (about one square meter radar cross section is equivalent to a 16-foot outboard). Larger targets require higher search altitudes to the extent that horizon range is sufficient to achieve maximum expected radar detection range.

g. Scanners. During radar searches scanners should be used to fill in the blind zone underneath aircraft and around larger ships and to identify radar contacts. The SLAR operator should advise visual scanners of the size of the blind zone so that search efforts can concentrate in this area. The radar operator should provide contact range/bearing information to scanners so immediate identification of targets can be attempted.

h. Operator skill. Radar operator skill and attentiveness are major factors in effective search. Fatigue and other aircrew responsibilities will degrade radar operator performance.

B. Reports

1. SITREPs should be submitted when the OSC arrives on scene and when time-critical information needs to be passed to the SMC, but no less often than every 4 hours. If only one SRU is involved, it functions as the OSC. Normally the SMC requires information on SRU arrival times, expected and actual departure times, and similar data in order to schedule SRU reliefs properly. The OSC obtains search results from each departing SRU and reports to the SMC. See Vol. II, Chapter 5, for further information.

2. "Operations Normal" Reports

a. The SMC schedules on scene arrival or rendezvous times for SRUs. If requirements change during SRU transit, these must bc coordinated with parent agencies, the SRUs, and the OSC. The SMC specifies CHOP (change operational control) requirements in the search action plan message. When arriving search aircraft CHOP to the OSC, the OSC provides flight-following service and assumes communications guard for each SRU.

b. For SRU safety, the OSC should establish periodic reporting procedures for marine craft, aircraft, and land search parties. The OSC should require an "operations normal" report at least every 30 minutes for multi-engine, fixed-wing aircraft and every 15 minutes for single-engine aircraft and helicopters. The OSC will assign each SRU an "operations normal" reporting time. If an SRU is unable to make the report directly to the OSC over an on scene channel, it should relay the report through another SRU.

c. Position reports are not required from SRUs in their assigned search areas. However, it is good practice for the OSC to periodically obtain and chart SRU positions to ensure that they are in the correct areas.

642 Aircraft Search

A. Overwater Searching

1. Maximum use of the autopilot allows pilots to devote more time to searching and keeps the aircraft closer to the track and assigned altitude. All surface vessels sighted in the search area should be plotted, noting course, speed, and identity. If survivors are sighted, these surface vessels may be asked to assist.

2. Large radar targets are often detected far outside visual range. If each target is investigated when contact is first made, considerable time may be lost and the entire search area may not be covered. When a target is detected at a distance beyond the assigned track spacing, it should be plotted. If the plotted position shows that it is closer to a subsequent search leg than the present leg, it should be identified later. Small objects should be investigated when contact is first made as the distance is usually short and they may be difficult to detect again.

B. Crosslegs

1. Searching with close track spacing requires accurate and careful navigation. The execution of the crosslegs is especially critical. The distance an aircraft moves on a crossleg includes the distance flown on the straightaway plus the turning diameter of the aircraft (see Figure 6-2). As a general rule, turns are started 15 seconds prior to the computed time for the end of the leg. Some autopilot systems are able to compensate for tight track spacing of short crosslegs and guarantee desired coverage.

2. The approximate no-wind turning diameter of an aircraft at various speeds in a standard rate turn (3 degrees/second) is shown in Table 6-1. The general formula is:

$$\frac{\text{TAS (kts)} + 10}{100} = \text{TD}$$

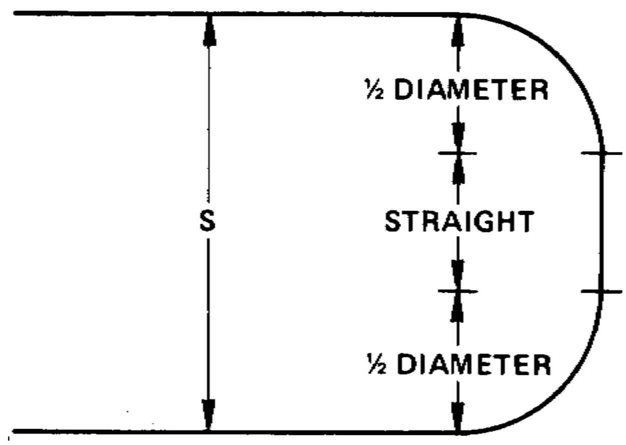


Figure 6–2. The Crossleg

Figure 6-2. The Crossleg

Table 6-1. Aircraft Turning Diameter

Speed (kts)	Turn Diameter (nm)
110	1.2
120	1.3
130	1.4
140	1.5
150	1.6
160	1.7
170	1.8
180	1.9

3. The crossleg wind component is that component parallel to the straightaway of the crossleg. In Table 6-2, two numbers are shown for each value of the wind component and track spacing. The number to the left of the slant line is the time required to fly the straightaway with a tailwind component; the number to the right is that required with a headwind component. (An aeronautical navigation computer quickly solves aircraft time and headings on searchlegs and crosslegs, and is recommended for aircraft navigation computations.)

TABLE 6-2. Time to Complete Crossleg at TAS of 150 Knots

4. When searching for small targets, or during periods of poor visibility, track spacing will often be reduced to less than the turn diameter of the search aircraft. An aircraft commander is expected to accomplish the pattern at the specified track spacing without further instructions from the SMC or OSC. One technique is to stagger the searchlegs that are consecutively searched, enabling the aircraft to turn from

one leg to the next without the need to perform S-turns, procedure turns, or other such maneuvers. Figure 6-3 shows this general procedure.

C. Locating an EPIRB/ELT

1. If SARSAT data is not available, the initial search for survivors equipped with an Emergency Position-Indicating Radio Beacon (EPIRB) or an Emergency Locator Transmitter (ELT) should be conducted at high altitude for increased range, particularly for VHF/UHF beacons. The SRU receiver should be tuned to the beacon frequency with the squelch off. The frequency should be guarded aurally and visually, if it is equipped with homing capability.

2. Initially a search pattern should be used which sweeps the probable area until a signal is detected and homing is begun. See Figure 6-4. If the signal is too weak to actuate the homing device, or if the aircraft is not so equipped, the aircraft should execute a homing pattern based

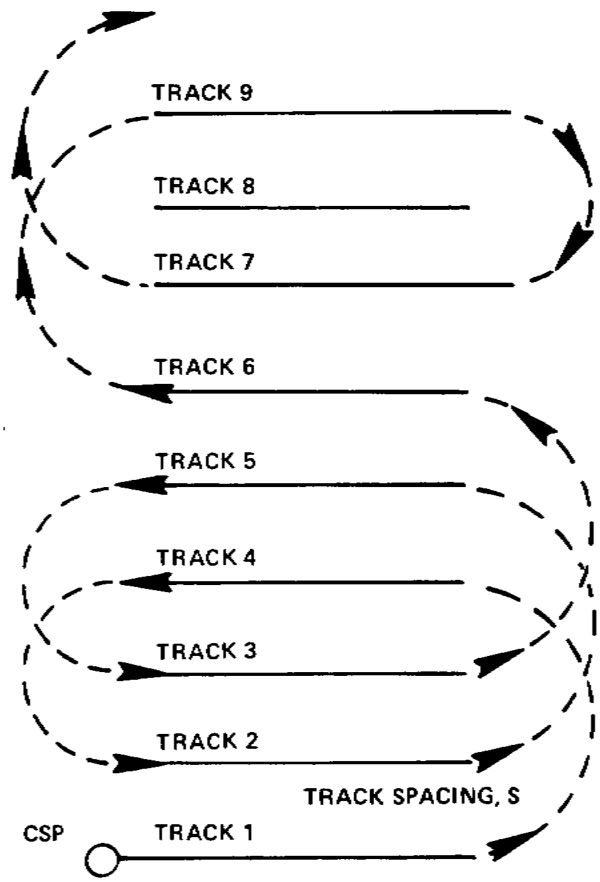


Figure 6–3. Close Track Spacing

Figure 6-3. Close Track Spacing

on the assumption that the area of equal beacon signal strength is circular.

a. When the emergency radio signal is first heard, the pilot adjusts receiver volume for normal listening and receiver squelch to the point where the signal is just lost. The squelch is then readjusted until the signal is just audible, and the position noted.

b. Continuing on the same course, and without adjusting the radio controls, the pilot notes the position when the signal is lost and reverses course along the same track. Half way between the points where the signal was heard after the initial squelch adjustment and where it was again lost is the closest point to the emergency transmitter along the track. The source is approximately 90 degrees to the right or left of this midpoint.

c. The pilot then makes a 90 degree right or left turn. The signal will either fade or build as the aircraft continues on the new heading. If the signal fades, the aircraft reverses course. The course on which the signal builds brings the aircraft approximately over the site of the emergency signal.

d. Passage over the signal source is indicated by a sharp rise in signal strength followed by a sharp drop, or a complete momentary loss of signal. If the aircraft has homing equipment, this track should bring it within range of that equipment, and the aircraft should descend and locate the source by both homing and visual detection. If the aircraft does not have homing equipment and a signal drop occurs, the crew should note the position and descend immediately and conduct a visual search around that point.

e. If a signal drop is not detected, the pilot should proceed on course until the signal is lost, reverse course, proceed to the midpoint of the second track, and then descend and conduct a visual search.

3. Similarly, en route commercial aircraft may help determine an approximate position of ELTs or EPIRBs by marking the position when they first hear the signal and when they lose the signal. A line connecting these two points should mark the chord of a circle with the EPIRB/ELT close to the center. After several such chords are obtained, the center of the circle can be determined. See Figure 6-5.

D. Executing Aircraft Intercepts. See Vol. II, Chapter 7.

643 Vessel Search

A. All preparations should be completed before the vessel enters the search area. Communications should be established with the OSC, SAR frequencies and homing equipment guarded, observers positioned, and rescue gear readied. Scanners should have binoculars and should be stationed as high as possible to increase sighting range. A 360 degree lookout should be maintained.

B. Marine craft searching where no electronic or visual reference points exist should maintain a dead reckoning (DR) plot of the best known position of the incident, their own position, and the position of other ships and aircraft in the vicinity. The plot should also show the date, time, possible drift of survivors, and areas searched.

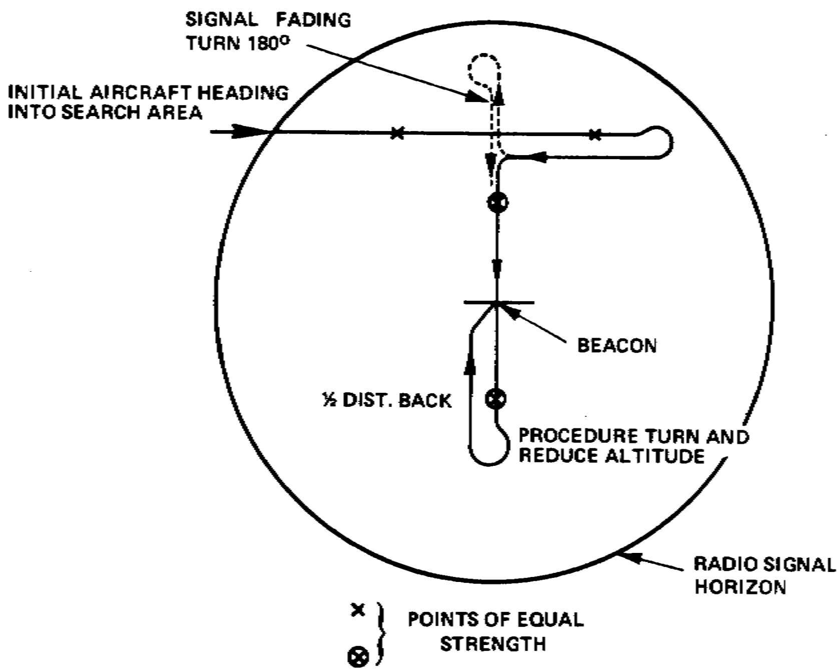


Figure 6-4. HSM Pattern

Figure 6-4. HSM Pattern

C. To attract survivor attention, a vessel should periodically make heavy black smoke, rotate a searchlight beam around the horizon during night time, or turn on deck lights. Periodic sound signals can help when searching for survivors under raft canopies. Crew members should be alert for signals from survivors and other signs, such as floating wreckage or objects, indicating their presence. At night or when visibility is seriously restricted, the engines, if feasible, may be stopped periodically and a listening watch maintained for survivor signals.

D. When executing search patterns, every SRU normally begins its turn from one searchleg to the next before actually reaching the end of the searchleg. A marine SRU should begin its turn, as shown in Figure 6-6, short of the end of each searchleg by a distance equal to the "advance" of the craft for the search speed and amount of rudder used entering the turn. The craft will begin the straightaway portion of the next leg--upon completion of its 90 degree turn--by a distance equal to the "transfer" of the craft for the search speed and rudder used entering the turn. Figure 6-7 depicts a typical vessel-turning circle, with the advance and transfer distances indicated. SRUs from some countries (e.g., Canada), execute turns outside the search area.

644 Inland Search

Information unique to inland search is presented in Chapter 8.

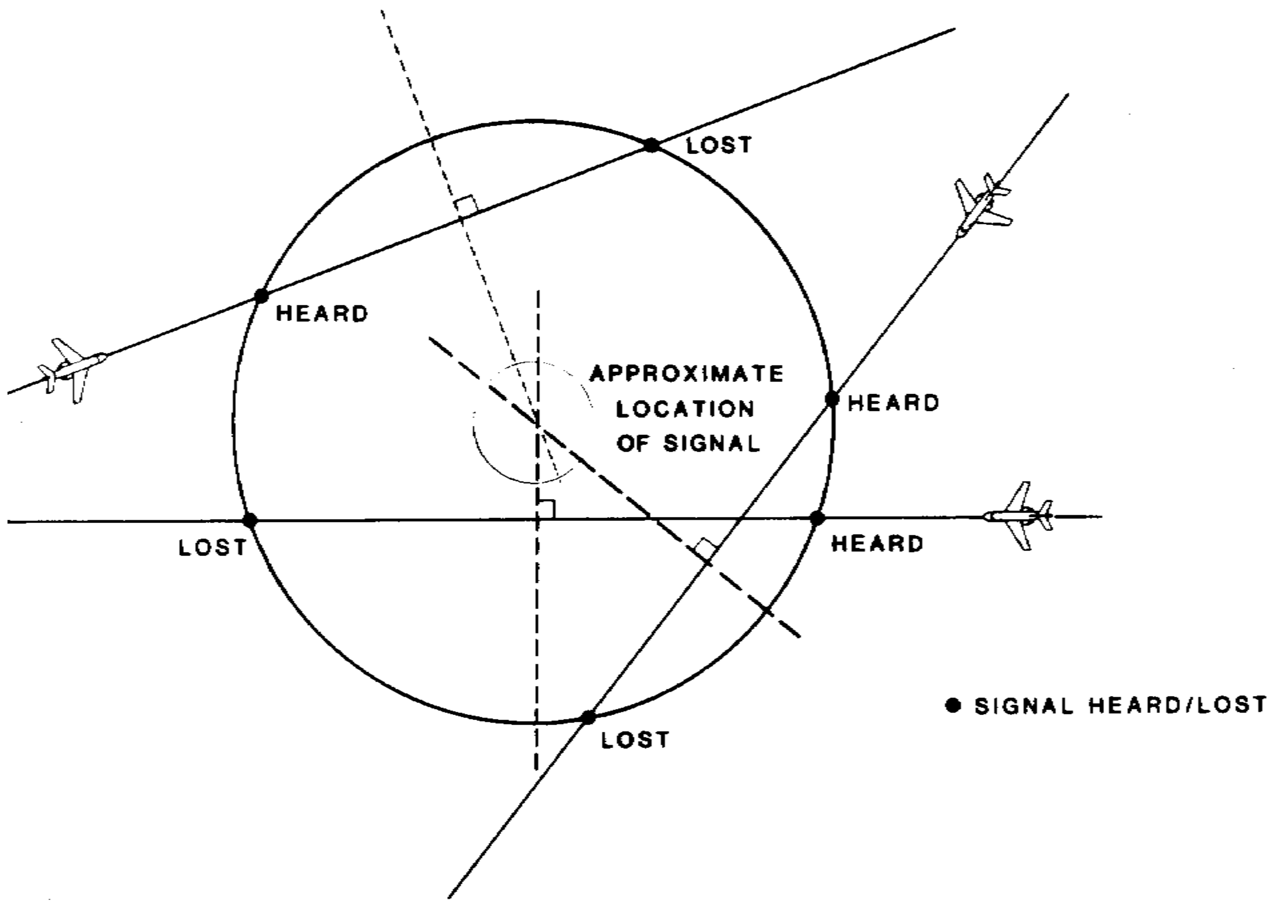


Figure 6–5. Search for EPIRB/ELT

Figure 6-5. Search for EPIRB/ELT

645 Scanning

A. A searching SRU is primarily a platform for scanners. The saving of lives, relief of suffering, or protection of property ultimately may depend on the number and effectiveness of scanners. To ensure effective searching, trained scanners should be used. Scanners should meet standards set by the service or agency for correctable vision, and normal color vision should also be required to enable the scanner to distinguish between a target and surroundings. As many scanners as possible should be used. However, all available scanners should not necessarily be used at one time. It may be more important to rest scanners and to keep an effective rotation, not only among crew but also among positions.

B. Scanner effectiveness depends on many factors, including number, training, positions, speed and motion of craft, duration of the search, fatigue, and motivation. The effects of these factors and interactions are so complex that it is difficult to gauge their individual impact systematically.

1. Trained scanners are less subject to fatigue, and experience with the appearance of a type of visual target increases POD. Scanners should receive training in their duties and in the appearance of common SAR targets as seen from their assigned SRU type. A scanner who has never seen a raft on the water from altitude, or a person in the water supported by a lifejacket, is at a disadvantage. Life rafts, small boats, and persons in the water may resemble flotsam, lobster pot/diving buoys, or other non-search objects. Figure 6-8 illustrates this problem. Sun elevation, cloud cover, search altitude, and sun bearing relative to the target position all can affect the appearance of the search object.

2. An individual's SAR experience is not a clear indicator of target detection performance. However, experience does appear to improve the ability of lookouts and scanners to judge distances, recognize and identify targets, and

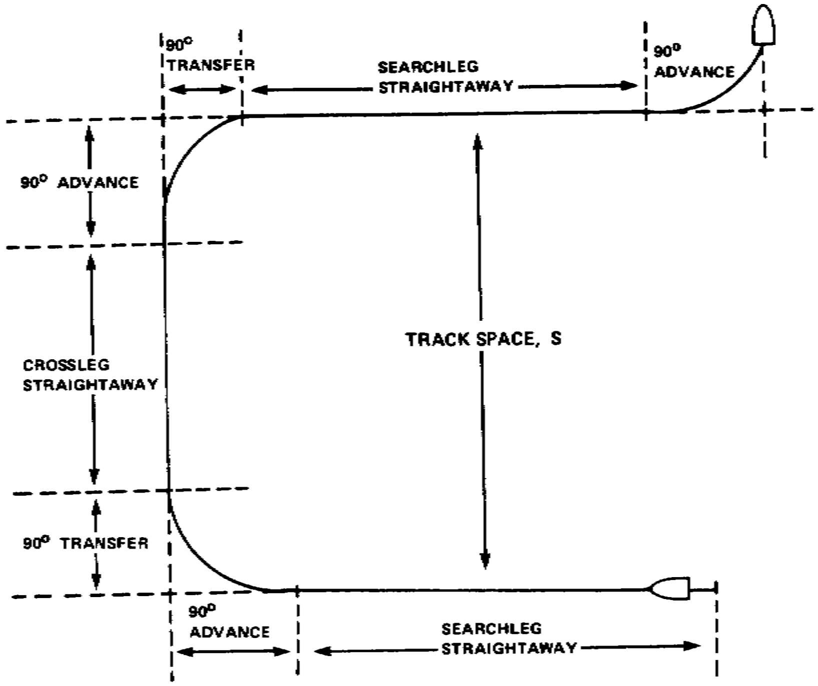


Figure 6–6. Marine SRU Crossleg

Figure 6-6. Marine SRU Crossleg

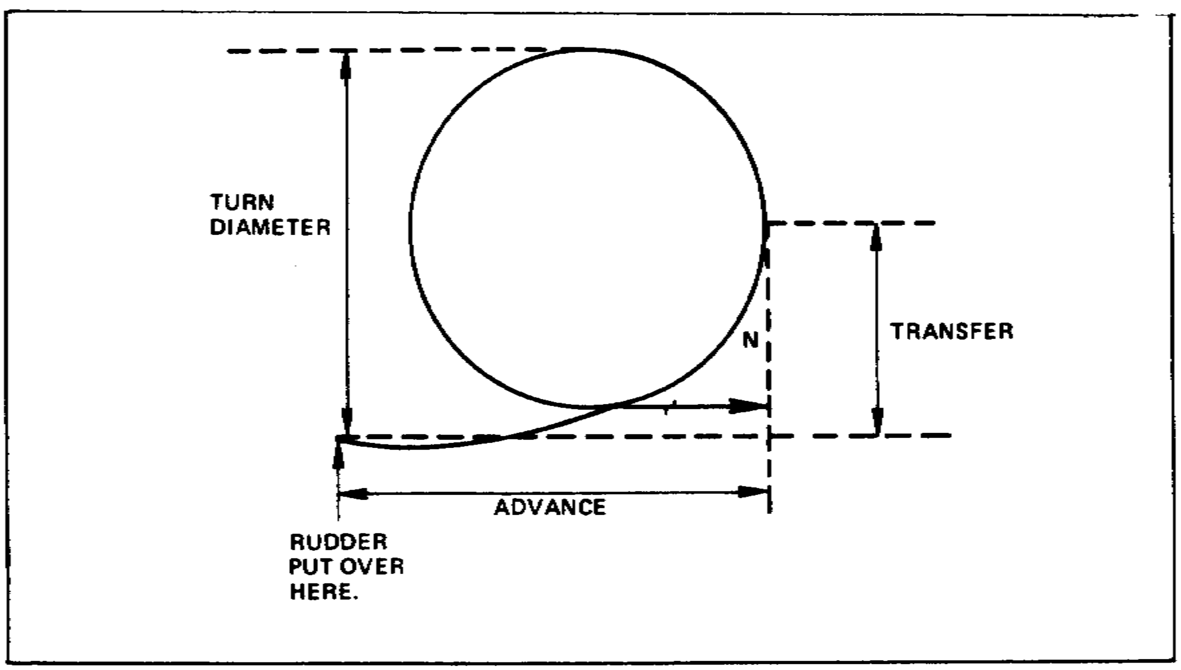


Figure 6–7. Typical Vessel–Turning Circle

Figure 6-7. Typical Vessel-Turning Circle

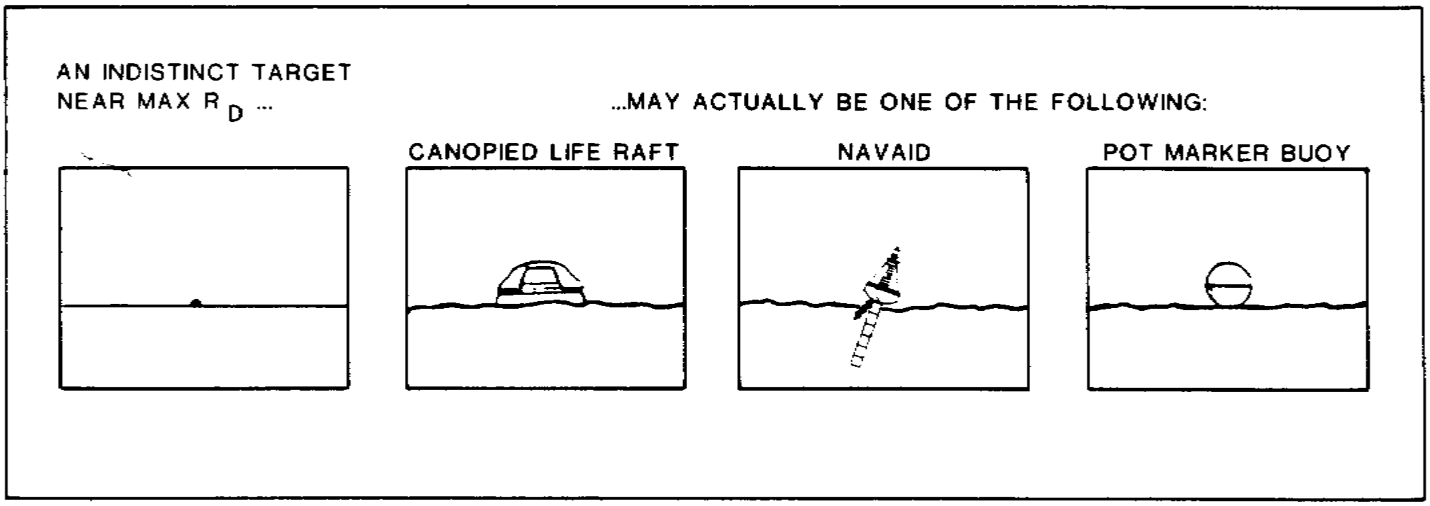


Figure 6–8. Small–Target Recognition Problems

Figure 6-8. Small-Target Recognition Problems

maintain a sense of SRU location within the search area. A search crew member should be reminded of the importance of recognizing, reporting, and identifying any object that could be a survivor or an indication of survivors. While en route to the search area or during the search, it is helpful to point out craft or objects that are similar in appearance to the search object.

3. Lookout positions affect scanning. The best lookout positions on most aircraft are occupied by the pilot, copilot, and forward lookouts. If no forward station is available, the burden of scanning is placed on the pilots. Even with the aircraft on autopilot, one pilot must concentrate attention mostly in the cockpit, possibly leaving areas unscanned. Lookout positions should be as comfortable as possible, and windows should be clean and free from scratches and oil or dirt, which may decrease light passing through. Lights inside the SRU should be kept dim to minimize reflections in the windows. Vessels and low-flying aircraft tend to pick up salt on the windshields, and seaplanes pick up salt spray during takeoff. It may be desirable to open the side windows of unpressurized aircraft for better visibility. Lookouts should be posted to maintain a wide field of vision, 360 degrees if possible, since survivors may not be able to set off their visual signals until after the SRU has passed.

4. Degradation of scanner effectiveness due to fatigue over the course of a search is significant. Shifting position on the SRU every 30 minutes will tend to reduce fatigue from the effects of the movement of the view across the field of vision.

a. The effects of time on task vary with SRU type. Units capable of rotating scanners into rest periods can be expected to reach a steady state of performance after initial degradation. Other SRUs will probably decline steadily in performance up to the limits of on scene endurance.

b. At night, scanner relief should be carried out with some caution as approximately 30 minutes is necessary for eyes to become dark adapted. Personnel should not be rotated directly from lighted parts of the SRU to lookout positions.

c. Frequent light snacks and coffee, together with a reasonable amount of conversation between observers, tends to reduce fatigue.

d. In aircraft, unstabilized binoculars rapidly cause eye fatigue and should be used only to check sightings made by the naked eye. On steadier and slower platforms, binoculars are useful for scanning.

e. "First-light" searches, although sometimes necessary, have a detrimental effect on crew search effectiveness.

5. Motivation affects the performance of the entire crew. During early stages of a search, motivation is high. After fatigue sets in and hope of locating survivors decreases, motivation can become a problem. Maintaining high motivation during the search is the responsibility of the SRU commander. All members of the crew should be made to realize they are important parts of the

team by keeping them informed of what is going on at frequent intervals throughout the search. Competition among crew members to locate the target helps maintain motivation during unusually long or difficult searches.

6. SRUs should search at the highest speed consistent with crew comfort and on scene endurance. Search speeds of up to 120 knots do not significantly reduce visual sweep width for most targets.

C. The scanning techniques employed can have substantial influence on detection probabilities and should be adopted to fit the various search circumstances.

1. The SRU commander should brief scanners on the maximum expected detection range of the search object for existing conditions. Scan patterns should be adjusted to include only areas that provide a reasonable chance of detecting the target. Valuable scanning effort should not be wasted on low probability areas. Lookouts should not scan areas beyond the expected detection range. On each SRU type, visual guides that aid search crews in improving scan technique should be identified. Examples on surface craft would be railings, window frames, or masts, and on aircraft would be wing pods, engines nacelles, sponsons, and window and door frames.

2. Range estimation can be helped by the same visual guides on an SRU that aid scan techniques. It is important, especially on board aircraft where search altitude can change, that scanners be informed of the lateral distances from the SRU represented by the projections of wing pods, engine nacelles, and sponsons, onto the ocean surface. Figure 6-9 illustrates this concept. Lookouts have a tendency to underestimate distance to objects, and the greater the actual distance the larger the error in estimation. {1}

3. SAR personnel tend to scan areas that are beyond the expected detection range for small (under 30-foot) search targets even when told specifically that the search object is small. Almost all small target detections occur within 6 nautical miles of the search craft (within 1 nautical mile for persons in the water) at relative bearings between 225 degrees and 135 degrees.

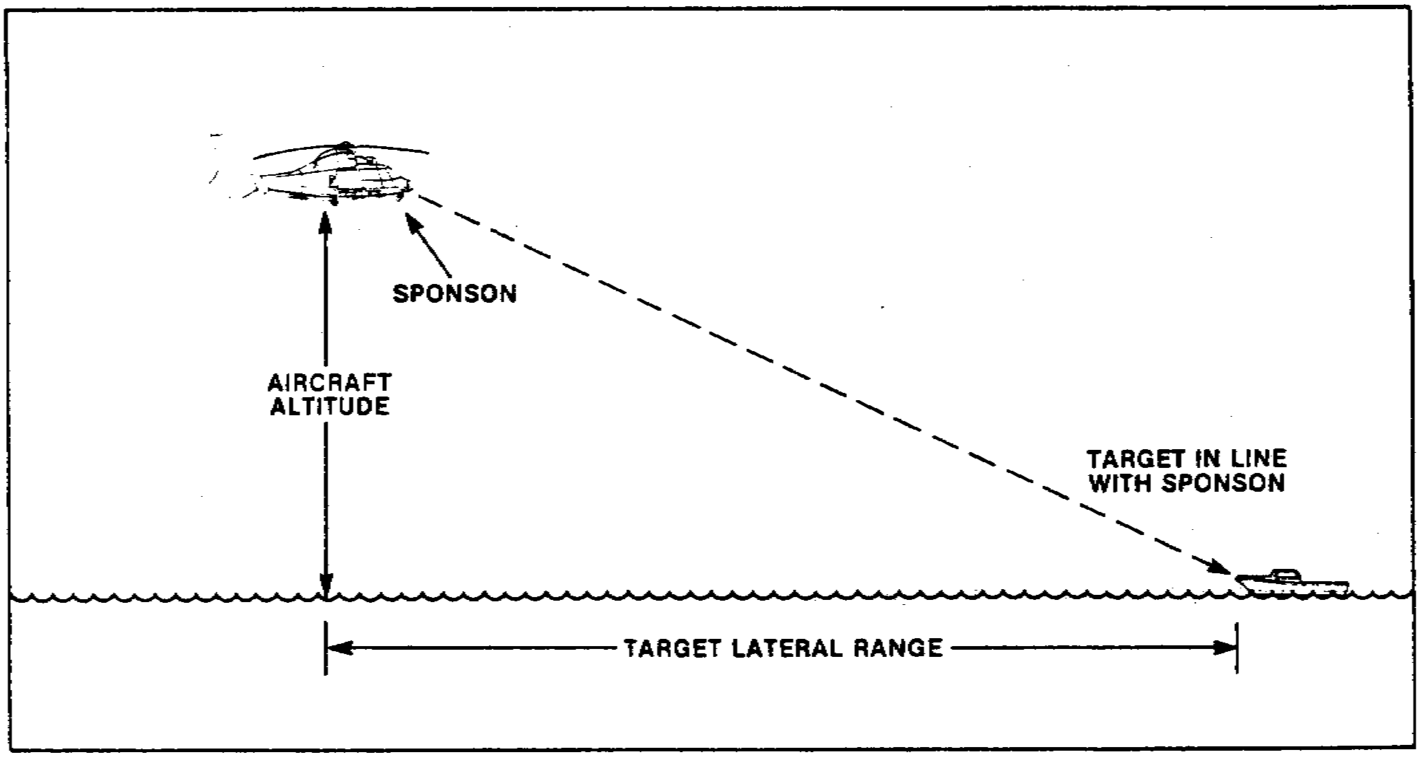


Figure 6-9. Range Estimation

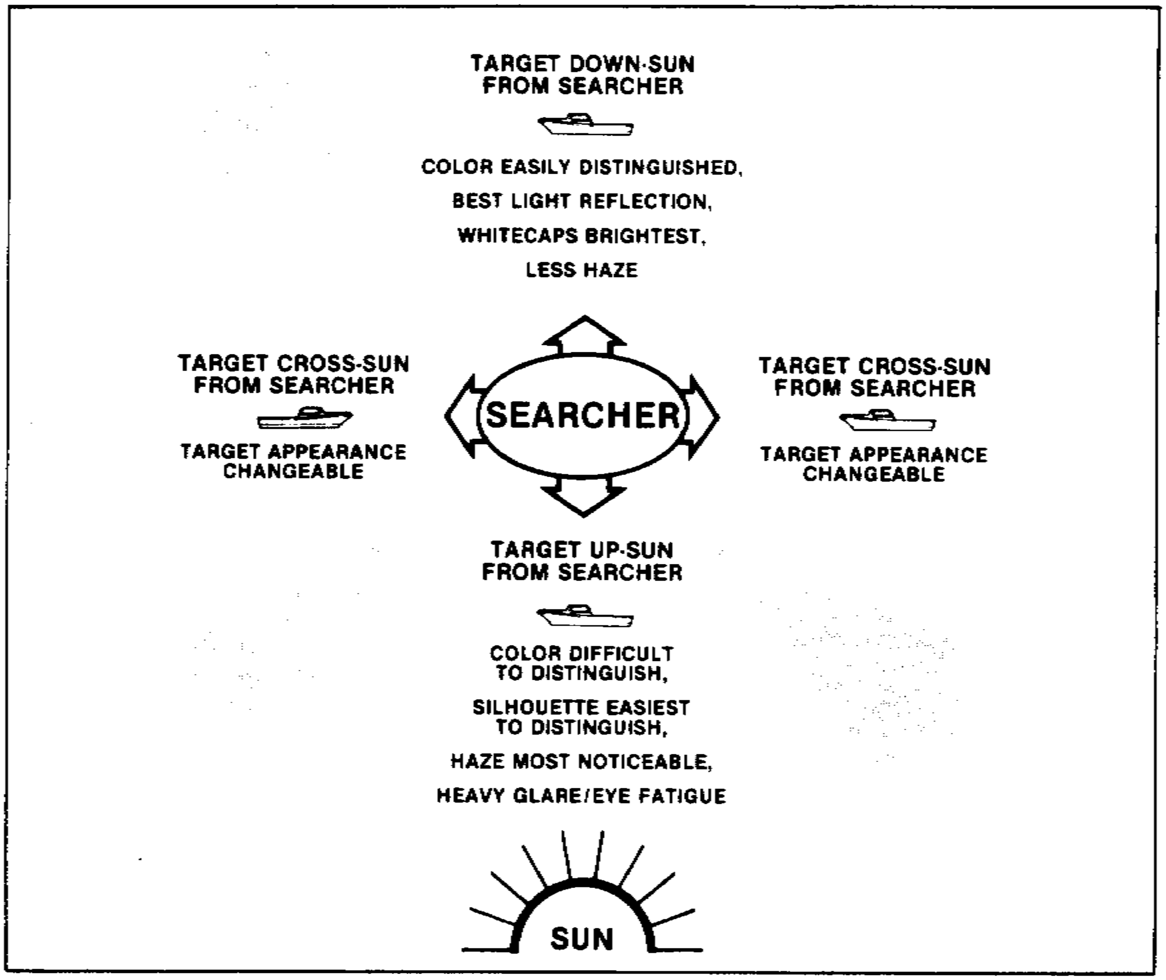


Figure 6-10. Sun Position and Target Detectability

Figure 6-10. Sun Position and Target Detectability

4. A geometric scanning pattern should be used routinely when searching. Ideally, the eyes should move and pause for each 3 degrees or 4 degrees of lateral and/or vertical distance at a rate that will cover about 10 degrees per second. A sighting is most likely to occur in an area limited by a 5 degrees radius in all directions from the point at which the eyes are focused. Scanners should not jump their eyes between fixations and should pause only briefly between fixations during daylight search. Poor scan patterns consist of prolonging fixations in a single area, allowing the eyes to jump around, or scanning along structures like window frames or environmental features within the field of view. When searching in areas of little contrast, eyes tend to focus short of the surface being searched. To preclude this, the scanner should periodically focus on some object in the "no contrast" area, or on a nearby object within or on the SRU.

5. Scanners forced to look into the sun or its path lose visual acuity, and can easily fail to detect an object. While the up-sun direction should not be ignored, searchers should never look directly into the sun. Rather, a systematic scan should be used to take advantage of all possible target/back-ground relationships as they vary with SRUs motion relative to target and sun. When looking into the sun, a searcher must contend with glare, reflections, and haze diffusion. If sun brightness is a factor, scanners should be provided with dark polaroid sun glasses or goggles.

a. The position of the sun (azimuth and elevation) relative to searcher and target influences target appearance. Targets appear as dark silhouettes against a bright background, and color is difficult to distinguish. Eye fatigue occurs quickly under these conditions. When targets are viewed down-sun, haze and glare are less of a problem, colors are more easily distinguished, and target/background contrast is better.

b. Target detectability, however, has been shown to be essentially the same whether an SRU passes a target on the up-sun or down-sun side. These relationships are illustrated in Figure 6-10.

6. Aircraft movement causes the field of view to be moved along. Eye movement should be away from the aircraft to the maximum detection range and then back toward the aircraft to a point as near under the aircraft as can be comfortably seen. Aircraft should consider using scanners from rear observation positions. For surface SRUs, the direction of movement is not as important. A systematic pattern that does not leave voids in the field of vision is all that is needed.

7. Night scanning poses additional considerations.

a. Eyes require about 30 minutes of dark adaptation, best accomplished in total darkness. However, the wearing of red goggles enables dark adaptation to occur in a lighted room. Exposure to intense sunlight may cause a person's dark adaptation threshold to rise, and the effect may take several hours to wear off. When a night search is scheduled, the crew should wear dark glasses during brilliant sunshine. The trip to the search area should be used for dark adaptation by ensuring that the SRU interior is dimly lit, with red light if available. Dark adaptation can be hindered by lack of oxygen, and by consumption of cigarettes and alcohol.

b. Night scanning can use any systematic geometrical pattern. Maximum effectiveness in night scanning is achieved by a series of short, regularly spaced eye movements. Scanners should concentrate their search on the horizon where the contrast between the craft's silhouette and the sky would be greater than the contrast between the dark target and the dark ocean surface. On the other hand, if the distressed craft is able to illuminate itself, the contrast would be greater against the dark ocean than against the lighter sky and low stars. If the search is being made at night with expectations of finding light signals or flares, the eyes need not pause so frequently in sweeping the visual field. Periodically, the lookouts should close their eyes for a period of 5 seconds to allow rest.

c. When binoculars are used for scanning at night, the principle of off-center vision still applies. Binoculars should be held straight forward and the eyes turned off-center toward the perimeter of the field. The scanner should avoid looking directly at any object located by scan, and should look instead off-center, thereby preserving night vision. A single stationary point of light may appear to move aimlessly.

This effect can be minimized by not looking steadily at any point of light and by having other objects in view. Another common illusion occurs as an approaching or receding light appears to expand or contract at a fixed distance. Shifting gaze counteracts this phenomena.

645 Search Target

A. The detectability of a target is related to target size, shape, and distance from the observer, color contrast and brightness contrast with the back ground, movement, and duration of exposure to the observer.

1. Color helps in detection because it contrasts with the surrounding or background colors. A small target that contrasts with the background can often be seen more easily than a larger target that blends with surroundings. However, small targets can be seen only at limited distance regardless of the color contrast. For the color to be effective, the eye must look directly at the target because the color receptors of the eye are concentrated in the center of the retina, and objects that would be seen out of the corner of the eye are unlikely to be detected by color contrast. White, yellow, red, and orange colors provide good contrast against a water back ground, but yellow and white objects are not easily seen against whitecaps. Under whitecap conditions, red and orange appear to be the easiest colors to detect.

2. Brightness will also influence a target's contrast with its surroundings. For example, fluorescent colors (such as international orange) are typically sighted at greater distances than flat or dyed colors. The density of color in fluorescent paint and tapes is so great that brightness contrast combines with color contrast to improve target detection probability by reflecting greater amounts of light.

3. In general, water wakes and colors are more

easily sighted down-sun, whereas a craft's silhouette is likely to be sighted first if viewed up-sun. Thus, color and brightness contrast are most influential when the target is down-sun.

B. Target motion influences detection range by contributing to the "something different" in a scanner's visual field and by disturbing the water. As a vessel moves faster, wake is larger and the detection range from the air increases due to the effective increase in target size. Any movement by an object in light seas is likely to attract attention. Conversely, a stationary target can sometimes be detected among whitecaps because target position remains the same while the whitecaps "blink" on and off.

C. The relative amount of time that a target is exposed to the observer affects target detectability. Target shape, particularly freeboard, can influence duration of exposure because waves and swells may hide the target intermittently. Small search objects are especially difficult to detect in high seas and swell because of this effect.

D. Target characteristics influencing detectability and, therefore, visual sweep width are summarized in Figure 6-11.

E. Search altitude affects a number of aspects of the visual detection process. As altitude decreases, the search target passes through the field of vision more rapidly than at higher altitudes, low-freeboard targets are more difficult to sight, and surface irregularities become more pronounced. Also, at lower altitudes pilots tend to concentrate more on their instruments and flying than they would if they had more of a safety margin. These effects are most pronounced at altitudes below 500 feet. For a surface search craft, the freeboard and the length of the target are more important than its beam. However, as altitude increases, the beam and length of the search target become more important because they determine the size of the target as viewed from overhead. See Figure 6-12.

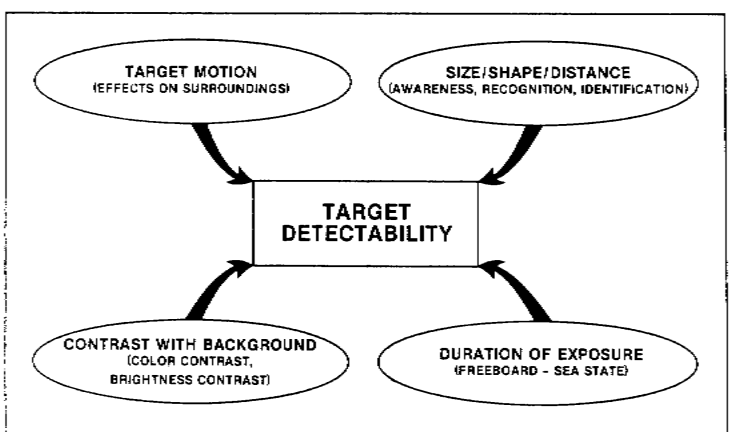


Figure 6-11. Target Detectability Factor

Figure 6-11. Target Detectability Factor

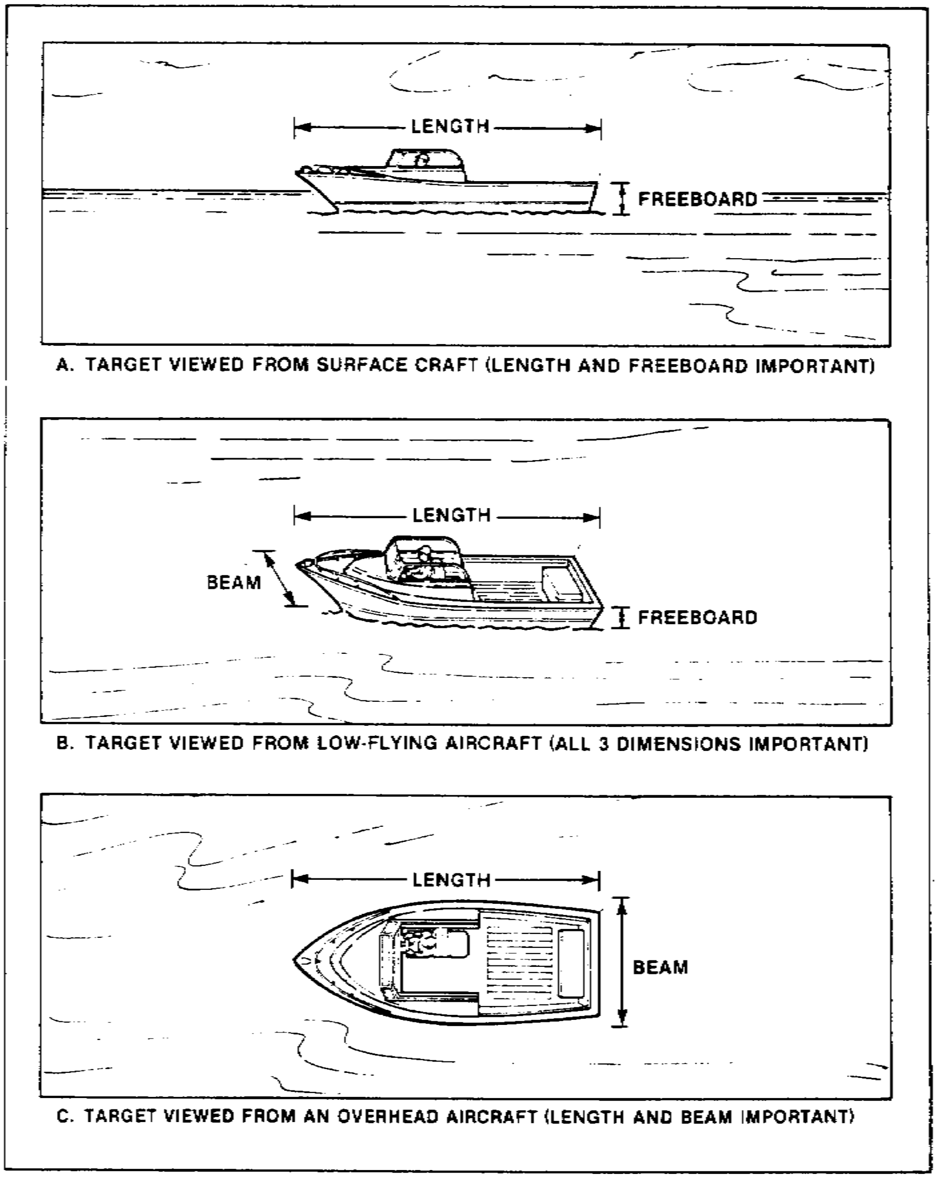


Figure 6–12. Effects of Altitude on Detectability

Figure 6-12. Effects of Altitude on Detectability

647 Electronic Searches

A. Search Radars that may be available for SAR missions include Surface Vessel Radars (SVRs), Forward-Looking Airborne Radars (FLARs), and Side-Looking Airborne Radars (SLARs).

1. Because of horizon distance limitations, which depend upon antenna height and target freeboard, SVRs rarely perform better than a visual lookout (especially if the lookout is equipped with stabilized binoculars) in clear

daylight weather. The primary advantage of this sensor over visual search occurs at night and in fog/haze conditions. Figure 6-13 illustrates typical SVR operation.

2. FLARs typically scan a 60 degree to 240 degree sector centered forward of the aircraft. FLAR detection range is limited more often by clutter or signal-to-noise ratio than by horizon distance. Figure 6-14 illustrates typical FLAR operation.

3. SLARs are usually capable of searching large areas to either side of the aircraft and include film or video records of the search for extended analysis. Figure 6-15 illustrates SLAR operation.

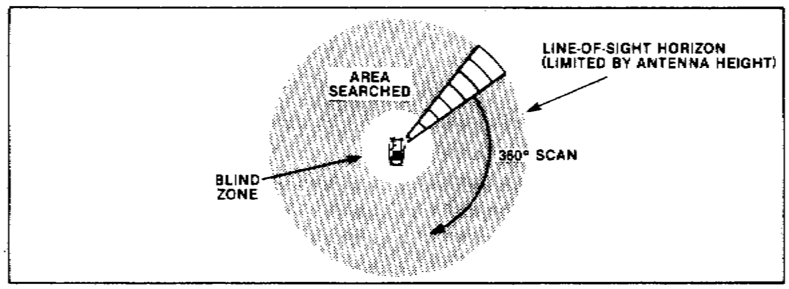


Figure 6-13. Surface Vessel Radar (SVR)

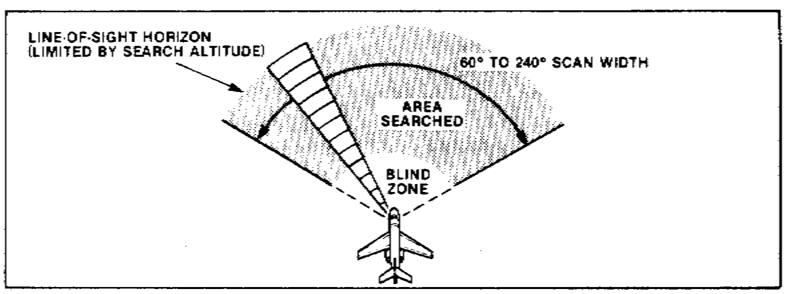


Figure 6-14. Forward-Looking Airborne Radar (FLAR)

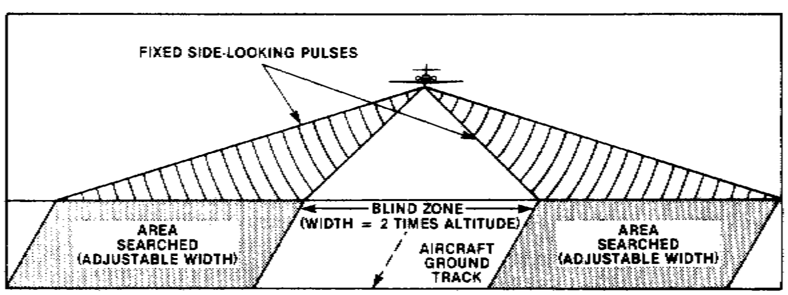


Figure 6-15. Side-Looking Airborne Radar (SLAR)

Figure 6-13. Surface Vessel Radar (SVR)
Figure 6-14. Forward-Looking Airborne Radar (FLAR)
Figure 6-15. Side-Looking Airborne Radar (SLAR)

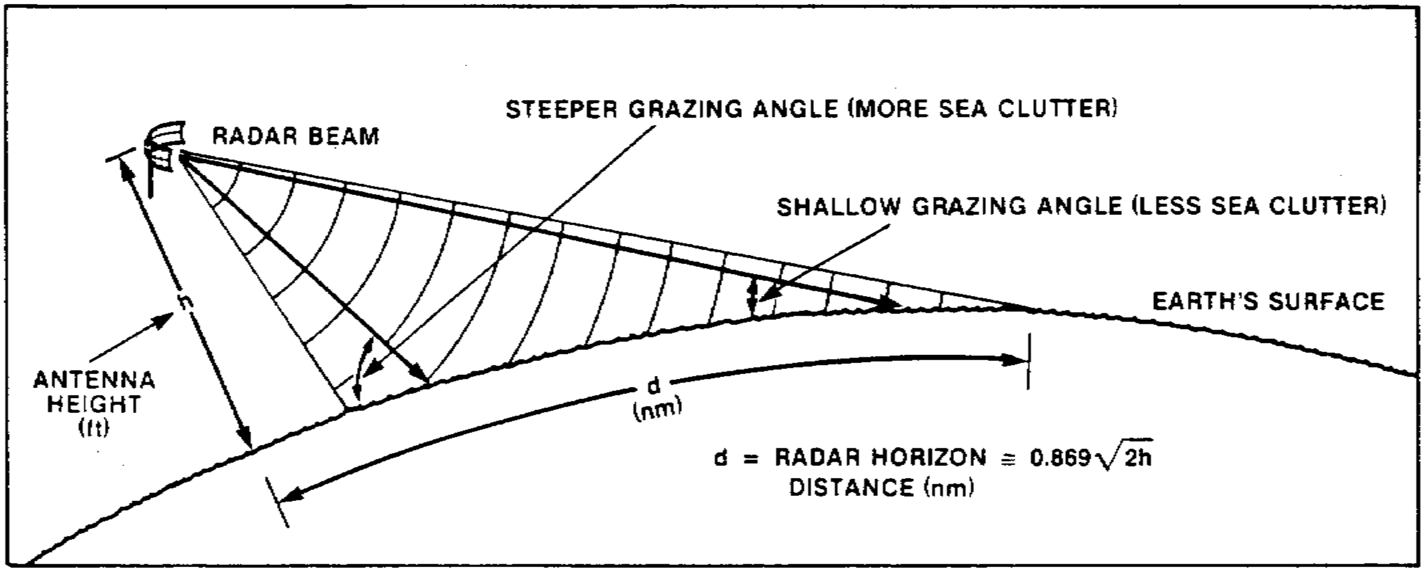


Figure 6–16. Factors in Radar Detection

Figure 6-16. Factors in Radar Detection

4. Radar detection is affected by a variety of environmental, target, and controllable parameters. Wind and sea state affect the amount of sea clutter present on the radar display. Rain, water vapor, snow, and other atmospheric content can have a drastic effect on radar detection ranges. Target size, shape, and material all affect radar detection range. In general, metallic targets are most detectable, while wood, fiberglass, and other "soft" targets are much less detectable. Target size determines the amount of transmitted power that potentially can be reflected and the size of the target's echo on the radar display. The effects of target shape on detectability are complex, but when devices such as radar reflectors are designed specifically to maximize the returned target echo, they can increase detection range dramatically. Antenna height affects the radar horizon and the grazing angle of the radar signal with the ocean surface. In general, shallow grazing angles produce the least clutter. Low altitudes are best when searching for most common SAR targets. Figure 6-16 illustrates the relationship between antenna height, horizon range, and grazing angle. Radar searches should always be used when:

a. A target may be detected by a radar-equipped search platform available in addition to primary SRUs using visual or other search methods.

b. Radar sweep width for the target and prevailing conditions is greater than for visual or other available search methods.

B. Forward-Looking Infrared (FLIR) search is a passive detection system used to detect thermal radiation.

1. All objects emit thermal radiation. Because the quantity of radiation is temperature dependent, a FLIR system observes the temperature differences to produce a video presentation. FLIR can detect objects in total darkness and in the presence of limited obscurations, such as dust, smoke, and haze.

2. FLIR detection capability is influenced by sea state and atmospheric content. Sea state is the primary limitation on maritime FLIR detection in clear weather. Rough seas mix surface and subsurface water, resulting in cluttered FLIR image. This makes small targets such as life rafts difficult to detect, and persons in the water nearly impossible to detect. The effects of sea state on detectability of medium and large targets is not as great. Water vapor, carbon dioxide, and aerosols in the atmosphere will reduce the effectiveness of FLIR; in some cases, these factors can degrade FLIR detection performance more severely than visual detection performance.

3. Visual searchers normally achieve better detection performance than FLIR in clear daylight conditions. Consequently, FLIR is a preferred night search sensor, unless certain daylight haze or smog/smoke conditions impair visual detection more than FLIR detection.

C. Multisensor search is either multiple SRUs searching with different sensors or a single SRU searching with two or more sensors simultaneously. While this can improve search performance of SRUs, careful search planning and appropriate tactics are required to maximize the contribution of all sensors and achieve the largest sweep width possible.

650 SIGHTING AND IDENTIFICATION

651 Investigation Sightings

A. During a large search many objects other than the actual search target may be sighted. Diverting from search to identify sighted objects diminishes the uniformity of search area coverage regardless of navigation accuracy. This will cause actual POD to be lower than calculated POD. Tactics that minimize this effect should be used. If a subsequent search leg will bring the SRU closer to the object, it may be preferable to delay identification until then. Marking the positions of targets of interest for identification should also be considered.

B. Objects sighted other than the actual search target may offer clues that, if properly interpreted, lead to the location of survivors.

1. When a large vessel goes down suddenly, the scene may be littered with considerable debris and a large oil slick, usually traveling downwind of the origin. Boats and rafts will usually be downwind of the debris. Persons in the water may be found clinging to floating objects. Lifeboats from large vessels are normally equipped with pyrotechnics and emergency radios and may have power or sail. If more than one boat is launched, they can be expected to be grouped, or tied together, to make sighting easier. If the vessel was abandoned before sinking, lifeboats, rafts, and personnel may be upwind of the point of foundering, so SRUs should search both upwind and downwind of an oil and debris area. In heavy seas, survivors may also be moved by the seas in the direction in which the seas are traveling.

2. An abandoned ship may drift faster than its survival craft. In such cases, concentrated search upwind is recommended. However, a half-sunken, loaded ship may drift more slowly than a floating survival craft, even if a drogue is used, and may also drift at a considerable angle off the prevailing wind direction.

3. Small craft, such as yachts and fishing vessels, sometimes carry only a small dinghy or raft. Others have only life jackets. Boats or rafts from small craft have a limited supply of visual detection aids. In the case of a maritime search for survivors of an aircraft incident, scanners should look for scattered wreckage such as oxygen bottles, floorboards, seat cushions, and pieces of rafts. In some cases there may be nothing but an oil slick.

C. Often an SRU, especially aircraft, will not be able to identify an object on the first pass, thus requiring maneuvering by the SRU. As it is not unusual for an SRU to lose sight of the target while maneuvering, it is important for it to have a definite plan for relocating and identifying sighted objects. SRU commanders should ensure that each crew member knows that procedure. If something is sighted, but remains unidentified, these aircraft procedures may prove useful in relocation:

1. Marking and Relocating Contacts. A smoke marker, illumination signal, or sea dye marker should be immediately dropped to mark the approximate location of the sighting. However, smoke and illumination signals are not used if there is danger of igniting fuel or oil on the surface. After marking, a survivor relocation pattern should be executed. Aircraft should not change altitude if that change may conflict with other aircraft in the area.

    a. A procedure turn can, if properly executed, position the aircraft back over the sighting area. The procedure turn recommended is the "90-270" method (Figure 6-17). This method also works if signals fail to function.

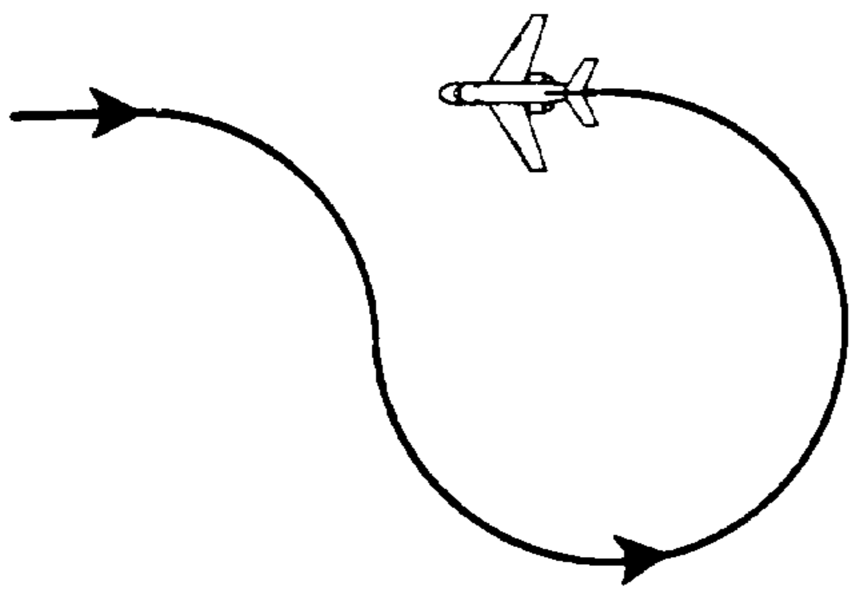


Figure 6–17. Procedure Turn for Investigating Sighting

Figure 6-17. Procedure Turn for Investigating Sighting

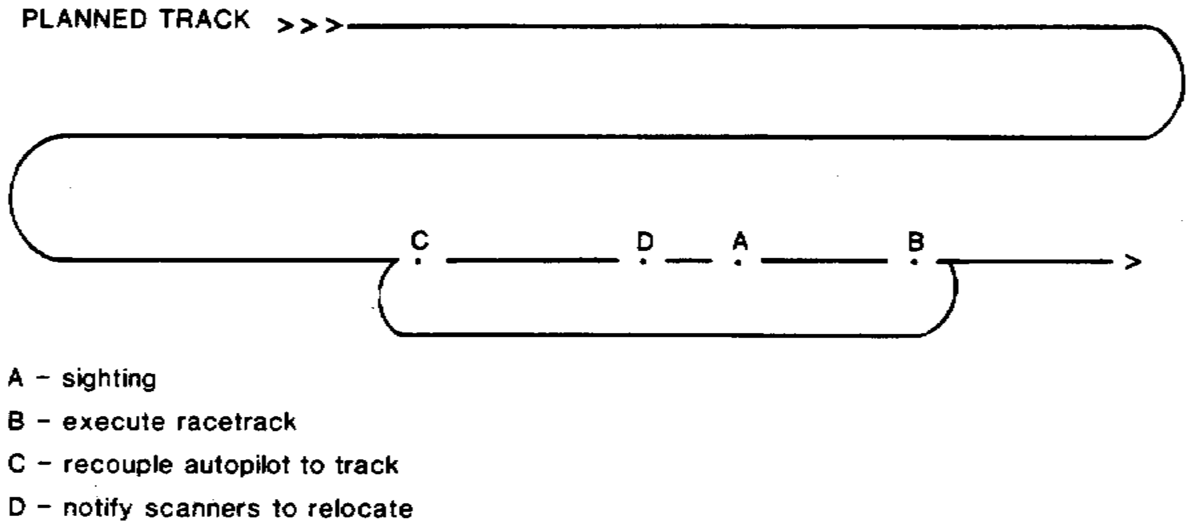


Figure 6-18. INS Pattern for Relocating Survivors

Figure 6-18. INS Pattern for Relocating Survivors

b. An alternative method for aircraft not capable of rapidly deploying markers is for the observer to call out the clock position and estimated distance immediately upon sighting an object. The pilot then immediately turns the aircraft in the direction of the sighting. The observer continues to call out the target position and distance to orient the pilot. As the turn progresses, the pilot or copilot should state when the target is sighted.

c. Although the use of a marker is the most accurate method to mark the position of a target, some sophisticated navigation systems can be used to relocate targets:

(1) When a sighting is called out, SRU position and distance to go on the current leg is noted.

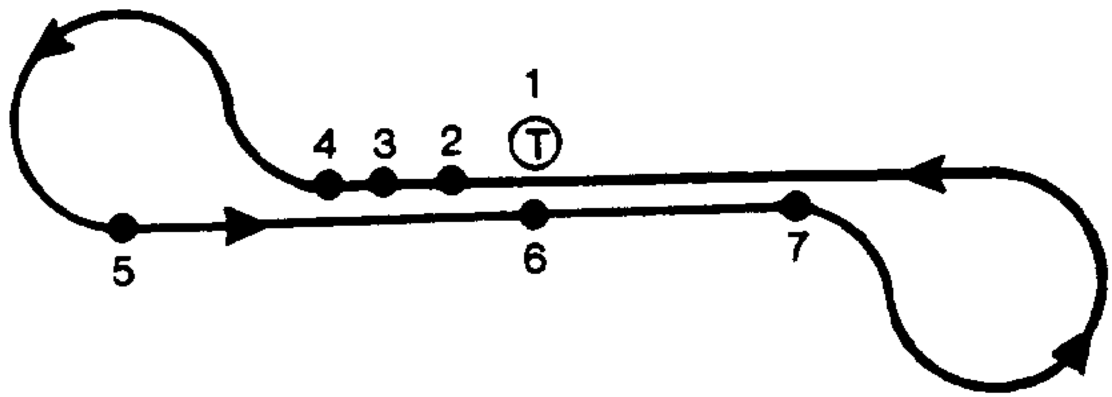
(2) A racetrack pattern is executed so that the search leg is intercepted at a point prior to where the sighting was made.

(3) As the sighting location is approached, the scanners are notified.

This method should allow the same scanner to sight the target under similar conditions, improving the chances of relocation. Aircraft altitude and speed can be changed to improve identification. The autopilot should be recoupled to the navigation system prior to each arrival at the sighting location in time to ensure the aircraft is "on track" when trying to relocate the sighting. See Figure 6-18.

d. If the other relocation methods cannot be accomplished after signal release, the pilot can use the standard pattern (see Figure 6-19) by noting and maintaining heading, altitude, airspeed, and time. Fifteen seconds after the first signal is dropped, a second is dropped. The pilot then 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 the aircraft is over the first signal, a smoke and illumination signal of approximately 45 minutes duration is dropped, hopefully close to target position. If a delay of "X" seconds was involved from the first sighting until the first signal ejection, an equal amount of time is delayed after passing back over the signal before ejecting the 45-minute signal. If the target is not resighted, the pilot continues for 30 seconds and drops another 15-minute signal. Parallel sweeps to the line of markers are then made until the target is relocated.

e. A major factor to consider in planning and conducting sensor searches is the means that will be used to identify contacts of interest. While some electronic sensors, such as FLIR and low-light-level television, may enable the operator to identify targets in real time, other sensors, such as radio and radar, cannot provide identification unless the target is equipped with a coded signal.



1. Initial sighting--Drop smoke and or illumination signal.

2. Maintain heading, altitude, and airspeed for 15 seconds.

3. Drop signal.

4. Make procedure turn to the right.

5. Make final turn to fly reciprocal track over markers.

6. When over marker No. 1, drop 45-minute smoke and 45-minute illumination signal.

7. If target is not resighted, maintain heading for 30 seconds and drop a 15-minute signal. Continue search using the line of markers for reference.

Figure 6-19. Standard Pattern for Relocating Survivors

Visual identification of sensor detections is often necessary. Careful consideration must be given to search tactics in these situations. Depending on expected target density and detection range, SRUs may achieve maximum effectiveness by:

(1) Immediately diverting from the assigned search pattern and altitude to identify each contact. This tactic is best suited to searches where few contacts are expected or sufficient time or resources are not available to use method b. or c.

(2) Marking each contact's position so it can be identified after the sensor search pattern is completed. This method is preferred when chase craft are not available and so many contacts are expected that diversions from the search pattern would be too numerous for uniform area coverage to be achieved. When this tactic is used, the SRU must have sufficiently accurate navigation equipment and fuel to mark and relocate the target position.

(3) Passing the positions of contacts to other SRUs for identification. This tactic is preferred when the expected number of radar contacts is high and additional SRUs are available as chase craft. It is especially desirable when search conditions would otherwise render the chase craft ineffective, that is, chase craft are not equipped for effective search and visual sweep width is poor. An additional advantage is that the search craft can be a high-speed SRU, such as a fixed-wing aircraft, that covers a large area rapidly, while chase craft can be surface craft and helicopters better able to rescue.

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

2. Post-Sighting Procedures. If survivors are sighted, or the distress scene located and marked, SRUs should effect rescue if possible. If they are not able to rescue, they should keep survivors in sight and inform them they have been seen, by either using a radio or, loud hailer, flying low with landing lights on, dropping two orange smoke signals a few seconds apart, firing two green star shells a few seconds apart, making two white flashes with signal lamps, or making two distinct puffs of stack smoke one minute apart. Efforts should be made to communicate. If only aircraft SRUs are involved, a radio transceiver can be airdropped to survivors for direct two-way communications. The aircraft may communicate by voice with the survivors, using a loud hailer. Survivors can reply using one of the surface-to-air signal codes; message blocks should be used as a last resort.

a. If immediate rescue is not possible, the SRU should determine the position, using several navigation aids. A survivor sighting report should be made to the OSC as soon as possible, giving position, survivor identity (individual identity and parent activity), condition of survivors, wind, weather, and sea conditions, hours of SRU fuel remaining, and emergency equipment received, used, or needed by the survivors. Passing this information in one message will avoid questions and answers, but the report should not be delayed if all the information is not readily available. SRUs should remain on scene until relieved by the OSC, or as endurance permits.

b. If the target is well marked and can be easily relocated, an aircraft on scene is not required to keep survivors in sight. It may climb to a higher altitude to make the sighting report and orbit the position to aid detection by other SRUs using radar, DF, Electronic Counter Measures (ECM), or similar equipment. The SRU should periodically relocate the target noting its position and condition. If authorized or directed by the OSC, aircraft may request the assistance of and guide passing vessels, boats, and helicopters to the distress as needed, even if the SMC has dispatched other SRUs. However, a dangerous situation may occur if several units converge on scene simultaneously. The OSC should be made aware of and coordinate the arrival of all units.

c. At night, SRUs should illuminate the scene. Vessels may have star shells, mortar flares, or searchlights. Aircraft can drop parachute flares. If the survivors at sea are visually lost at dusk, or if survivors have not been actually 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. A search pattern can then be executed between the lights.

D. SRUs must inform the OSC promptly and completely on any sighting and identification developments.

1. Survivor Signal Report. If an SRU hears or detects an emergency signal or transmission, the OSC should immediately be advised of SRU position, description and evaluation of the signal or transmission, time signal began and ended, bearing of signal from SRU, signal frequency and strength, and SRU actions.

2. Debris Sighting Report. If an SRU sights empty lifeboats, liferafts, debris, oil slicks, sea-dye marker, flares, smoke, or any unusual object, the OSC should immediately be advised of the position, description, evaluation and concentration of object(s), and wind, weather, and sea conditions.

3. Aircraft Crash Sighted Report. If an SRU sights the scene of an aircraft crash, the OSC should immediately be advised of the position, orientation of aircraft impact, scattered wreckage, or parachutes along track, and condition of the wreckage (fire/explosion, controlled or uncontrolled impact, survivability), identity and condition of survivors. If survivors are not seen, the SRU should advise the OSC of any indications of direction of departure of survivors; presence or absence of surface-to-air signals; wind, weather, and sea conditions; SRU endurance remaining; emergency equipment received, used, or needed by survivors; accessibility by rescue vessels, aircraft, pararescuemen, or ground teams; recommendations for recovery; and SRU actions.

652 Diverting Vessels

A. While merchant ships have a moral obligation to assist those in distress, they are not generally suited for extensive searching. The master makes the final decision to proceed to the distress. The responsibility international law imposes on masters to assist applies to distress situations, and not to Uncertainty and Alert phases of SAR missions. Vessel assistance should be requested by SAR authorities rather than directed. The SMC or OSC should arrange for the ship requiring assistance to communicate directly with other ships which seem best able to assist. When a merchant ship is no longer needed, the SMC or OSC should thank the vessel, in terms of "your assistance is no longer needed" rather than "you are released."

B. SRU navigators should plot the position, course, and speed of all vessels sighted during a search and the vessels listed in the AMVER SURPIC. If survivors are sighted, or the distress scene is located, the nearest vessel can then be quickly determined. The following methods may be useful in the effort to divert a vessel:

1. A radio message to the vessel giving survivor position, and requesting the vessel to divert to assist. If unsure of the frequency guarded by the vessel, contact should be first attempted on channel 16 VHF-FM, then 2182 kHz.

2. A homing signal transmitted on 522 kHz, 410 kHz, 500 kHz, or other frequency allowing the vessel to obtain a DF bearing.

3. A message block airdropped to the vessel, giving survivor position(s), and requesting assistance.

4. A pyrotechnic flare signal fired.

5. The vessel circled at least once at low altitude, then the bow crossed while rocking wings, opening and closing throttles, or changing propeller pitch, followed by flying in the direction of the distress, repeated until the vessel follows, or indicates it is unable to comply by hoisting the international flag "November" (a

blue and white checkered flag), or signals the Morse code signal "N" (- þ) by lamp.

6. Radio request from the OSC or SMC.

660 ON SCENE RELIEF AND DEPARTURE

A. SMCs obtain, brief, and dispatch relief SRUs and OSCs. As relief SRUs arrive on scene, each should be given an initial briefing by the OSC and monitored until in its assigned search area. The SRU being relieved, or finishing the assigned search, reports search results to the OSC and departs after OSC clearance.

B. Arrangements for on scene SRU reliefs must be made by the SMC with the providing agencies. If the aircraft or vessel assigned as OSC experiences a malfunction that prevents it from effectively carrying out OSC duties, one of the SRUs already on scene is usually selected as an immediate relief.

C. OSC relief involves passing information normally given to each arriving SRU and information about SRUs currently within the search area or SAR airspace reservation.

D. When several search areas are involved, departing aircraft may be authorized to climb out of the search area airspace within the lateral boundaries of the assigned search area, obtaining clearance from ATC for the return flight.

E. Vessel departures are controlled by the OSC. Normally surface vessels are cleared to depart the search area from their present position. They may be used to search en route.

670 RETURN TO BASE AND DEBRIEFING

After the SRU is released from the search, operational control returns to its parent agency. However, the crew should be debriefed by the SMC or his representative. Proper debriefing of search crews is frequently as important as the briefing. The use of written debriefing forms helps ensure that all pertinent information is obtained and recorded. A search craft debriefing form should be provided to the SRU during initial briefing.

CHAPTER 7. RESCUE PLANNING AND OPERATIONS

700 GENERAL

Efficient and effective rescue planning and operations are critical to saving lives. Planning involves evaluating survivor location and condition, selecting an appropriate rescue method and facilities, devising a rescue plan, and selecting a delivery point and means of transport. The Rescue Units (RUs) are then briefed and carry out the rescue plan. The RU commander determines the actual rescue method used, based on conditions on scene and RU capabilities. Safety of the RU and the survivors is the primary concern. The terms "Rescue Unit" and "RU" are commonly used internationally and refer to units on rescue-only missions, or to facilities designed and equipped primarily for rescue work. Such units may or may not be useful as search platforms.

710 RESCUE PLANNING

Rescue planning involves dispatching or diverting RUs for rescue of personnel and property in distress. SRUs at the distress scene should, if able, rescue without delay; if they are unable, rescue planning may be necessary to effect rescue. Rescue planning follows a logical sequence:

1. Evaluating survivability.
2. Evaluating the environment.
3. Selecting the rescue method.
4. Selecting rescue facilities.
5. Developing an optimum rescue plan.
6. Developing an attainable rescue plan.

711 Survivability Considerations

When evaluating rescue response, survival time of personnel is the foremost consideration. The SMC should consider injuries or other medical conditions that might require special rescue response, such as the need for quick recovery or specialized rescue equipment. Factors to consider include:

A. The number of survivors.

B. The condition of survivors. If not known, assume urgent medical attention will be required. If known, obtain a detailed description of injuries. This will determine the need for stretchers, oxygen, blood plasma, intravenous fluids, or other medical supplies.

C. Medical action taken by the survivors or resources at the scene.

D. Hazardous environmental conditions.

712 Environmental Considerations

Environmental considerations are many and varied. They include:

A. Nature of environment, such as desert, arctic, ocean, or swamp.

B. Location of survivors within the environment, particularly survivors trapped in hazardous areas.

C. Weather conditions and potential effect on rescue operations and survivor life expectancy.

D. Time of day, particularly how darkness may affect a rescue attempt.

E. Environmental constraints on RU use, such as boat drift, need for a four-wheel drove vehicle, or lack of a landing or hoisting area.

713 Selection of Rescue Method

Selecting the rescue method usually depends on the environment on scene and survivor number and condition. Selection of a rescue method is sometimes left to the discretion of the OSC or SRU. However, the SMC usually develops a rescue plan, and coordinates its execution if needed.

714 Selection of Rescue Facilities

A. SMCs should consult with parent agencies to determine RU capabilities and limitations to rescue and transport survivors. Time delay in reaching the scene and schedule of availability area also prime considerations. If possible, at least one RU should be selected that can both search for, and rescue, survivors.

B. The nature of the incident also influences RU selection. Considerations include:

1. Special medical services needed, such as a heart attack care unit.

2. Special equipment requirements, such as fire fighting equipment or hoist capability.

3. Number of survivors needing transport.

4. Communications capabilities.

5. Special rescue techniques or trained personnel, such as a cave rescue team, as required by the environment, or qualified rescue swimmers, as required by the condition of the survivors.

715 Special Medical Considerations

If survivors are known or suspected to be injured, the delivery of trained medical personnel to the scene is an important consideration.

A. Helicopter transport of medical personnel is preferred in both inland and maritime missions. While ground vehicles or marine craft might be used, both are relatively slow and subject to limited access routes.

B. When helicopters are not available or capable of reaching the scene, use of specialized RU such as a pararescue or mountain rescue team should be considered. When search operations are in remote areas, it may be desirable to carry such a team in an SRU. The capabilities of pararescue teams can place medically trained personnel at the distress scene with a minimum of delay. These teams, qualified for jumping into both open ocean and inland environment, may be requested through the AFRCC.

716 Optimum Rescue Plan

A rescue plan may not be necessary for many SAR missions. However, when one is needed, the SMC, in developing an optimum rescue plan, should weigh the above considerations and also the type of casualty or incident, the urgency and magnitude of the situation, the results of an aerial survey, and the available access routes to the scene and most suitable RU for each route. The route chosen should take the least en route time while providing adequate safety and navigational references for the RU. The SMC determines RU availability, selects specific RUs for various tasks, and specifies a rescue method for the circumstances, subject to RU commander approval. Possible need for aerial delivery of supplies and other supporting equipment or technical advice to SRUs should be considered. RU efforts are coordinated in rescue missions as they are in search operations.

717 Attainable Rescue Plan

Having developed an optimum rescue plan, the SMC should then coordinate with parent agencies having suitable RUs for executing the plan. If the original conditions of the plan change (e.g., if the selected RU is not available), the SMC alters the optimum rescue plan to meet changing conditions. The SMC then informs all participating agencies of the final plan. Vol. II, Chapter 5, provides a sample rescue action plan message.

720 DELIVERY PLANNING

The final step in the planning sequence involves the safe transport and delivery of all survivors and, where possible, their property. The SMC should select a safe delivery point, such as a hospital, airport, or safe mooring, and a means of transport.

721 Selection of a Safe Delivery Point

Selection of a delivery point is usually based on distance to the distress scene and suitability for receiving survivors or accepting delivery of a distressed craft. Generally, the closest safe delivery point that the transporting RU can reach is selected.

A. Selection of emergency care points for survivors is made easier by having safe delivery points preselected and plotted on the RCC response chart. Many major metropolitan areas have disaster plans. Many first aid stations, clinics, private hospitals, city/county hospitals, and emergency medical care centers are available, but they vary in capacity to handle survivors.

B. Suitability of airports for escorted aircraft involves consideration of runway length, approach and landing aids, availability of adequate crash/rescue equipment, and weather. Normally, the first suitable airport along the aircraft route or within a reasonable distance is selected as the safe delivery point. If the suitability of an airport is in question, the pilot-in-command or the unit's parent organization should be consulted. If an escorted aircraft indicates that it does not desire to land at the nearest safe airport, the aircraft may be advised that their situation is not severe enough to require and escort. Unless the aircraft diverts to the nearest safe airport, normally SAR system response ends and the escort service is withdrawn.

C. For missions involving emergency services, such as towing or escort of marine craft,normal procedure is to deliver the disabled craft to the nearest safe harbor in which emergency repairs can be made, or to an available commercial towing service. SAR system response to vessels being towed or escorted ends when they are safely delivered. Harbors should have sufficient depth to receive both the SAR vessel and the disabled craft, and should be protected from the elements so that, upon delivery, the SRU can depart without expecting a further emergency to develop. If the disabled craft declines delivery to a safe harbor, the SRU should withdraw assistance to avoid delay in resuming readiness for another mission. The disabled craft should be advised of the reason for SAR service termination.

D. If the number of survivors is large, it may be necessary to establish a temporary safe delivery point for intermediate handling of survivors. In major aircraft or marine disasters a short distance offshore, survivors might be transported to a suitable nearby landing area where a temporary emergency care center could be established. The survivors should be processed, provided with emergency care, and transported to a permanently established emergency care center. By using a temporary delivery point, a large number of survivors can be evacuated quickly from an immediate hostile environment, and secondary SAR facilities, such as local police and ambulance services, can then transfer survivors to medical care centers.

722 Selection of a Rescue Unit (RU)

Speed and ability to sustain survivor life during transport are the major considerations when selecting RUs. Whenever possible, the RU should carry medical personnel and necessary life-sustaining equipment. The OSC should recommend the need for an RU to the SMC, who will arrange for suitable aircraft, vessels, or other units to respond. Occasionally the recommended craft are not available and the OSC will need to use on scene resources or request aid from passing vessels or other craft or vehicles, without SMC direction or assistance.

A. Helicopters are ideal transport RUs because of their capability to recover survivors from inaccessible or hard-to-reach sites and deliver them at high speed directly to emergency care centers. Helicopter capabilities normally will be limited by radius of action, weather, and load-carrying capacity. Adequate planning will minimize these limitations.

1. The radius of action of some helicopters can be extended by air-to-air refueling. When this is not possible, fuel may be cached or delivered in freefall "blivit" bags or palletted fuel drums that are parachute-dropped by other aircraft along the route to and from the incident site.

2. A shuttle may be necessary if the number of survivors exceeds the capacity of the helicopter. Triage should be conducted to determine the order of evacuation. A medical evaluation should be conducted by a doctor whenever possible. An on site evaluation is ideal but communication with a physician in an aircraft in the vicinity of the survivor (SURCAP) or a medical ground facility is acceptable.

3. Fixed-wing escort of helicopters may be desirable to help with communications and navigation, or to provide a SAR safety backup

for helicopters in remote regions or far out at sea.

B. Fixed-wing Aircraft can transport survivors to the landing area. Specially configured aircraft for medical evacuation are ideal for long-range transportation of seriously injured survivors. They maybe able to land and take off from the surface at or near the incident site. Aircraft with aerial delivery systems are excellent for delivering supplies and equipment to survivors. Aircraft having bomb bays or exterior racks capable of carrying droppable containers or packages of survival stores are also usable. Other aircraft not designed for dropping operations may have to be used. The position of hatches and doors, the ease with which doors may be removed, and the ability to operate at low air speeds are factors that will affect selection.

C. Marine Craft or various types may be appropriate. High-speed boats can transport survivors form rescue vessels near shore to the delivery point. When a rescue is made by a vessel with limited treatment facilities, it is sometimes necessary to locate another with better medical facilities and transfer survivors in need of treatment. It also may be necessary to transfer survivors in need of hospitalization from the RU to another vessel inbound.

D. Ambulances, properly equipped, are usually selected for short-range land transport when helicopters are unavailable. Ambulances are satisfactory when traffic conditions are light and suitable roads are available between the distress scene and emergency care center. Land transportation is subject to traffic tie-ups.

E. Ground Rescue Teams can reach the distress scene in a remote area inaccessible to helicopter or ambulance. Local, State, and county authorities normally have jurisdiction and should provide trained ground parties. Properly trained ground parties area preferred to evacuate injured survivors.

730 PLANNING FOR RESCUES IN DIFFICULT ENVIRONMENTS

Certain geographical areas with unique terrain, weather, or accessibility conditions pose special considerations.

A. Arctic environments present a difficult rescue situation. Harsh weather, sparse population, and a lack of natural food and shelter make extended survival doubtful. Extreme cold, snow, ice, and lack of bases for rescue operations further complicate survivor recovery. Unless otherwise known, it should be assumed that personnel stranded in arctic areas lack the physical ability, equipment, and necessary skills for survival. Rescue planning should begin early during the search. Once the distress site is found, the means of rescue should be determined. Aerial evacuation is normally preferable. Where rescue is by land party, logistical support will usually be by aerial delivery. Continuous air coverage should be maintained for any land RU dispatched until recovery is effected.

1. Sustaining life. Immediately upon location of the distress site, the SRU should deliver provisions for continued survival even if it appears no survivors are present. Survivors may have built snow caves or other shelters and may not be visible from the air. Arctic SAR aircraft should carry air-droppable arctic survival kits or substitutes.

   a. Arctic survival professional may assist. Pararescue teams should be considered as a primary means of polar rescue. Appropriate agencies should be alerted and briefed as to the possible need for pararescue teams.

   b. Continuous, regular support of survivors and the safety of rescue teams are paramount. Harsh conditions in arctic areas can cause death in minutes without proper equipment and in hours even with good survival equipment.

2. Arctic Rescue Methods. The most effective methods depend on the location, weather, and physiological condition of the survivors. A base camp may be established and aerial recovery from it should normally be used.

   a. Aircrew qualifications should be considered in arctic rescue by helicopters, including training in emergency medical care and arctic survival. Icebreakers as helicopter advance bases may be desired.

   b. When using fixed-wing aircraft, an evaluation of surface conditions, ice thickness, and terrain features is essential.

   c. If land SRUs are used, survivors should not leave the incident site unless accompanied by a rescue party member. Surface transportation should be provided for the land party. The first choice is usually snowmobiles, followed by dog teams and sleds, and lastly, snowshoes and skis.

B. Swamp rescue is usually performed by helicopter, but air boats and hovercraft may be used in tidal grass swamps. All types of swamps have been penetrated by land SRUs, but the time required and difficulties encountered indicate that all other possible methods of reaching the distress scene and evacuating survivors should be considered first. When RUs must be dispatched into swamp areas, the following should be considered.

1. While the bottom in a cypress swamp is relatively firm, it is pocketed with many holes not visible from the surface.

2. Ground party visibility is limited in tropical cypress, palmetto, and mangrove swamps. Covering aircraft may have to be used to vector the RU to the distress scene.

3. Mangrove trees and root systems present considerable barriers to walk-in penetration.

4. The many tidal runs in tidal swamps, averaging 3 feet in depth, will impede progress. Both inland and tidal grass swamps have areas of silt-laden mud which may be quite deep.

740 RESCUE OPERATIONS

A. Rescue operations consist of rescue briefing, dispatch of units and en route travel, on scene procedures, survivor transport and debriefing, return to base, and debriefing of SAR personnel.

B. Rescue operations do not end until all located distressed persons or craft are rescued or accounted for. Since search operations continue until all survivors or distressed craft are located or the search is suspended, there may be an overlap when more than one person or craft is involved.

C. During rescue operations, safety considerations are critical. No RU should be directed to execute a maneuver hazardous to the craft or crew unless a thorough evaluation indicates that the risk is acceptable. While the OSC and SMC should have the experience, training, and knowledge of the capabilities of the RU to make the evaluation, the RU commander has ultimate authority and responsibility for determining whether and operation can be executed safely.

741 Rescue Briefing

The crew of the dispatched RU should be thoroughly briefed on the plan developed by the SMC. If no rescue action plan has been developed, the RU commander develops and executes a rescue plan. The briefing may include the situation, weather, access routes, rescue unit assignments, recommended rescue method and technique, on scene communications, coordinating instructions, evacuation plan, safe delivery point, expected relief times, expected support from other SAR facilities, and other factors affecting rescue.

742 RU Dispatch and Transit

When SRUs are unable to complete a rescue, RUs should be alerted and dispatched. The time an RU will need to depart and arrive on scene should be considered by the SMC. Delays in rescuing survivors in a hostile environment should be avoided.

743 SAR Helicopter Escort

Fixed-wing aircraft may escort SAR helicopters with limited navigation capabilities to offshore locations. SAR helicopters are also normally escorted over hazardous or remote areas. The fixed-wing escort may provide navigation, communications relay, and rescue assistance.

A. Prior to escort the escorted pilot will be briefed on the escort flight pattern. The escort crew should know the number of personnel on the escorted aircraft and advise what method of rescue would be used if an emergency arises.

B. Visual and communications contact should be maintained. MF, VHF, or UHF homing procedures may be used to aid navigation. If weather conditions prevent visual contact, the escorted aircraft should be advised. Based on fuel remaining, terrain, terminal facilities, terminal weather, and mission urgency, a decision will be made on whether the helicopter should land and wait for favorable weather, return to base, or continue. The escort should continue to monitor and assist the aircraft being escorted, using any effective electronics or communications equipment.

C. Depending on the difference of speed between the escort aircraft and the helicopter, one of the following patterns may be used:

1. Procedure Turn Escort Pattern. The escort 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 will make a procedure turn and return to the helicopters position. Altitude of the escort will normally be 300 to 500 feet higher than the escorted helicopter. This type of escort gives the maximum navigation assistance.

2. Dogleg Escort Pattern. The escort normally flies 300 to 500 feet above and with legs 45 degrees alternately to the left and right side of the escorted aircraft flight path. Length of the legs is adjusted to ensure the escort passes approximately one-half mile behind the escorted aircraft. See Figure 7-1.

3. Racetrack Escort Pattern. The escort normally flies 300 to 500 feet above and in a racetrack pattern that progresses along the flight path of the escorted aircraft. Size of the pattern flown by the escort may be adjusted to provide maximum coverage. See Figure 7-2.

4. Formation. If the two aircraft are capable of maintaining the same speed, the escort may wish to maintain a constant position relative to the helicopter.

5. Precautions with Helicopters.

   a. A minimum vertical separation of at least 200 feet must 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 lose control.

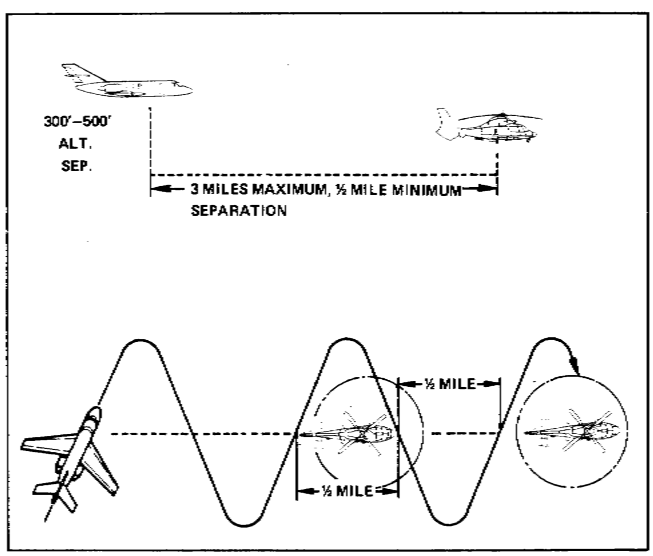


Figure 7-1. Helicopter Dogleg Escort Pattern

Figure 7-1. Helicopter Dogleg Escort Pattern

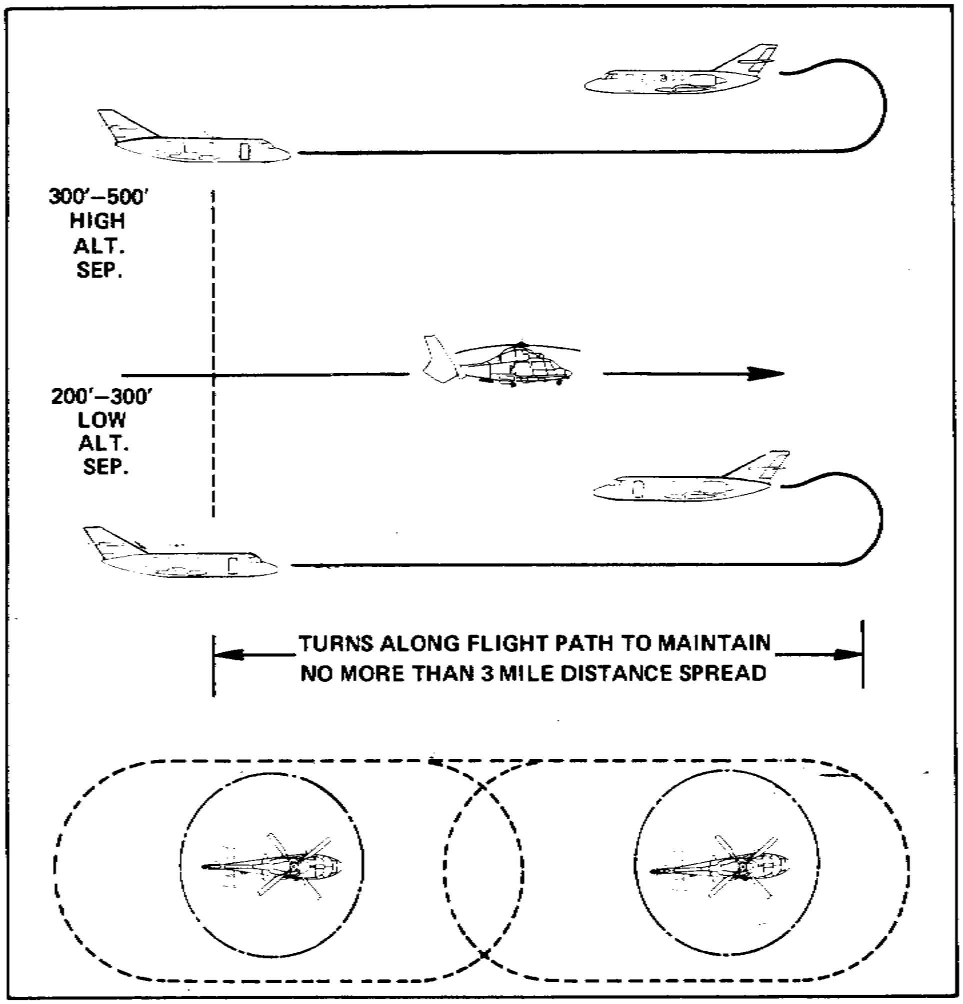


Figure 7-2. Helicopter Racetrack Escort Pattern

Figure 7-2. Helicopter Racetrack Escort Pattern

b. Although helicopters operate at night and in near-zero visibility, they require more time to maneuver under these conditions. Radio discipline is essential for uninterrupted crew communication during the approach, and to permit DF equipment to give a steady bearing when homing. Aircraft should avoid transmitting to helicopters executing a hoist.

c. In dropping flares, aircraft should exercise extreme caution when helicopters are in the search area. A descending parachute flare (lighted or unlighted) is hazardous to helicopter rotors, degrades effectiveness of night visual detection aids (pyrotechnics, strobe lights, and flashlights), and may induce vertigo to helicopter pilots during low visibility conditions. Flares should be dropped only when requested by the helicopter.

750 ON SCENE RESCUE AND DELIVERY PROCEDURES

A. Inland rescue information is contained in Chapter 8.

B. When two or more SRUs capable of conducting the rescue operation arrive on scene and the SMC or OSC has not assigned one SRU to conduct the rescue, generally the first to arrive will make the first rescue attempt. The SMC coordinates the dispatch of relief RUs and other personnel or equipment required by the OSC.

C. Basic procedures for all rescues may include accounting for all people, conducting initial survivor debriefing, taking remedial action including emergency medical care or delivery of equipment or supplies, transporting or escorting survivors, and conducting extended survivor debriefing.

751 Aerial Delivery

A. Aerial delivery of supplies to survivors may be necessary. The SMC should consider factors such the relative locations of the distress site and RUs, delay expected before rescue, and dangers of exposure. Aerial delivery procedures should follow agency directives.

B. If a search is prolonged, supplies are usually dropped to survivors to help sustain and protect them while they await rescue. Supplies may also be dropped to augment those carried by approaching RUs. Mobility of personnel on land generally enables them to recover equipment dropped some distance away, but air-drops to survivors at sea require a high degree or accuracy.

C. Droppable survival equipment should be marked to assist survivors. Colored streamers may be attached to the equipment, using the international color code. Where supplies of a mixed nature are dropped in one container, color codes should be combined. The code follows:

1. Red - medical supplies and first aid equipment.

2. Blue - food and water.

3. Yellow - blankets and clothing.

4. Black - miscellaneous equipment.

Instructions, printed in English and preferably in al least two other languages, on the use of the survival equipment should be enclosed in each package.

D. Survivor supplies and equipment may include:

1. Medical supplies - first-aid kit, insect repellent, aspirin, sunburn lotion, and sunglasses.

2. Rations packs - concentrated or canned food, water (should normally take precedence over food), coffee, sugar, and salt.

3. Signaling equipment - portable radio, pyrotechnics, Very pistol and cartridges, whistle, signaling mirror, and signal code card.

4. Coverings - tent, sleeping bag, blanket, water proof clothing, socks, gloves, poncho, and protective footwear.

5. Fire and lighting materials - waterproof matches, emergency stove, candles, and flashlights with spare batteries and bulbs.

6. Other items - can opener, cooking and eating utensils, axe, rope, writing pad, pencil, soap, paper towels, and a survival booklet.

E. Supply dropping should be coordinated with ATC. Notify ATC of the details of the flight as far in advance as possible to avoid delays in air traffic clearances. For delivery to remote sites, the margin between endurance and the time required for the mission may not be great.

752 Rescue by Aircraft

A. Rescue by helicopter. Helicopter rescue may be accomplished by landing or by hoisting. Landings are made when a suitable site is available; they are usually necessary at high altitudes because hovering capabilities are limited there. Hovering and hoisting not only require more power, but also present a greater risk to the aircraft and survivor. Helicopter operations close to collapsed parachutes can cause inflation by rotor downwash and result in survivor injury or parachute entanglement in the helicopter rotor.

1. An electrical shock hazard exists to individuals being rescued if they contact an ungrounded helicopter hoist. The hoist should be first grounded by contact with a vessel, ground, or water.

2. Caution must be exercised when hoisting from vessels with flammable/explosive cargo, or in the vicinity of a flammable spillage. The hoist rig must be grounded clear of the spillage or tank

venting area, to preclude a possible fire or explosion from an electrostatic discharge.

3. The hoist line must never be "tied off' to a vessel or any fixed object.

B. Rescue by fixed-wing aircraft. The primary role of fixed-wing aircraft in rescue operations is providing assistance to survivors and other SRUs.

1. Some of the functions provided include orbiting the survivors, dropping survival equipment, confirming position, serving as a radio and radar beacon, showing lights, dropping flares or using other visual signals, and providing DF steers. They also improve the morale of survivors, provide immediate emergency needs, fix the distress location, and save time in getting RUs on scene.

2. A landing in unknown terrain, even with an aircraft designed for operating on unprepared landing areas, is hazardous. The urgency of the situation should be carefully considered. If the survivors are at or near a place that is suitable for aircraft to land, and aerial evacuation would offer sufficient advantages, it may be prudent to have a qualified person parachuted in, or flown in by a light aircraft, to evaluate the location.

C. Water rescue by amphibious aircraft and seaplanes. Since amphibians and seaplanes are able to operate from lakes, rivers, sheltered waters, and bays, it is sometimes possible to land close to survivors in such areas. However, it may not be possible to detect obstructions such as sand banks, submerged logs, or snags from the air. A landing in uncharted or unknown water is risky. In cases of great urgency and under favorable weather and water or sea conditions, if no other means of rescue is reasonably available, such RUs may be used.

1. Because the SMC may have information about prevailing conditions from surface units near the distress scene, or about other means of rescue not known to the pilot, the SMC should be contacted before landing. The final decision for landing is the pilot's and should be based on the number and condition of survivors, the ETA of more suitable units, and the risk.

2. Open water landings should be considered only with amphibians or seaplanes that are designed for rough water work and which have good maneuvering and taxiing capabilities. Any open sea landing or takeoff is hazardous, even in favorable circumstances. While a seaplane may be able to operate safely under one set of conditions, it may be almost helpless under another which would be no rougher to a surface vessel. Landings should not be made in open waters if rescue can be assured by dropping airborne supplies and survival equipment,

diverting or dispatching surface vessels, or using a helicopter, hovercraft, or other marine craft.

753 Rescue by Ship

A. Rescue methods used by ships vary according to displacement and whether the rescue is made in mid-ocean or close to land. Weather, tides, currents, sea conditions, shoals, reefs, or darkness may also be important factors.

B. Although it may be obvious that a marine craft should be used for rescue operations, developing an alternative method of recovery is often advisable. For example, helicopters may be used for evacuating survivors picked up by marine craft to speed their delivery to emergency care. Rendezvous between a marine RU and a helicopter can be made at great distances offshore.

C. Removal of survivors from the water, life rafts, lifeboats, or other vessels to the RU may be the most difficult phase of a maritime SAR mission. The condition of the survivors may be such that they are unable to help themselves; usually they will have to be assisted or actually hoisted aboard. For this reason all SAR vessels or boats should be prepared to lift survivors from the water without expecting survivor help.

D. Rescue methods used by SAR vessels include:

1. Rescue of survivors directly from their vessel, using ship-to-ship methods of direct, raft haul, raft drift, small boat, or haulaway line.

2. Rescue of survivors in the water, using ship-alongside methods of swimmer, line thrower, or lifeboat, or ship circle/trail line.

754 Rescue by Boat

A. When survivors are located on lakes, sheltered waters, rivers, or coastal areas, rescue will often be make by fast, limited-range boats based close to the distress, or by private boats in the vicinity.

B. Since boats may be too small to take all survivors on board at one time, a sufficient number of boats should be dispatched to the scene. When this is not possible, each boat should deploy rafts so that those survivors who cannot be taken aboard immediately can either be towed ashore or kept afloat while waiting. Survivors left behind should be made as safe as conditions permit.

C. Assistance to a crashed or ditched aircraft will generally consist of transferring personnel from plane to boat and picking up survivors from the water or life rafts. It may also include towing the aircraft.

755 Coordinated Helicopter/Boat Rescues

A. Occasionally both a helicopter and a boat will be dispatched. When the helicopter arrives first and begins its rescue attempt, the boat should take position upwind of the helicopter in the 2 o'clock position at a safe distance and stand by as a backup. The boat must be careful not to cross over the helicopter hoisting cable, nor to cross between the survivor and helicopter, and must stay within pilot vision.

B. If the helicopter aborts the attempt, the pilot should depart the immediate area of the survivor and signal for the boat to attempt rescue. Helicopters may turn out the anticollision rotating beacon to indicate they require boat assistance or are unable to complete the rescue. Specific signals should be prearranged.

C. If the boat arrives first and makes the rescue, transfer of survivors to the helicopter for more rapid delivery to medical facilities may be advisable.

756 Underwater Rescue

Underwater rescue usually occurs in the United States Maritime Area where the Coast Guard has coordination responsibility. Common casualties include entrapment in capsized, damaged, or sunken vessels and submersibles, and swimming and diving mishaps. Often, the Coast Guard or local resources can respond effectively. However, in more complex or major cases, the resources and expertise of the Navy are used. In such cases the Navy normally assumes SMC and the Coast Guard provides support. The organization and the procedure for submarine rescue are described in the Navy Addendum to this manual (NWP 19 add). For rescue of civilian submersibles, the SAR coordinator may use Navy submarine rescue capability by asking the Chief of Naval Operations to declare SUBMISS/SUBSUNK, putting the Navy submarine rescue forces into operation. Specific procedures are contained in Coast Guard COMDTINST 16116.1 series and Navy OPNAVINST 3130.4 series.

757 Special Considerations

A. Civil aircraft break-in points. Areas of the fuselage of civil aircraft that are suitable for emergency break-in by rescue crews are usually marked. The markings are red or yellow, and may be outlined in white to contrast with the back ground. If the corner markings are more than 6 feet (2 meters) apart, intermediate lines will be inserted so that adjacent marks are not more than 6 feet apart.

B. Ejection seat mechanisms. Many military aircraft are fitted with ejection seats. If a pilot ditches or crash lands rather than bailing out, and has to be removed from the aircraft while still in the ejection seat, extreme care should be taken to avoid triggering the seat mechanism. The activating handles are indicated by red or black/yellow coloring.

C. Chemical and radiation hazards. Rescue personnel must exercise caution when approaching or boarding an unfamiliar vessel, or when approaching a vehicle or aircraft crash site. In addition to obvious dangers of fire and explosion, there may be danger of exposure to chemicals or radiation. For example, many fishing vessels use liquid ammonia to refrigerate their catch. If a fishing vessel crew is sick or unconscious, there may be an ammonia leak in the refrigeration system. The Chemical Hazard Response Information System (CHRIS) Manual provides information on chemical hazards, symptoms following exposure, and treatment of exposure victims. It also shows hazardous material labels that should, but may not, accompany chemicals.

760 RU RELIEF AND RETURN TO BASE

RU relief on scene follows the same general procedures as the relief of SRUs on scene. When possible, a complete briefing should be given to the relieving RU. The time required for an RU to return to base should be considered for units which have a limited on scene endurance. The SMC should coordinated on scene reliefs to ensure that the relieving RU arrives before the time when the RU on scene must depart.

770 SURVIVOR EMERGENCY CARE AND DEBRIEFING

The emergency care and debriefing of survivors are covered in Chapter 9.

CHAPTER 8. INLAND SAR OPERATIONS

800 GENERAL

A. SAR operations unique to the inland environment are discussed in this Chapter, while aspects common to inland and maritime regions are discussed throughout this Manual. Inland SAR incidents usually involve missing light aircraft or lost persons.

B. For light aircraft crashes:

1. About three-fourths of all crashes occur within 5 miles of a proposed course.

2. Inclement weather is a factor in over 70 percent of crashes.

3. Mountainous terrain is a factor in about 40 percent of crashes.

4. If weather deteriorates, most pilots continue on track and descend to maintain visual conditions.

C. SAR procedures for lost persons are normally based on available data about individuals, environment and case histories.

810 AIRCRAFT SEARCHES

Aircraft searches overland differ from maritime searching in that diverse and often changing terrain usually makes location of search objects more difficult. Repeated searches of an area are almost always necessary to attain an acceptable Cumulative Probability of Detection. Natural and man-made obstacles and turbulence in mountainous areas may make flying more dangerous.

811 Grid Searches

To promote uniformity, and to maximize effectiveness of SRUs, the Civil Air Patrol (CAP) has established a complete nationwide system of sequentially numbered square search grids. These grids are 15 minutes of latitude by 15 minutes of longitude. Complete information may be found in VOL. II, Appendix D.

812 Inland Probability of Detection Tables

A. The following inland POD tables used by the CAP and Air Force assume a crash location is more difficult to see in heavy terrain, and the search object is relatively small, such as a light aircraft.

B. Single Search POD. PODs in Table 8-1 should be adjusted for each search object and for conditions encountered in individual search areas.

C. Cumulative POD. POD will increase if the same area is searched more than once. Table 8-2 allows for calculation of cumulative POD. The table is entered with cumulative POD to date and POD of the latest search. The intersection of the two PODs gives the new cumulative POD.

D. Considerations when estimating POD include:

1. Ability to maintain optimum altitude and airspeed.

2. Visibility and weather conditions.

3. Nature of terrain.

4. Accuracy of navigation.

5. Size and characteristics of search object.

6. Search crew fatigue.

TABLE 8-1. Inland Probability of Detection: Single Search

TABLE 8-2. Inland Probability of Detection: Cumulative

813 Weather Conditions

Weather conditions must be evaluated before SRU dispatch. Clouds, especially thunderstorms, create turbulence and reduced visibility. Inadvertent entry into clouds should be avoided. Air currents are unpredictable and may cause cloud formations to shift rapidly. Since it is hard to judge distance from cloud formations and cloud movement, low-hanging clouds and scud should be avoided.

814 Aerial Sightings

In timbered mountainous areas, search objects will often be obscured by terrain, covered by snow, or otherwise extremely difficult to locate. The only visible clue to a crash site may be broken tree tops or a reflection from a broken fuselage or windshield. Anything that appears out of the ordinary may be a clue. Personnel may be impossible to see unless they signal or move into an open area. In these cases, the SRU may prove effective as a loud hailer platform.

820 AIR/GROUND SEARCHES

Prerequisites for a safe and effective mountain search are thorough preparation and constant aircrew vigilance. Full attention of one pilot should be dedicated to flying. Only highly experienced pilots should be permitted to fly mountain searches. Certain precautions and procedures should be observed in planning and executing a SAR mission.

A. Extreme caution should be used when searching canyons and valleys. Pilots should maintain adequate terrain clearance and "exit" plans ahead of the SRU. They should know which way to turn at all times in case of an emergency, and should be aware of power lines and other hazards to low-level flight. Searches should be flown close to one side of a canyon or valley so the entire width may be used if a 180 degree turn becomes necessary. Aircraft should not enter any valley too narrow to permit a 180 degree turn.

B. Areas of possible severe turbulence should be identified. Pilots should determine turbulence and downdrafts before descending to search altitude or flying close to a mountainside. Wind direction and air currents in mountainous areas may vary greatly. If turbulence is encountered, the pilot should take immediate steps to keep from exceeding SRU structural limits.

1. While turbulence is often associated with thunderstorms, up and down drafts may be encountered in clear air. In mountainous terrain, any surface wind will be diverted by natural obstructions and possibly create hazardous flying conditions.

    a. Orographic turbulence is proportional to wind velocity and dangerous if severe. Updrafts occur on the upwind side of slopes and ridges, and downdrafts on the downwind side. The amount of downdraft depends on the strength of the wind and steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, wind will tend to blow off the slope and not follow it down. In this situation there will probably be severe turbulence several hundred yards downwind of the ridge just below the top. Under certain atmospheric conditions, a cloud may be observed at this point. On more gentle slopes turbulence will follow the slope, but will be more severe near the top.

b. Orographic turbulence will be affected by other factors. The intensity will be less climbing a smooth surface than climbing a rough surface. It will not follow sharp contours as readily as gentle contours.

c. Convective turbulence, caused by rising air currents created by surface heating, is most prevalent over bare areas. It is normally found below 2,000 feet above the terrain, but may reach as high as 8,000 feet. When practical, flight paths should be over vegetated areas. Morning searches will often avoid the convective turbulence.

2. When crossing mountain peaks and ridges at low altitude under windy or turbulent conditions, the safest crossing is downwind, where downdrafts will be met after the terrain is crossed. If this is not practical, altitude should be increased before crossing. The safest ridgeline crossing may be at an angle, so a shallow descending turn away from the terrain can be made if unexpected weather or turbulence are encountered.

3. When wind blows across a narrow canyon or gorge, as shown in Figure 8-1, it will often veer down into the canyon. Turbulence will be near the middle and the downwind side of the canyon or gorge.

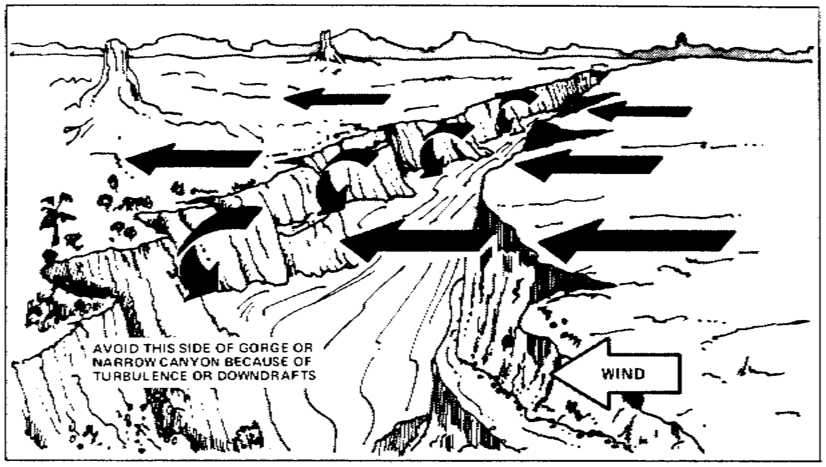


Figure 8–1. Wind Flow Over Gorge or Canyon

Figure 8-1. Wind Flow Over Gorge or Canyon

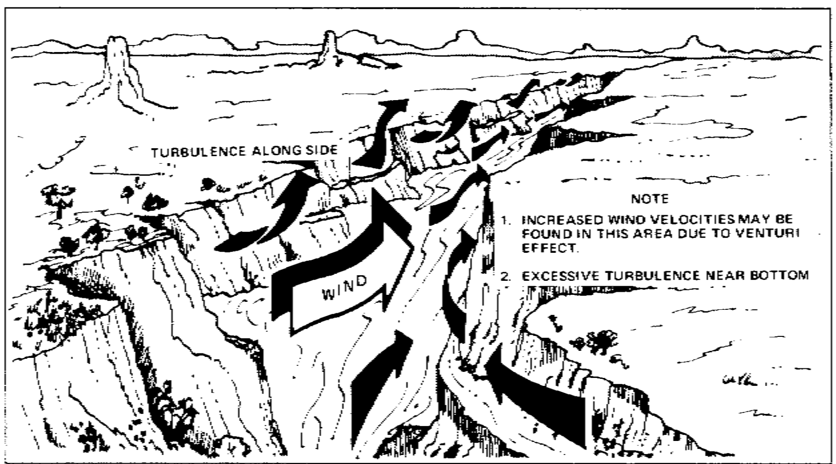


Figure 8–2. Wind Flow in Valley or Canyon

Figure 8-2. Wind Flow in Valley or Canyon

4. When wind blows parallel to the valley or canyon axis, typical turbulence patterns are as shown in Figure 8-2.

C. When an aircraft is operated at or near its "service ceiling" and encounters a downdraft, the aircraft may be forced to descend. Although the downdraft may not continue to the ground, the rate of descent may be such that the aircraft will continue descending and crash even though it is no longer affected by the downdraft. Therefore, the procedure to transit a mountain pass is to fly close to that side of the pass or canyon which affords an upslope wind. This provides additional lift for an exit in case of emergency. Maximum turning space is available, and a turn into the wind will be a turn to lower terrain. Flying through the middle of a pass to avoid mountains is dangerous, as this is frequently the area of greatest turbulence, and, in case of emergency, provides insufficient turning space.

D. Do not rely solely on terrain elevations or contour lines printed on aeronautical charts. Errors in position, altimeter setting, or chart information may result in less terrain clearance than anticipated.

E. For safety, mountainous search areas should be assigned to multi-engine aircraft when possible.

F. ELT signals can "bounce" and be blocked in mountainous areas. Homing may be difficult. Occasionally, location of an ELT will require coordination of SARSAT alert data with both high- and low-flying aircraft.

821 Mountain Helicopter Considerations

A. High altitude causes several undesirable effects on helicopters. Available power and hovering ability is reduced. Helicopters are also susceptible to blade stall, aggravated by high forward speed, high gross weight, high altitude, low r.p.m., induced "G" loading, and turbulence. Since power-to-weight ratio may be critical, shallow turns and slow air speeds will be required. Thermal heating in mountainous terrain may cause "heat bubbles" localized higher temperatures. Higher than expected temperatures should be anticipated, and power or SRU selection made for that air density.

B. Extreme caution should be used when operating or hovering near objects or foliage. Turbulence may reduce clearances suddenly and the rotor tips may be below the landing gear or skids at angles of bank over 45 degrees.

822 Contour Search Patterns

Contour search patterns are often used in mountainous and hilly areas.

A. Contour Single-Unit (OS). For safety, only one SRU is assigned in any one area for contour searches. As shown in Figure 8-3, the SRU searches from top to bottom, starting above the highest peak and flies around the mountain "tucked in" closely to the mountain side. As one contour circuit is completed, the altitude is normally decreased 500 feet (descending 360 degree turn opposite to direction of search pattern) and a new contour circuit begun. Contour searches can be extremely dangerous and ineffective, unless:

1. The crew is experienced, well briefed, and possesses accurate large-scale contour maps.

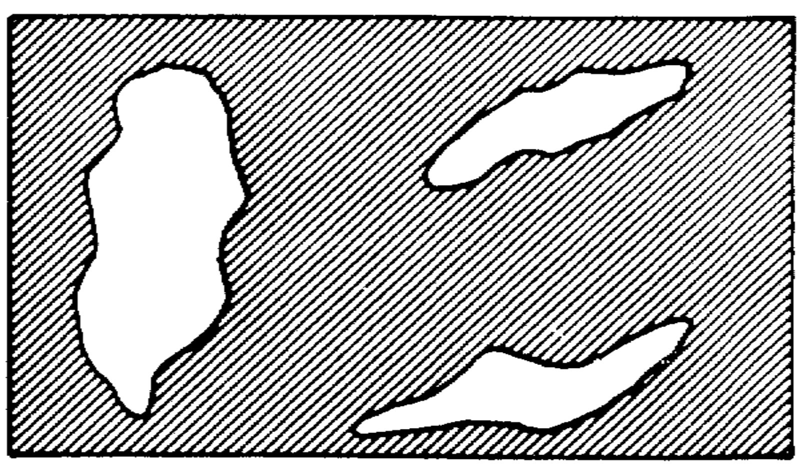
2. Weather conditions are good, with both good visibility and lack of turbulence. Flight should be avoided in mountainous areas when winds exceed 30 knots, because downdrafts can exceed 2000 ft/min.

3. The SRU is highly maneuverable and has a high climbing rate and small turning radius.

4. An accurate record is kept of the area searched. There may be some mountain peaks and valleys shrouded in clouds which need to be searched again when conditions permit. The aircrew should plot actual search coverage as tracks are flown. One method is to shade areas searched and outline areas unsearched on a large-scale topographical map with overlays. This should be provided to search planners at the first opportunity.

B. Contour Multiunit (OM). Multiunit searches are conducted only by land teams because of difficulty in maintaining aircraft separation in multiunit searches.

a. Contour Pattern



b. Contour Search Record

Figure 8-3. Contour Search Patterns

Figure 8-3. Contour Search Patterns

823 Air/Ground Coordination

An SMC, IC or OSC should not hesitate using air and ground SRUs on the same search. For air searches, ground units may be needed to check possible targets, secure distress beacons and rescue persons in distress. Air SRUs may be able to provide airlift to ground units, locate the objective sooner, signal survivors or indicate to them that they have been located, and lead ground units to the scene. The aircrew may be able to ascertain whether a distress situation exists, allowing ground response to be modified as appropriate. Airborne communications support is also possible.

A. When either element is supporting the other, effective communications are needed. Common radio frequencies should be established when possible; standard air-to-ground and ground-to-air signals are not adequate.

1. Since aircraft have at least one radio, it is easiest for the aircrew and ground units to use an aeronautical frequency.

2. Since portable aircraft radios are normally not available to ground SRUs, communications can be provided by equipping an aircraft with a radio operating on ground frequencies. This is particularly useful when working with military aircraft which normally have only UHF communications. Generally, ground frequencies provide more complete communications since there are usually more ground units than aircraft involved.

3. A portable radio used by one of the aircrew can suffice. If a particular aircraft is used for air support often, an external antenna should be mounted on the aircraft with a connection inside for the portable radio. The best method is to permanently mount in the aircraft a multichannel radio covering normal ground SRU frequencies.

4. Regardless of the radio system used, all units should have knowledge of, and access to, the list of standard air-to-ground and ground-to-air signals.

B. Air and ground SRUs should use the same maps.

1. Aircraft sectionals and military Joint Operations Graphics (JOG, scale: 1:250,000) are not detailed enough for ground search, but are necessary for land SRUs working with air SRUs. U.S. Geological Survey and Defense Mapping Agency topographic maps are difficult for aircrews to use but are needed when low level and contour searches are flown.

2. Medium scale maps, such as U.S. Forest Service, Bureau of Land Management, USGS intermediate scale (1:100,000), and local road maps are most versatile for air/ground coordination.

3. If each SRU has similar maps and charts, search efficiency and coordination will be maximized.

C. When air and ground SRUs are used on the same mission, consideration must be given to time differences required for each to be dispatched and reach the scene.

1. If aircraft are the primary search resource, ground units should be put on standby at the same time, or preferably be dispatched to advance positions. Sudden weather changes may force suspension of the air search, and if ground units have not been alerted, considerable time can be lost in organizing them. Should the aircrew make a sighting and ground SRUs are not immediately available, valuable time is lost in organizing and transporting units to the area.

2. If ground SRUs are the primary resource, but air SRUs may be needed, the air units should be alerted at the beginning of the search. Besides time needed to locate proper aircraft, time is needed by aircrews to get to the aircraft, preflight them, and launch. This is true of both military and civilian air resources.

D. Personnel. SAR personnel should be selected for physical stamina, knowledge of the outdoors, and search experience. The size and number of search parties will be governed by available personnel and type of terrain to be searched. Volunteers may be enthusiastic but underqualified, and should be used accordingly.

1. Use of team leaders is recommended for typical land search operations. Leaders should be selected on the basis of experience and knowledge of SAR operations. As a minimum, they should be equipped with radios, portable loud hailers, whistles, and maps of the search area.

2. A team leader is responsible for:

   a. Individual equipment.

   b. Team equipment.

   c. Team transportation.

   d. Briefing, debriefing, and accounting for all team members.

   e. Obtaining search data and outlining search areas on maps.

   f. Execution of the search action plan.

   g. Recording search coverage.

   h. Providing life support and evacuation of located survivors.

   i. Obtaining primary and alternate communication frequencies and schedules, and establishing communications with the SMC, IC or OSC.

824 Search Execution

A. Land Search Area and Patterns. Review 830-832 for additional search methods. Parallel-track, contour, and trackline patterns may be used for land searching. Each search area should be well marked and reasonably small, so the team can move in and effectively cover the entire area within imposed time limits. Generally, the maximum area size will be a 1-mile by 1/2-mile block. Close track spacing and thorough area coverage are essential when searching for typical small targets. If the area is densely wooded, helicopter SRUs may be used to assist in maintaining the search pattern.

1. The total search area may be subdivided into SRU search areas according to terrain. Moderately level terrain may be divided into squares or rectangles for parallel track searches. Contour patterns are used to search along and around peaks, razorbacks, steep slopes, or other mountain features, or irregular shore lines. Trackline patterns are used to check trails, paths, streams, or other routes a lost person may naturally follow.

2. A baseline may be blazed through the area to designate each search area border. Trail blazing with small flags, aerosol paint, or string is preferred over methods that damage trees. Natural borders or prominent landmarks may be used to correct any progressive errors that may develop during the search.

3. Lost persons often fight topography and are likely to be found in the most rugged portion of the surrounding country. Persons who follow natural routes are seldom lost for long periods. Children under 5 years old frequently travel uphill.

B. Search Patterns

1. Parallel patterns are generally the most effective for land search. Execution requires a team leader, normally two flankers, and as many linemen as the terrain will allow. The searchline is first formed along the search area boundary, with individual linemen positioned one track spacing apart. The team leader maintains overall team control in the same manner an OSC maintains control of a multiunit search. Boundary control of each successive sweep through an area is normally assigned to the pivoting flanker.

   a. After the searchline is formed, it moves forward on a signal from the team leader. Linemen remain evenly spaced as the team progresses. If part of a team encounters an obstacle, they should investigate it while the rest of the team continues just past the obstacle and stops to wait. When the checkers have rejoined the searchline, the entire searchline again moves forward on signal of the team leader.

   b. When the searchline completes its first search leg, it does not use the flanking movement of a multiaircraft or multivessel searchline to reposition itself for the second searchleg. Instead, the land SRU will use a pivoting movement about the flanker. As each sweep is made, the inboard flanker is blazing the line of search, possibly with a string. At the end of the searchleg the searchline pivots about that flanker, and then is guided by the same flanker on the return searchleg, retracing the blaze line. Meanwhile, the other flanker is blazing a search track during the second searchleg, and will be the pivot flanker for the maneuver between the second and third sweeps (see Figure 8-4).

2. Contour patterns are normally used for mountainous or steep terrain. Their execution requires a team leader, normally two flankers, and up to 25 linemen. The searchline is initially

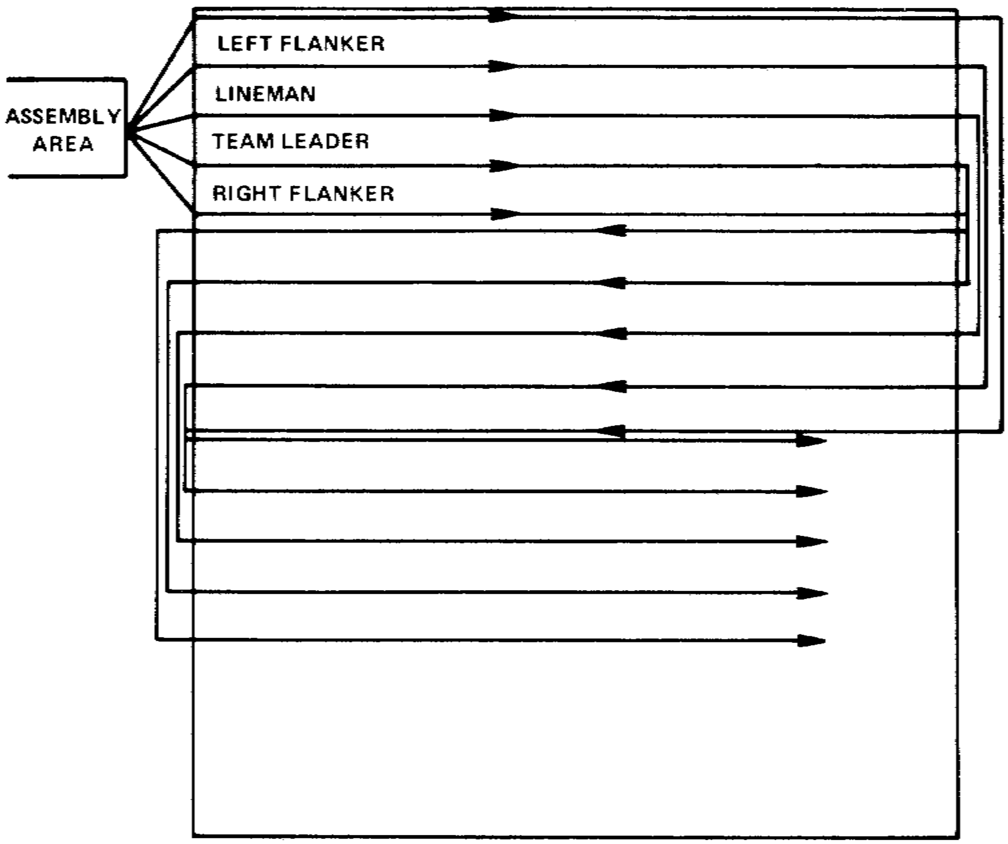


Figure 8-4. PM Search Pattern for Land SRU

Figure 8-4. PM Search Pattern for Land SRU

formed on a line perpendicular to the ridgeline or on a radial from the mountain top. The team leader maintains overall team control, with sweep boundary control assigned to the upper flanker.

a. The searchline of the contour pattern starts at the highest level to be searched. It maintains a constant altitude during each sweep, and progresses down the slope on successive sweeps. When the searchline completes each sweep, it reforms on the low side of the bottom flanker. The lineup order is reversed as in the parallel pattern pivoting maneuver between search sweeps. The line then continues the search moving in the same direction around the mountain as was followed on previous search sweeps. Searchline checking, starting, and stopping are all controlled by the team leader, as when executing a parallel pattern.

b. Contour patterns are also useful for terrain that prevents using straight searchlegs efficiently, such as long irregular shorelines or other irregular terrain. This procedure may require special SRUs to cover areas missed by the weaving searchline.

3. Trackline patterns are executed by one or more searches along a trail or track suspected of having been followed by a lost person. When three or more persons are assigned for a trackline search, a team leader and two flankers should be designated by the SMC, IC or OSC. Normally a "V" searchline is used, with the team leader following the center of the suspected path, and an equal number of searchers on either side of the track.

C. Track Spacing. In executing a ground search pattern, constant distance is maintained between searchers. Land search track spacing is determined by the distance a person can effectively search while keeping adjacent searchers in visual or audible contact. For example, if each searcher could effectively search 50 feet on each side of their track, the track spacing would be 100 feet, and searchers would be spaced at 100-foot intervals. If searchers were unable to see adjacent searchers from 100 feet away, then track spacing would have to be reduced.

1. In jungle or thick underbrush, both visual and vocal contact must be maintained between adjacent searchers. This ensures full area coverage and protection for inexperienced searchers. Whenever contact with a lineman is lost, the team leader must be immediately notified. The searchline will then stop until complete team contact is reestablished. If the searchline is more open, only adjacent visual contact must be maintained, though vocal contact is usually also maintained.

2. The team leader always makes the final determination of track spacing. Generally, track spacing depends on target characteristics, weather, and terrain.

3. Track spacing for lost persons is typically between 15 and 25 feet, with search progress through wooded areas conducted at a slow gait, and each thicket and depression checked. About one square mile of woods can be searched by a land SRU of 20-25 persons in slightly less than 4 hours.

D. Searchline. Searchers may proceed in a straight line abreast, a "V" formation, or a right or left slanting formation. "V" and slanting searchlines are more efficient than line-abreast searchlines because it is easier for each searcher to keep only the searcher ahead in visual contact. The team leader takes position in the center of a straight line-abreast or "V" formation, or as the leading searcher in a right or left slanting searchline. The "dress" of the searchline is on the team leader. Two flankers are needed for line-abreast or "V" searchlines, while only one flanker is needed for a slanting searchline (see Figure 8-5). Flankers also assist in maintaining searchline dress. Both the team leader and flanker must continuously check their compasses, marked base lines, or topographical lineup features to ensure correct searchlegs are maintained.

825 Recording Search Coverage

A. To accurately plot positions of various finds, a large-scale grid plot of the search area should be made. As the search progresses, search sweeps are shown on the plot, providing an exact position of each sweep. Forward distances may be estimated by pacing off forward movement of the searchers. Exact locations of finds may then be shown, as the relative position is known both forward and across each search sweep or searchleg. These findings may be transcribed from the large-scale to a smaller scale chart as necessary. When search of an area is completed, the team leader should cross-hatch the areas searched, note areas not searched, and report these areas to the OSC, IC or SMC, along with the search results, weather, and other debriefing information.

B. U.S. Geological Survey Charts are best for executing land searches.

```
  FLANKER             FLANKER             FLANKER
 --------->          --------->          --------->


 --------->            --------->          --------->

    TEAM                    TEAM
 --------->              --------->          --------->
   LEADER                  LEADER

 --------->            --------->              --------->

  FLANKER             FLANKER                     TEAM
 --------->          --------->                --------->
                                                  LEADER

LINE-ABREAST          V FORMATION          SLANT FORMATION
```

Figure 8-5. Searchlines for Land SRU

1. Scale 1:24,000 is the best for land searches as it shows the most detail. This chart reduces 2,000 feet of horizontal topography to 1 inch. Each chart covers 7.5 minutes of latitude and longitude.

2. Scale 1:62,500 reduces 1 mile of horizontal topography to 1 inch. Each chart covers 15 minutes of latitude and longitude.

3. Scale 1:125,000 reduces 2 miles of horizontal topography to 1 inch. Each chart covers 30 minutes of latitude and longitude.

4. Scale 1:250,000 reduces 4 miles of horizontal topography to 1 inch. Each chart covers 60 minutes of latitude and 120 minutes of longitude. This scale is useful when a large view of the search area and surrounding terrain is desired.

Topographical charts may use any of four coordinate systems: latitude and longitude, Universal Transverse Mercator (UTM) grid, state plane, or rectangular surveys. When reporting the positions of finds, the latitude and longitude should be used if known, supported by, if possible, a bearing and distance from a prominent geographical feature.

C. Search Area Plot

1. The search area should be plotted on a topographical chart, showing all search area and sweep boundaries. Two adjacent sides are designated as baselines, each running from a common corner point.

2. On a sheet of paper of suitable size, an area, sized in proportion to the search area depicted on the topographical chart, should be drawn. Each side of the expanded search area should be marked with a scale, for every tenth of a mile, creating a grid system.

3. The grid lines should be numbered in two directions, starting from zero at a convenient corner. Each grid can be identified by referring first to a vertical grid line number, then to a horizontal grid line number. Furthermore, found objects can be referred to by fractional estimates of the grid line number at their locations. Grid lines are numbered only for convenience of the team leader. Positions of found objects are always converted to latitude and longitude for reporting to the OSC, IC or SMC.

4. The gridded, large-scale plot of the search area is now ready for depiction of each search sweep and any findings. To determine search sweep boundaries, track spacing should be estimated by the team leader. The track spacing is then multiplied by the number of team searchers to obtain the full width of the area searched on each search leg. This is then measured on the search area plot, using double lines to indicate boundaries and arrows for direction of each sweep.

Actual search progress can now be monitored using the search area plot, and findings readily plotted. Figure 8-6 shows a typical search plot.

826 Search Interrogation

A. Appeals for information through press and radio, on scene interrogation, or interviews with local population may lead to discovery of the search object. Land SRUs are often used as interrogation parties or the nucleus of such parties. However, before assigning this function, the SMC or IC should ensure that another SRU is readily available for the search area.

B. Normal communication equipment and a portable tape recorder will be adequate for interrogation.

C. Proper interviewing obtains pertinent information from witnesses. Individuals seeking publicity, those with overactive imaginations, or those who desire to help despite lack of information should be interviewed with caution. Unnecessarily revealing factual data to such a person may encourage "exaggeration". Leading questions should be avoided. Try to eliminate false leads based on imagination or power of suggestion.

D. Details are important. Information obtained should be given to the SMC or IC at the earliest opportunity. Addresses and telephone numbers of persons interviewed should be recorded in case more information is needed.

827 Wreckage Precautions

A. Both motor vehicle and aircraft crash sites can pose hazards to searchers from wreckage, chemicals, explosive munitions, or radiation. An aircraft crash site may have each hazard spread over several miles following impact. Appropriate safety precautions should be observed.

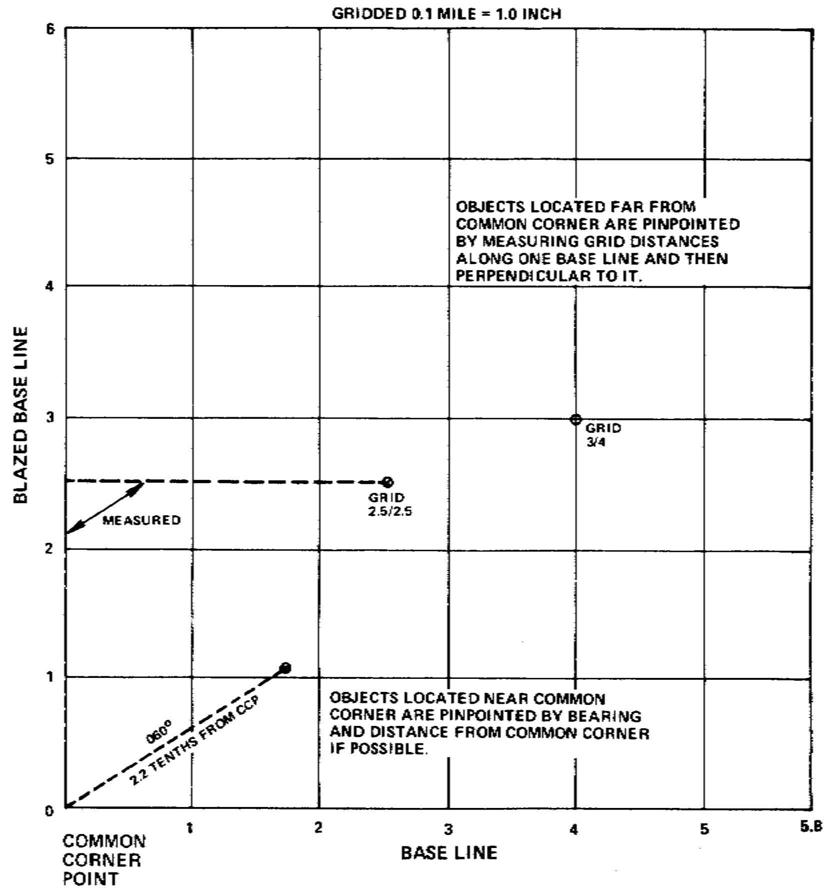


Figure 8-6. Ground Search Area Plot

Figure 8-6. Ground Search Area Plot

B. Search parties should not disturb aircraft wreckage, except to assist in the recovery of survivors. Not only does the wreckage pose dangers, but other mechanisms, such as ejection seats, may be hazardous. See Chapter 7 for rescue procedures. The position of flight controls, location of debris, and other factors are important in post-flight accident analysis. Charts, flight plans, and other documents should be preserved if threatened with destruction, and if preservation can be accomplished without danger or undue movement of debris.

C. Be aware that some "lost" persons may not want to be located. The possibility exists that survivors were engaged in illegal activity such as drug trafficking, or of intruding upon unlawful activities while searching.

1. Some remote rural areas have marijuana farms guarded by armed personnel. To ensure the safety of search personnel, searchers should be alert for such activity.

2. ELT signals may sometimes be false alarms from aircraft smuggling illegal drugs. SRUs , should be alert when approaching aircraft,

especially if there is no apparent damage, and especially at night.

D. DOD personnel, and CAP or Coast Guard Auxiliary members do not have authority to enforce laws, and can normally only take action necessary to preserve federal property. In general, SRUs should not take any chance in a situation that might endanger SAR personnel. See Chapter 12 for more detail.

830 LAND SAR

Land SAR is implemented for many types of incidents including lost children, mental patients, the elderly, and lost hunters. The following procedures apply to any land search, but are only a guide because of the large variations in topography, SRUs, and search objects. Close coordination is advisable with the local sheriff, state police, or state emergency services office, as well as with local volunteer SAR groups.

831 Lost Persons

A. Preplanning allows rapid and flexible activation of resources in the event of a distress or possible distress situation.

1. Local jurisdictions can increase efficiency and minimize costs by developing a SAR preplan. The preplan allows resource identification, recognizes hazards, creates its own critical review, avoids duplication of effort, and is an orientation guide for new personnel.

2. Preplanning should consider the history of local land searches, potential problems created by local terrain, legal constraints, etc. The preplan also establishes clear lines of authority.

3. Each SRU should have adequate communications with the SMC, IC or OSC, either directly or via the base camp or covering SAR aircraft. Hand-held or portable backpack radios are best for land use. If the radio communications link is broken, ground-air visual codes in Appendix C can be used to communicate with aircraft. The SRU should also carry backup communications equipment such as pyrotechnics, signaling mirrors, flashlights, and whistles.

4. Each preplan should identify all known SAR resources in the area and contact procedures. This information should be updated annually. Resources such as trained search dogs are available throughout the United States, and can usually be located through state or local law enforcement agencies, or through the AFRCC which maintains 24-hour call-up lists of qualified teams.

   a. Tracking or trailing dogs usually work from the last known position of the objective. A tracking dog will need an unlaundered carefully preserved scent article. The dog's effectiveness may be limited because ground scent will begin to fade in a short time. It is important that the search area remain undisturbed until the dogs arrive. If the search is for snow-buried survivors, most dogs may be used successfully. Avalanche case histories show that buried victims have sometimes been located by untrained dogs who happened on the scene and instinctively joined the search.

b. Air-scenting dogs work free of their handlers in a sterile search area cleared of all other searchers. The dogs generally work upwind across the air currents through the scent core transmitted by the objective. These dogs should alert if they pass a ground scent, but should continue to track the air scent. They are usually not limited by rain, snow or other precipitation that erases ground scent.

B. Incident Command System (ICS). Many local and state agencies employ ICS to manage their SAR incidents on scene. ICS is a management-by-objectives system adaptable to any size SAR mission.

1. The following basic components work interactively to provide direction and control over the incident response:

a. Common terminology.

b. Modular organization.

c. Integrated communications.

d. Unified command structure.

e. Consolidated action plans.

f. Manageable Span of Control.

g. Predesignated incident facilities.

h. Comprehensive resource management.

The key elements for a successful search mission are unified command and consolidated action plans.

2. Unified command simply means all agencies involved with the SAR effort jointly:

   a. Determine overall incident objectives.

   b. Select strategies.

   c. Plan and integrate tactics.

   d. Maximize use of resources.

3. Consolidated action plans list objectives and strategies and include an organizational chart, divisional assignments and incident maps. The plans are updated for each operational period.

832 Action Plans

A. The first consideration is search urgency which is influenced by subject profile, experience and equipment, and by weather and topography.

B. Once urgency is established, information to plan search strategies is collected and analyzed, including the subject's personality traits and last known position, and elapsed time since last observation of the subject.

C. Certain actions require immediate implementation once the urgency of distress is known. Many of these actions will continue throughout the search mission building on leads obtained, and possibly generating new information.

1. Investigation should be started to determine the subject profile and gather other clues. The investigation should continue throughout the mission and, if clues indicate, investigative effort increased.

2. Determine the outer perimeter of the search area by locating the last known position and computing the distance the subject could have traveled. Mission personnel should be assigned to this perimeter to preserve clues and confine the subject to the known area. Confinement should be maintained through-out the search. Using devices such as signs, flags, sirens or whistles can help the subject locate the searchers.

3. Two to three person teams that are clue conscious and equipped to operate independently for 24 to 48 hours should check hazards and high probability areas within the search area.

4. If available, persons highly trained as trackers should be called in immediately, while tracks and other clues are still fresh. The area should be protected until the tracker arrives.

5. As indicated previously, it is important that the search area be protected until the search dogs arrive.

6. Air scent dogs can search portions of the search area with a high probability of detection. They will be attracted to any human in the search area, so the segment of the area to be searched should be cleared at least 15 minutes prior to using a dog.

D. Once the initial tactics have been implemented, the IC needs to refine and segment the search area. The IC should use statistical data, subjective and deductive and group consensus reasoning to determine areas of high probability. This provides high probability areas which are more easily managed and searchable in one shift. The IC can assign probabilities to the areas so when additional resources arrive they will be placed in high probability areas.

E. Upon completing their search, each team will provide the IC with their POD. This indicates the confidence level that if the subject were in the area, he or she would have been found. This provides the IC with information to evaluate the search areas and continually update the search strategy and Action Plans so the most efficient use of all resources is maintained.

F. Briefing/Debriefing. Briefings and debriefings should be conducted for each shift action plan. See VOLUME II, Chapter 6, for key briefing guides.

CHAPTER 9. EMERGENCY MEDICAL SERVICES

CHAPTER 9. EMERGENCY

900 GENERAL

The capability of sustaining life after rescue is as important as the searching for, and rescuing of, survivors. The SAR system has four major Emergency Medical Services (EMS) capabilities:

A. Personnel trained in emergency care.

B. Lifesaving and life sustaining services to survivors.

C. Survivor evacuation and transport.

D. Medical facilities to receive injured survivors.

910 EMS PERSONNEL

Emergency medical services personnel are trained to provide emergency medical care lifesaving services at the distress scene. In addition, these personnel may be trained to provide life support and life-sustaining services during survivor extraction from wreckage, evacuation, and transport to a receiving medical facility. They include SAR crewmen and pararescuemen qualified to administer basic lifesaving first aid and specially trained EMS personnel such as doctors, nurses, corpsmen, paramedics, or SAR emergency medical technicians (EMTs).

920 EMERGENCY CARE

Emergency care that may be needed includes extraction or removal from wreckage, triage (the sorting and assignment of priorities for attendance, care, treatment, and transportation of multiple survivors), first aid and emergency care to stabilize survivor condition, survivor debriefing, transport to a delivery point, life support during transport, transfer/delivery of survivors at the delivery point, and briefing of receiving authorities at the delivery point.

921 SRU Procedures

SAR personnel should ensure the rescue of all persons trapped in a hazardous environment who can be rescued without unduly compromising the survival of others. Survivor processing begins as soon as possible after the survivor is extracted from wreckage, or boards a rescue craft. The number of survivors, type of SRU, and medical resources available determine the nature of processing and any further SAR efforts. Medical evacuation involving transport by aircraft should be coordinated closely with a recognized medical authority. A search team should:

A. Conduct triage and render medical care.

B. Begin extraction if it will not unduly jeopardize other survivors.

C. Provide shelter for survivors until evacuation.

D. Evacuate survivors.

In addition, SRUs should report survivor status to the OSC, debrief survivors, examine personal effects of deceased persons for identification, begin to locate missing survivors, safeguard personal effects of survivors, and preserve medical evidence, physical evidence, mail, and classified matter for future use. Detailed debriefing of survivors should be conducted for reports and accident investigation. Statements given by survivors shortly after accidents may be significant for prevention of other accidents and for revision of search plans.

922 Cold Water Near-Drowning

Victims of near-drowning in cold water (70 degrees F or less) often appear lifeless, cold, blue, non-breathing, and show no detectable heartbeat. If immersion is less than one hour, prompt CPR should begin and the victim rapidly transferred to a suitable medical facility.

923 Diving Accident Victims

Medical advice should be obtained immediately upon receipt of a report of a diving accident. Symptoms of diving-related illnesses are quite varied. Any unusual occurrences, including pain, confusion, dizziness, numbness, or shortness of breath, within 24 hours of diving should also be considered a possible diving accident. For all reported or potential diving accidents, SAR personnel should:

A. Obtain the dive history: time, depth, activity, problems encountered, stops during ascent, time at the surface, time to onset of symptoms, predive problems, the symptoms or signs currently being experienced.

B. Contact the USAFSAM Hyperbaric Medicine Division, Autovon 240-FAST or (512) 536-FAST, or Diver's Alert Network (DAN), 24 hours per day at Duke University, (919) 684-8111. They can provide emergency advice, and if recompression is needed, they will assist in locating the closest available chamber. For non-emergency information, contact DAN, (919) 684-2948, during eastern time zone working hours. RCCs should maintain a list of chambers in their area.

C. Be prepared to transport both diver and the diving partner (diving buddy), who may develop the same symptoms.

D. Air transportation of a diving accident victim is safest in a pressurized aircraft that can maintain sea level cabin altitude. Nonpressurized aircraft should maintain an altitude safe for flying and no higher than 200 feet above the location from which the victim was received. Cabin altitudes should also not exceed 200 feet above this location except in life-threatening situations where no other form of transportation is available. If oxygen is available, it should be administered by mask at the highest concentration available.

E. A thorough discussion on diving casualties is presented in the U.S. Navy Diving Manual, NAVSHIPS 0994-001-9010 (available from Commander, Naval Sea Systems Command) and the National Oceanic and Atmospheric Administration Diving Manual (available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, Stock Number 003-017-00468-6). The general information contained in these publications should not replace or delay SAR consultation with experts.

924 Survivor Emotions

A. SAR personnel should be alert to the psychological condition of survivors. Grief, despair, or the ordeal of survival may cause irrational behavior such as neglect of personal safety, or attempts at suicide during the rescue. Resources permitting, rescued persons should not be left alone, especially if injured or showing signs of physical or mental exhaustion. Uninjured survivors may possibly be on the verge of complete mental collapse due to their basic temperament or occurrences they encountered or witnessed. This condition could result in a state of uncontrollable shock.

B. Specialized psychotrauma teams are available from several agencies. Such teams may be used to counsel survivors, families, and SRU personnel following a catastrophic SAR incident. The Navy SPRINT team with counseling professionals, such as psychologists and chaplains, has been used to counsel personnel following an SRU crash. Such counseling should not be overlooked, especially if an SRU crew member has perished during a rescue attempt.

925 Survivor Debriefing

A. Survivor Debriefing Kit. Just as survival often depends on availability of a survival kit, successful debriefing depends on availability and effective use of a survivor debriefing kit. The kit should contain debriefing forms for the gathering of data important for future SAR planning. The form should guide the questioner through a logical and orderly set of questions without omitting essential information, and provide an on scene record of information that might be forgotten before the mission is completed and documented. Forms should be short and self-explanatory, and should be filed in the SAR mission documentation folder.

B. Debriefing Topics. Survivors should be debriefed about:

1. Other survivor or occupant information. The survivor should first be asked about other survivors, and leads as to their whereabouts. Additional information, such as bailout altitude

and position, may be important in determining the probable datum for subsequent search efforts.

2. Self-help and clinical medical treatment, particularly prescribed or over-the-counter medication. If a survivor has a history of a recurring disease, such as heart trouble, diabetes, or epilepsy, this information should be noted on survivor processing tags or in the medical log for future attending medical personnel. The RCC should be informed of these situations.

3. Experiences during the survival, search, and rescue phases. Debriefing survivors helps to ensure that search personnel are aware of information that may be important for further SAR efforts, and assists in evaluating procedures used. It also may help prevent future accidents. Depending on the case, this step may be delayed until survivors are adequately cared for and rested.

C. Responsibilities in Debriefing Survivors

1. Since about 60 percent of all survivors experience injury and most have come through harrowing experience, survivors will usually be in shock. Care should be taken to avoid worsening their condition by excessive questions. The key element in survivor questioning is the interviewer, who should at all times be considerate, tactful, sympathetic, calm, authoritative, and knowledgeable.

2. If the survivor is frightened or excited, the questioner should consider survivor statements in light of this condition. The validity of answers may be questionable.

3. Questions should be asked in a calm voice and paced to the survivor's ability to respond. Words should not be put in the survivor's mouth. Each survivor should be informed that replies are voluntary and they will, if given, be used in pursuing the SAR case, or preventing such incidents in the future. Survivors should be provided with a copy of their statement on request.

4. Information obtained from survivors should be treated with discretion. Survivors should be advised that release is governed by the Freedom of Information Act, 5 USC 552, and the Privacy Act of 1974, 5 USC 552a. Service directives implementing these laws should be consulted.

930 SURVIVOR EVACUATION AND TRANSPORT

A. Survivors should be removed from the distress scene, transported to a safe delivery point, or medically evacuated (MEDEVAC) to receiving medical facilities by the most expeditious means. Considerations when selecting or requesting a transport RU are the medical training, qualifications, and operational capabilities of personnel, RU capability to reach a survivor in the shortest possible time, RU capability to transport a survivor without aggravating injuries or producing new complications, and environmental conditions.

B. Prior to MEDEVAC, every effort should be made to seek advice from doctors qualified in emergency medicine, and knowledgeable of SAR operations. When relying on medical advice from doctors who are not well versed in SAR, it may be necessary to explain the hazards involved to the doctor, so that a decision can be reached on whether a MEDEVAC is warranted. Operational authorities should advise consulting doctors of the fear-inducing nature of any operation necessary to evacuate a patient. For example, transfer of a heart attack patient to an SRU may cause apprehension and worsen the situation. The risk of the overall transport mission is weighed against the risk to the patient. Operational mission risk must be balanced against the patient's present clinical status, and the patient's probable clinical course if MEDEVAC is delayed or not performed.

931 Evacuation From Marine Craft

A. For a MEDEVAC at sea, the primary controlling factors are distance, weather, and threat to patient and crew. Normally the SMC will ask the vessel to divert and head for a certain position or port. The sooner the vessel acknowledges it will divert and gives an ETA, the sooner the helicopter flight or surface rescue can be planned. If the vessel is already within helicopter range, it may still be preferable to divert in the direction of the RU departure point to expedite patient removal.

B. Fixed-wing aircraft may be dispatched to serve as escort, navigation aid, and communication relay for the RU. The vessel should provide as accurate a position as possible, time of position, course, speed, weather and sea conditions, wind direction, and velocity. Medical information should include whether the patient is ambulatory. RUs do not normally carry a stretcher, and, if one is needed, this information should be obtained prior to dispatch.

C. After the RU has departed base, the vessel should be advised of its ETA. The vessel should stand a continuous radio guard on a specified frequency to establish communications with the fixed-wing escort and later with the RU. Frequent transmissions may be requested from the ship for homing.

D. When personnel are removed from vessels, all immigration, quarantine, and customs laws must be observed. Agencies concerned with these laws are normally advised. If the patient is a foreign national, the appropriate embassy or consulate should be notified.

E. If the vessel is far at sea, MEDEVACs are often accomplished by another vessel, possibly the Coast Guard or Navy. Merchant vessels with doctors or medical facilities may provide a source of medical treatment, or the patient may be transferred from an outbound merchant vessel to one inbound. The AMVER system can be of great help in finding a suitable merchant vessel to assist. SMCs can only request, not direct, assistance from merchant vessels.

932 Evacuation From Land Areas

Evacuation for land areas is covered in Chapter 8, Inland SAR Operations.

933 Survivor Delivery

When survivors are delivered to a medical facility, the person in charge of the delivering unit should provide information on all first aid and emergency treatment given. The degree of briefing depends on the medical competence of the personnel who administered emergency treatment. Information which should be passed includes the type of injury or condition, treatment given and medications, including time and amounts, and times when tourniquets, splints, or compress bandages were applied. The survivor processing tag, medical logs, and any other medical records should be delivered to medical personnel.

940 FIXED MEDICAL FACILITIES

The SMC normally selects, based on knowledge of local capabilities, a suitable medical facility to receive injured survivors. Fixed medical facilities involved in SAR work include emergency medical care centers, general hospitals, private hospitals, clinics, sanitariums, and first aid stations. Some military hospitals and clinics provide medical advisory services to the SAR system, but they are survivor receiving hospitals only for those persons authorized to be admitted. Generally, this service is limited to military personnel, their dependents, and certain government officials. Where civil hospitals are not available, military hospitals will usually admit civilian patients for emergency treatment.

CHAPTER 10. SAR MISSION CONCLUSION

1000 GENERAL

Mission conclusion is the final stage of the SAR incident. The conclusion is successful when the search objectives are have been located and recovered. The conclusion is unsuccessful when the search objectives were not located and the SAR mission was suspended.

1010 MISSION SUSPENSION

The decision to suspend a mission is a difficult one. Each SAR case must be considered on its own circumstances and care should be taken not to suspend the search prematurely. Prior to suspension, a thorough case review should be made. The decision to suspend should be based on the probability of the objective surviving the initial incident, the probability of survival after the incident, the probability that the victim was within the computed search area, the quality of the search effort, and the consensus of several search planners. The reasons for suspension should be clearly recorded.

1011 Reviewing the Case

The following actions should be part of the case review:

A. Search decisions should be examined to ensure that proper assumptions were made, and that planning scenarios were reasonable. The certainty of initial position and any drift factors used in determining search area should be reconfirmed, and significant clues and leads should be re-evaluated. Datum computations should be reviewed.

B. The search plan should be reviewed to ensure that:

1. All assigned areas were searched.

2. Cumulative POD and POS are as high as desired.

3. Compensation was made for search degradation caused by weather, navigational, mechanical, or other difficulties.

C. A determination about the survivability of the search objective should be made, considering:

1. Time elapsed since the incident.

2. Environmental conditions.

3. Age, experience, and physical condition of potential survivors.

4. Search objective's will to live.

5. Survival equipment available.

6. Immersion tables, light aircraft crash studies, and other studies or information relating to survival in similar situations. Maritime survival charts usually apply to persons without protective clothing, and times will be longer for persons with survival suits or other thermal protection.

1012 Notifying Relatives

The SMC should make the notification to relatives of the distressed or missing persons that the mission has been suspended. Relatives normally are more willing to accept the decision to suspend if they have been allowed to follow the progress of the search. During the search the SMC should maintain daily contact with relatives to provide information and outline future plans. Providing access to SMC headquarters, if appropriate, enables relatives to see the search effort. Notification of the decision to suspend should be made at least one day prior to suspension of operations, allowing relatives at least one more day of hope, while giving them time to accept that the search cannot continue indefinitely.

1020 REOPENING A SUSPENDED MISSION

If significant new information or clues are developed, reopening of a suspended mission should be considered. Reopening without good reason may lead to unneeded use of resources and risk of injury to searchers, and possible inability to respond to other emergencies.

1030 EXTENDED SEARCH OPERATIONS

Some missions are continued beyond the time when they ordinarily would be suspended because of lack of a reasonable probability of locating survivors. Extended searches may be conducted due to humanitarian considerations, number of persons involved, or a forecast of greatly improved search conditions. Searching is inherently dangerous, and SRUs should not be risked when potential for saving life is minimal, or when their use may preclude their availability for other missions. SRUs should not be hazarded in extended search operations to the same degree as during normal search operations.

1040 SRU RETURN

SRUs are limited in the number of hours they can operate safely and efficiently. The operating agencies and services providing the units establish these limitations. When long missions are contemplated, augmented or additional crews should be made available. A SAR mission is not ended until the last SRU has returned to its operational base and all participating agencies are de-alerted.

1041 SRU Use and Diversion

SMCs must consider the time required for SRU return to base, refueling, maintenance, and replenishment, and remaining operating time limitations, when projecting SRU capability to respond to another SAR mission. When a mission involves extended large-scale search operations, the SMC must account for crew and SRU availability. Anticipating and planning for these time requirements can alleviate much of the frustration caused by delays in SRU return to scene. The parent agency should be able to provide an estimate of the time when an SRU will be ready for another assignment. While an SRU would normally return to its operational base, it could be diverted directly to another SAR mission. If an SRU is diverted, or departs on a new mission, the time of diversion should be recorded as the end of the first mission for that SRU.

1042 SRU Debriefing

Debriefing of all participating SRU crews is desired. It should occur as soon as possible after the sortie. Debriefing while a SAR mission is still in progress may determine whether additional information is available for the SMC. Furthermore, the SRU crew reaction to instructions received, coordination and control support furnished, briefings given, and any other aspects of the SAR mission can contribute to improving SAR system effectiveness.

1043 Interagency Communication

A. De-alerting Participating Agencies. A SAR mission is not complete until all agencies and facilities are de-alerted. Failure to de-alert an agency when services are no longer required may impose unnecessary expense or inconvenience. SMCs should continually monitor the mission to de-alert facilities and agencies when their assistance is no longer required.

B. Accident Investigation. The SMC should inform appropriate accident investigation authorities when the case involves a casualty to aircraft or marine craft. The National Transportation Safety Board (NTSB) normally investigates all aircraft and major marine accidents. The SMC should ensure that marine casualty debris and lifesaving equipment are recovered and protected for examination by accident investigators.

C. Post-Mission Events. It may be necessary to inform other agencies to take follow-up action. The Coast Guard may need to check marine aids to navigation after a grounding, the FAA may need to check aeronautical aids after aircraft accidents, and the Army Corps of Engineers may need to remove stranded or wrecked ships in navigable waters. Other agencies may also be involved.

1044 Documentation

The final mission conclusion step is documentation. It is an official government record used for statistical analysis, system feedback and improvement, and private and public judicial purposes. While each agency prescribes the degree of documentation needed, all require some form of final record of participation in the SAR system. Various aspects of SAR documentation are described in Chapter 11.

CHAPTER 11. DOCUMENTATION

1100 GENERAL

Documentation consists of SAR mission logs, forms, folders, charts, and reports. Any situation about which a unit opens a file, whether or not SRUs are dispatched, should be documented. Documentation promotes operational efficiency, and creates statistical data, information for SAR case studies, and official chronological records. See Vol. II for specific forms and checklists.

1110 LOGS AND DIARIES

Logs and diaries provide the written records of SAR activities.

1111 Case Title and Numbering

Each SAR case is normally assigned a number and title as soon as the SAR system is notified of the case.

A. Case titles identify the craft, individual, or event, and the nature of the emergency.

B. The numbering system may be simple serial numbers, or may show the date started, or identify the SAR coordinator. Area SAR coordinators determine which numbering system subordinate SAR coordinators use. SAR case numbers are maintained primarily for statistical purposes and are kept by fiscal or calendar year.

1112 SAR Operations Log

Each RCC maintains a chronological narrative account of operational SAR activity for cases handled by the RCC. Many SAR coordinators have found that combining routine RCC administrative and non-SAR operational entries tends to obscure information concerning SAR missions, so they have adopted a case narrative log to supplement the SAR operations log. When SAR coordinators permit this procedure, the only entries required in the SAR operations log about a case are the opening entry at the beginning of a SAR case and the "Case Closed" or "Case Suspended" entry at conclusion.

1113 Case Narrative Log

The case narrative log is a chronological narrative of a SAR case. A case narrative log is kept for each case and is usually filed in the SAR case folder. When case narrative logs are used, they are an official part of the SAR operations log, even though filed separately. Chronological narrative entries may include the date and time of mission opening and title assigned, phone call summary, SITREP release and receipt, SRU movements, emergency phase classification, communication checks, and offers of, and requests for, assistance from others. Information recorded on incident processing forms or checklists need not be duplicated in the case narrative log if filed with the log.

1114 RCC Diary

An optional summary of cases may be used to brief the SAR coordinator and staff on SAR missions during a single 24-hour period, usually beginning at midnight local time. It should include a short paragraph summarizing the actions taken, SRUs used, and current status of all SAR missions in progress. In RCCs with high SAR activity, major cases may be summarized in paragraph form, with minor missions merely tabulated by total number and types.

1115 Information Case Log

This log contains information received by RCCs on missions conducted by other SAR coordinators from craft encountering difficulties for which no assistance is currently required, or from persons reporting unusual information. To monitor these situations more efficiently, some SAR coordinators establish a separate information case log for such entries, and a separate case folder for each situation.

1120 SAR FORMS

Several types of SAR forms are used by the SMC, OSC, and SRU commanders to speed the flow of information and ensure complete consideration of possible steps and events during the case.

1121 SAR Mission Forms

A. Incident Processing Forms are used to record immediately available information concerning any emergency incident that may develop into a SAR mission. They provide an easy sequence for obtaining information and ensure that the informant may be contacted for additional information.

B. SAR Mission Checklists provide a step-by-step course of action to follow in prosecuting SAR missions.

C. Search Planning Forms are used to develop an efficient and attainable search action plan.

D. Search Action Forms help the SMC or briefing officer ensure that SRUs and OSCs are briefed and debriefed on mission details.

E. Rescue Planning Forms are used to develop a suitable rescue plan.

F. Delivery Planning Forms consider factors influencing delivery planning and emergency care.

1122 SAR Message Forms

"Fill-in-the-blank" message forms are used to reduce the time needed to draft and release common, standard messages. Unessential "blanks"/information should be eliminated when using these forms.

A. Urgent Marine Information Broadcast (UMIB) Forms aid in drafting an "All Ships Message" to alert vessels near the scene of an emergency.

B. Notice to Mariners Forms help in preparing notices concerning hazards to navigation, unsuccessful SAR searches when survivors may still be adrift, or other items.

C. En Route Aircraft Alerting Forms are used to ask ATC to alert aircraft that they are near the scene of an emergency.

D. Notice to Airmen Forms are used to inform pilots of SAR operations that may hazard their flight, or to request their assistance (such as in monitoring distress frequencies).

E. Sample SAR Message Forms aid in drafting common SAR messages.

1123 SAR Liaison Forms

SAR liaison forms are used by the SAR liaison officer or SMC deployed to another RCC, RSC, or staging base to assist with SMC duties. Deployed SMC checklists may be used to organize an SMC team, and SAR liaison officer checklists may assist a deployed SAR liaison officer.

1130 SAR FOLDERS

A. The SAR Case Folder contains all logs, forms, messages, and data for one case. SAR case folders usually have, on one side, a copy of all incoming and outgoing messages and, on the other side, the incident processing form, checklists, planning forms, action forms, briefing and debriefing forms, notes, and the case narrative log.

B. The Information Case Folder is an aid in monitoring missions conducted by other SAR coordinators that may require local action. The folders usually contain all message traffic and information for a single situation.

C. The SAR Mission Briefing Folder is used to brief departing SRUs and to debrief SRUs. This folder is used primarily during large, multiunit SAR cases. Upon SRU return and debriefing, the completed SRU briefing form, SRU debriefing form, and OSC briefing form are normally filed in a SAR mission briefing folder instead of in the SAR mission folder. It summarizes mission progress to date and the action plans for the operational stage assigned.

D. An SRU Briefing Folder should be used during large SAR cases to ensure that each SRU receives a complete briefing. When the SMC's operation center and the SRU staging base are not co-located, this information may be transmitted via the best means available. The information contained in the SRU briefing folder should supplement the information transmitted in the SMC's SAR action plan. Possible items to include in each SRU briefing folder are:

1. Most recent search action plan message.
2. Prepared search area chart.
3. Search briefing checklists.
4. SRU briefing and debriefing forms.
5. Arriving SRU information required by OSC.
6. OSC initial SRU briefing.
7. OSC procedures.
8. OSC search status checklist.
9. Sighting reports.
10. Procedures for diverting merchant vessels.
11. Helicopter hoist instructions for vessels.
12. Most recent AMVER SURPIC.
13. Aircraft separation procedures.
14. Aircraft "operations normal" reporting procedures.
15. Shipboard lookout and aircraft scanner instructions.
16. Prepared aircraft clearance form.
17. Survivor sighting procedures.
18. Communications/IFF plan.

1140 SAR CHARTS AND OVERLAYS

Charts, overlays, and graphical summaries are aids in planning, execution, and evaluation. Separate SAR mission charts should be kept for each case.

A. SAR charts should have detailed information about the case, including the projected trackline of a missing craft, last known position, estimated position at time of last radio contact, search areas for the first search effort, mission number and title, type of search (day or night), date, search area assignments, SRUs assigned, PODs obtained for each search area, and total size in square miles of area searched. As each assigned search is completed, it should be cross-hatched on the chart.

B. SAR mission overlays are used when the SAR case continues beyond one day and the SAR case chart, if continued in use, would become too cluttered for effective planning. Transparent overlays of thin plastic or tissue should be used on top of the original SAR chart, and sequential search efforts (first-day search, first-night search, second-day search, etc.) plotted on successive overlays using the same mission data and color codes used on the original SAR mission chart. When the SAR chart and overlays are placed on an underlit table, the top overlay will show only its information when the table is unlighted, but the entire mission effort is presented when the table is lighted. This is useful only when using charts blank on the reverse side. Some SMCs file a color photograph of each search overlay in the SAR case folder.

C. Color codes, as follows, have proven effective when plotting on SAR mission charts and overlays:

1. Search area boundaries and all lettering - black.

2. Last known position, last communications position, planned track of distressed craft, and objects sighted - red.

3. SRU tracks - blue.

4. Permanent land areas - brown.

5. All other - black.

6. Completed search areas - cross-hatching color optional, but different for each day, or night, and not blue, brown, red, or black.

D. For large missions, charts outlining search areas should be prepared by the briefing officer and delivered to SRU commanders. These SRU charts should include boundaries of the assigned search area, en route track, return track, and search tracks. This is effective in overwater searches where the SMC directs searching by aircraft and vessels proceeding to and from the scene. Information about adjacent search areas and SRUs should also be on the chart.

1150 SAR CASE STUDIES

A. A SAR Coordinator should always consider SAR case studies if it will enhance the SAR system.

B. Often an examination of search effort after recovery of survivors will provide information for improving SAR techniques and procedures, and for passing experiences to other SAR coordinators. SAR case studies should also be considered when a search failed to locate a target that was subsequently found, a mission is believed to be of unusual interest due to new methods or procedures used or unusual experience gained, or a mission fails to locate a target with resulting loss of life.

C. The studies, normally brief, deal only with factors considered contributory to the purpose of the study, together with recommendations for improving the SAR system. Some areas of interest include initial error in position of the distressed craft, drift computations compared with actual drift, search area determination, thoroughness of area coverage including cumulative POD, search patterns used, use or lack of detection aids, communications difficulties, reasons for failure to locate the target, performance of CASP and other computer SAR programs, and SRU efficiency, quantity, and quality.

1160 SAR COMMUNICATIONS

All communications equipment, including RCC telephones, should be attached to a multichannel tape recorder with a timing channel. This allows the RCC to review information received over a voice system, and may resolve disputes about what information was received. Tapes should be retained per agency directives. When it is suspected that tapes may be evidence in a judicial dispute, originals should be retained.

CHAPTER 12. LEGAL ASPECTS

1200 GENERAL

SAR personnel should generally not be concerned with legal issues other than as set forth in this chapter. If the primary purpose of SAR, saving of life and property, is carried out with reasonable care, good judgment, and common sense, SAR personnel and agencies should not fear potential legal liability.

1210 DOMESTIC FRAMEWORK

A. 14 USC 88 permits the Coast Guard to rescue persons or property in distress, take charge of and protect property saved, provide food and clothing to persons in distress, and destroy or tow hazards to navigation. This provisions authorizes the Coast Guard to engage in saving life and property in the broadest possible terms, without limitation as to place. This is a discretionary statute; duty to perform SAR is not mandatory. Once a mission is undertaken, it should be conducted in a responsible manner. The agency performing SAR may be subject to liability to a person needing assistance if physical harm results from a rescuer's failure to exercise reasonable care in carrying out a rescue, or if harm results because a person reasonably relied on the rescue effort, foregoing other opportunities to obtain assistance. However, liability normally results only where injuries are caused by unreasonable actions on the part of the rescuer.

B. 14 USC 2 establishes maintenance and operation of rescue facilities as a primary mission of the Coast Guard.

C. Chapter 23 of 14 USC provides for establishment and operation of the Coast Guard Auxiliary, establishes as purposes of the Auxiliary to promote safety and effect rescues, defines Coast Guard Auxiliary vessels under orders as public vessels of the United States, and allows reimbursement of certain expenses incurred.

D. 10 USC 9441 establishes the Civil Air Patrol (CAP) as the official auxiliary of the Air Force and provides for reimbursement of fuel, oil, and limited aircraft maintenance expenses, while under orders. CAP officers are "military" insofar as "Posse Comitatus" is concerned (see par. 1210.F).

E. 46 USC 4302 and 4308, although restricted to certain specific categories of vessels, provide authority to stop voyages that are dangerous or otherwise high risk.

1. "Terminate Unsafe Use" empowers boarding officers to suspend further use of a boat until correction of various deficiencies is made; such as overloading, no personal flotation devices, or no fire extinguishers.

2. "Manifestly Unsafe Voyage" authorizes Coast Guard District Commanders, by delegation from the Secretary of Transportation, to designate a voyage manifestly unsafe due to a craft's unsuitable design or configuration, improper construction or inadequate material condition, or inadequate operational or safety equipment.

F. 18 USC 1385 (Posse Comitatus Act) contains prohibitions for military participation in civilian law enforcement activities. There are some exceptions to this prohibition, including assistance in hijackings. All DOD SAR planners, including Civil Air Patrol personnel, who are "military" when under orders, should be aware of DOD Directive 5525.5 and the regulations of their own Services. This act does not generally apply to the Coast Guard.

G. 46 USC 2304 requires a master or individual in charge of a vessel to render assistance to any individual found at sea in danger of being lost. This provision applies to all vessels operated on waters within 12 NM of the U.S. and to U.S. owned vessels on the high seas.

1220 INTERNATIONAL FRAMEWORK

There are various principles under international law that SAR personnel should be aware of. Additionally, SAR operations in, or in the vicinity of foreign nations, involve two principles which sometimes conflict -- The sovereignty of a nation and the humanitarian need to assist those in distress without regard to nationality or circumstances. International instruments and national policies of countries attempt to resolve these conflicts.

1221 Obligations of Ships at Sea

There is an obligation under international law to rescue mariners regardless of nationality based on the principle and time honored tradition that those at sea will, whenever they can without undue risk, assist fellow mariners in distress. Additionally, most nations are party to the International Convention for the Safety of Life at Sea (SOLAS). Regulation V/10 of that instrument contains pertinent requirements for masters of ships of these nations. Masters of a ship at sea are required on receiving a signal from any source that a ship or aircraft or survival craft is in distress, to proceed with all speed to the assistance of the persons in distress informing them if possible that he is doing so. If he is unable or, in the special circumstances of the case, considers it unreasonable or unnecessary to proceed to their assistance, he must enter in the logbook the reason for failing to proceed to the assistance of the persons in distress.

1222 Right of Assistance Entry

A. Under this principle, the right to enter a foreign territorial sea to engage in bona fide efforts to render emergency assistance to those in danger or distress from perils of the sea is known as Right of Assistance Entry (RAE). RAE has been recognized since the development of the modern territorial sea concept in the eighteenth century. Acknowledgment of RAE is evidenced in customary international law. RAE is independent of the rights of innocent passage, transit passage, and archipelagic sea lanes passage. Perils of the sea are dangers commonly associated with operating on, over or under the oceans.

B. Where a bilateral agreement with other nations (states) exists and assistance in the territorial sea is specifically addressed, the terms of the agreement are controlling. Where agreements do not exist, agency directives should be followed when implementing RAE. In general the conditions under which RAE by vessels is appropriate are:

1. There is reasonable certainty that a person, ship or aircraft is in danger or distress from the perils of the sea;

2. The distress location is reasonably well known; and

3. The rescue unit is in position to render timely and effective assistance.

C. RAE is not as well developed for aircraft and accordingly the conditions are more restrictive. The general conditions include those that apply to vessels with the additional condition that a person is in danger or distress from perils of the sea, and delay in rendering assistance is potentially life threatening.

D. RAE is not dependent upon seeking or receiving the permission of the coastal nation. While the permission of the coastal state is not required, notification of the entry should be given to the coastal state both as a matter of courtesy and for alerting rescue forces of that nation. RAE extends only to rescues where the location of the danger or distress is reasonably well known. The right extends only to bona fide rescue operations, and not to conducting searches within the foreign territorial sea without the permission of the coastal nation. It is desirable that prearranged procedures be developed for working directly with SAR authorities of foreign countries. IMO and ICAO provide a medium for such cooperation.

E. Account should be taken of the sensitivity that may result from use of military units for SAR within the territory or territorial waters of some nations.

F. Ships and aircraft of other nations should be afforded comparable rights of entry into U.S. territorial seas. U.S. actions that unreasonably restrict RAE will inevitably jeopardize the ability of U.S. vessels and aircraft to exercise RAE.

G. Since domestic and international law are involved, SAR coordinators should be aware of the differing requirements of each country where their SRUs are likely to become involved. SAR should be conducted in accordance with existing agreements. Most agreements provide for automatic SRU entry into foreign territorial seas with timely notification to certain agencies in that foreign state. Some go beyond customary international law, particularly in relaxing requirements concerning aircraft entry.

1223 SAR Agreements

To respond more effectively to those in distress, the U.S. has entered into SAR agreements with neighboring states. Negotiations of such agreement can only be authorized by the Secretary of State. The Commandant of the Coast Guard has been delegated the authority to negotiate and conclude SAR agreements. Once various parties which can participate in SAR operations are determined, agreements, understandings or other arrangements for cooperation may be appropriate with those not under direct control of the SAR Coordinator. These written arrangements should be sufficiently detailed and delegate sufficient authority to help assure immediate action. Copies of relevant parts of written arrangements should be kept in RCCs to help avoid the risk that any agency will be reluctant to initiate action because they feel they may lack authority to do so. Arrangements usually cover the types of facilities available, state of readiness, scope of assistance which can be provided, area within which assistance can be provided, points of contact for requesting assistance, and conditions for participation in SAR exercises. Each federal SAR agency should provide more specific guidance for various levels of their organization related to establishing written SAR arrangements with other parties. See Appendix B for various SAR treaties and international instruments.

1224 United States SAR in Foreign States

A. Factors to consider about distress incidents in foreign countries include the responsibilities of commanders for the safety of personnel under their command, and the general responsibility of any government with respect to its own citizens when they are abroad. The safety of United States citizens in foreign countries is primarily the concern of the United States Foreign Service of the Department of State. Since this service does not have rescue facilities, its Embassies and Consulates depend on facilities provided by the resident country or facilities of other United States agencies. Most Embassies have a Defense Attache Office that deals with incidents involving United States military craft or personnel in need of assistance, and with making arrangements for entry of such military craft. The Defense Attache Office can also help obtain permission to engage in operations, and can assist in coordinating United States operations with those of the resident country. Communications with these attaches or foreign service posts should be used in SAR cases when no other prearranged procedure exists.

B. The USAF Foreign Clearance Guide provides worldwide guidance for entry of United States military aircraft into foreign countries, and provides procedures for SAR missions in these countries. The operations plan and other instructions of overseas SAR coordinators should include guidance for their areas of operation. RCC personnel should be familiar with these and other applicable references so that appropriate and timely action can be taken.

1225 Foreign SAR in the United States

Situations may arise when SRUs or other craft of foreign countries need to enter the United States for SAR operations. While Canada and Mexico often enter our territory for this purpose, other states may also have such a need. The following procedures should be followed.

A. Canada

1. Canadian vessels may render aid and assistance to vessels in the following United States waters or on adjacent shores without prior notification: the portion of the St. Lawrence River through which the international boundary line extends, Lake Ontario, Lake Erie, Lake St. Clair, Lake Huron, Lake Superior, Niagara River, the Sault Ste. Marie canals, and the Atlantic and Pacific coasts within 30 miles of the international boundaries. As soon as practicable, Canadian vessels rendering such aid and assistance must make a report of the case to the nearest United States Customs Office. (United States/Canada Treaty on Reciprocal Rights in Matters of Conveyance of Prisoners and Wrecking Salvage (1908), 35 Stat. 2035, TS 502)

2. Canadian aircraft may engage in SAR in the United States, including its territorial sea, under the direction of the appropriate United States

RCC, which will plan the search and assign search areas. When such aircraft are used, the RCC will provide the following information as quickly as possible to the United States immigration and customs authorities nearest the search area: the purpose of the flight and the territory to be searched, the identification markings of each aircraft, the number and nationality of the crew of each aircraft, the duration of stay, and the landing location if a landing is planned. If a Canadian aircraft lands in the United States, either the RCC or the aircraft pilot reports to the nearest collector of customs to assist with any special importation required in the SAR operation. (1949 Agreement Between Canada and the United States Respecting Air Search and Rescue Operations, 63 Stat. 2328, TIAS 1882)

3. The SAR Agreement between Chief of Defence Staff, Canadian Forces and Commandant, USCG, October 25, 1974, provides for SAR response in certain waters. These waters are adjacent to ICAO Search and Rescue Regions (SRRs), as well as waters on either side of the international boundary between Canada and the United States. In these waters, SAR forces of either nation may begin or coordinate SAR operations in the maritime area of the other, when such are required or appropriate. Each nation keeps the other informed of activities of mutual interest, or when it may help to ensure continuity of SAR operations.

B. Mexico. Mexican vessels and aircraft may assist Mexican vessels and aircraft and their crews and passengers in the following United States territorial waters or on their shores: within 720 NM of the international boundary on the Pacific coast, and within 200 NM of the international boundary on the Coast of the Gulf of Mexico. The commanding officer, master, or owner must send notice of his action or intended action to authorities at the port of entry nearest the distress. Having made this report, the Mexican unit may continue to assist the distressed vessel or aircraft unless the RCC or other competent authority determines that adequate assistance is otherwise available or that assistance is not necessary. Upon departure from the United States territorial waters, the commanding officer, master, or owner of the vessel or aircraft must notify the competent authorities of departure. (1935 Treaty Between Mexico and the United States Relating to Assistance to or Salvage of Vessels, 49 Stat. 3359, TIAS 905)

C. Other Nations

1. If an RCC receives a non-urgent request or notification from a country other than Canada or Mexico for SAR operations in the United States, including the territorial sea, and follow-up procedures are not otherwise established by prior agreement, the RCC immediately acknowledges receipt and informs the military commander responsible for the defense of the area and the Department of State. Where overflight of the United States land areas is involved or landing is planned, the

immigration authorities and customs authorities should also be notified. Unless the military commander or Department of State objects, the RCC will permit the entry, assign search areas, and specify any other conditions under which the operation is to be conducted. If the military commander or the Department of State does object, the RCC will deny the entry and advise the nation that any appeal should be made through diplomatic channels. (Annex 12 to the Convention on International Civil Aviation, and the International Convention on Maritime Search and Rescue--1979)

2. When a request or notification from a foreign source indicates need for expedited entry to United States territory, including the territorial sea, the RCC should immediately acknowledge receipt, may specify conditions under which the SAR mission may be performed, and should proceed as follows:

a. When the position of a casualty is fairly well known, RCC may request or permit foreign units to proceed to the vicinity of the casualty to rescue personnel, and to search the immediate vicinity to locate the casualty or survivors. The RCC immediately notifies the military commander responsible for defense of the area and the Department of State. Where overflight of United States land areas is involved, the immigration and customs authorities are also notified.

b. When the position of a casualty is not fairly well known, an RCC may request or permit nearby foreign units to assist in an extended search for a missing or overdue unit or persons, within areas under its direction and control. Before assigning search areas to these units, the RCC must obtain the approval of the military commander and the Department of State. The immigration and customs authorities are to be kept advised of the situation and where overflight of United States land areas will occur.

3. Except in cases of distress or as provided for by prior agreements, no foreign vessel may undertake salvage of any vessel or aircraft in United States territory or territorial sea unless an application completely describing the operation has been approved by the Commissioner of the Customs. (46 USC 316, 19 CFR 4.97)

4. Unless otherwise specified in international agreements, an aircraft entering the United States or its territorial sea will make an entry report to the nearest customs officer, stating the character, quantity, destination, and use to be made of the aircraft. The report should be made prior to entry, or as soon thereafter as possible, but not later than 10 days after entry. If practicable, the aircraft will be removed under customs supervision. In any other case, as soon as possible after removal a report will be made to the customs officer to whom the arrival was reported, stating the character, quantity, and circumstances of the removal. The entry reports are required of the person in charge of sending the aircraft from the foreign country, or by the person for whom it was brought into the United States. Removal reports are required of the person in charge of removal. The reports may be made by the RCC on behalf of both parties.

D. Landing of Foreign Units. When it becomes necessary for foreign units to land in the United States for SAR, the RCC notifies interested authorities, such as the Bureau of Customs, Immigration and Naturalization Service, Public Health Service, and Department of Agriculture, and ask that they make necessary arrangements.

1230 BODY SEARCHES

While the military services have no legal responsibility to search for bodies, humanitarian interest may permit such a search. The decision to assist local agencies rests with the commanding officer having operational control. Assistance may be provided when it does not interfere with the unit's primary mission.

1231 Removal of Human Remains

A. On Land. Human remains may be removed only upon the approval of a law enforcement officer or coroner. In the absence of a law enforcement officer or coroner on scene, the SMC should obtain clearance, usually through the law enforcement authority in the area, and relay it to the SRU on scene.

B. At Sea. Remains may be recovered when possible and preserved for delivery ashore. Upon arrival ashore, the SRU or vessel should contact local law enforcement officials for disposition of the remains.

C. By Air Force. Air Force regulations prohibit use of Air Force aircraft for removal of a civilian body from a search area, unless removal will lessen danger to ground parties who would have to do the job. The Air Force will not search for a body as SAR. However, base commanders normally have the authority to assist local law enforcement officials provided such action does not interfere with their primary mission.

D. Across International Borders. Removal of human remains, military or civilian, across international borders involves local and national laws of the countries. Prior to removal, United States diplomatic officials in the countries must be consulted for necessary clearances.

1232 Disposal of Human Remains

Careful preservation of human remains has important implications for humanitarian reasons, legal requirements, and accident investigations. Medical examination of bodies may lead to important conclusions by accident investigators. State and local laws usually require official determination of cause of death. Certification of death is important to settlement of estates and insurance claims, and other legal proceedings. Remains should normally be delivered to the local coroner or medical examiner. In cases involving military deceased, further transfer should be arranged between the coroner and the Mortuary Affairs/Decedent Affairs Officer, following Service regulations.

1240 PRIVATE PROPERTY

1241 Entering Private Property

Trespass is defined as an unlawful entry upon land belonging to another. As a general practice, SAR personnel and land SRUs engaged in SAR should obtain permission from the property owner or occupant prior to entry. If this is not possible, it is usually prudent to notify local law enforcement authorities if time allows. Trespass by SAR personnel is justified if necessary. Every effort must be made to minimize damage to the property, as the SAR agency may be liable for such damages.

1242 Handling Privately Owned Property

Private property coming into possession of SAR personnel should be safeguarded, inventoried, and returned to its owner, and a receipt obtained. If the owner cannot be immediately found, SRUs should take the property to the officer assigned for handling property. Recovered private personal property may, under direction of the SAR coordinator, be delivered directly to local law enforcement authorities.

1243 Unclaimed or Abandoned Property

Unclaimed property is property not called for by its owner. Abandoned property is property that the owner has voluntarily relinquished, with the intent of giving up ownership and not specifically vesting title in anyone else. Property abandoned by registered owners is not always legally abandoned. Insurance underwriters, owners of cargo aboard the vessel, and others may have to declare abandonment for the vessel to be totally abandoned. Such property should be inventoried and handled following agency directives.

1250 CHARGES FOR SERVICES

No charge is normally made for SAR. However, agency directives may allow charges for saving or assisting property.

1260 CIVIL ACTION FOLLOWING SAR INCIDENTS

A. Citizens, private attorneys, life insurance companies, and government agencies may seek information about a SAR case to assist in settling estates of persons missing after casualties, or to resolve other legal matters. SAR agencies do not issue statements of presumptive death after these cases, but merely provide a factual account of the action taken. All such accounts must be cleared by a legal office before release.

B. Many civil actions involving SAR begin years after the event. If a SAR mission may result in such action, SAR controllers and personnel should preserve complete and accurate records, including original RCC tapes if possible. If in doubt about whether to preserve documentation or how long to preserve it, responsible personnel should consult agency directives or legal staffs.

C. SAR personnel may be needed as witnesses. Agency attorneys provide guidance whenever SAR personnel are called upon to testify. Generally, SAR personnel should provide factual information, but should not make any statements that could, if taken out of context, be construed as an admission of error or a statement of opinion.

CHAPTER 13. SAR MISSION PUBLIC RELATIONS

1300 SAR MISSION PUBLIC INFORMATION

The information policy for SAR missions is to inform the public, within the limits of security, of SAR system actions. Early release of information may provide important leads, precluding unnecessary use of SAR resources, and may forestall time-consuming requests from the news media. Releases should be made periodically to keep the public updated on mission progress, and a final release summarizing the entire mission made when the case is concluded.

1301 Cooperation With News Media

Information concerning a SAR mission should be released to all interested media simultaneously. Information may be provided to an individual or media representative when a specific request is received. If similar inquiries are received before the information is provided, the following procedures should be used:

A. Each reporter who has placed a request should be informed that another request for the same information has been received. Neither reporter should be advised of the other's identity or the media represented.

B. If requests for similar information have been received from not more than three reporters, the information should be provided simultaneously to each.

C. If more than three requests are received for similar information, the requesting media should be advised that the information will be provided to all requesters in a simultaneous release.

1302 Requests For Public Assistance

Asking, via the news media, for assistance from the public may benefit the SAR case, especially in a thinly populated, extensive area. The news release should request information, such as sightings or unusual occurrences, and include a reporting method, such as the RCC telephone number. The release should omit some easily verifiable information, such as high-wing vs. low-wing aircraft, to allow the SMC to confirm the accuracy of reports.

1310 SAR MISSION INFORMATION ORGANIZATION

The information organization for a SAR mission may consist of a SAR Mission Information Officer (SMIO), journalists, and photographers.

A. The SMIO coordinates and releases news concerning a SAR mission. If an SMIO is not assigned, the SMC performs those duties.

1. The SMIO should have a knowledge both of SAR and of the techniques for presenting public information. Major military commands that may be assigned SMC responsibilities usually have a staff public information officer serve as SMIO.

2. SMIO authority is derived from SMC authority. Service directives govern whether the SMIO is authorized to release mission information without approval of higher authority.

3. SMIOs impartially collect, prepare, and pass out information concerning a SAR mission to news media and members of the public. To perform this function, an SMIO should:

    a. Collect mission information from the SMC, RCC operations log, SAR operations log, SAR mission log, and interviews with rescued personnel.

    b. Establish early liaison with news media to prevent the SMC from being flooded with requests for information, and use news media to release mission information.

c. Keep informed on the procedures and techniques used and the stage the SAR system is in at any particular time, and provide prepared statements from the SAR Coordinator.

d. Have previously prepared photographs of RCC and SRU action scenes suitable for release, in addition to photographs taken of mission activities.

e. In many situations, more than one agency is involved in a SAR incident. When releasing information, give credit to the local, State, and other Federal agencies that may have assisted in the SAR operation.

B. Journalists may be appointed to assist the SMIO. For mission support lasting more than one day, the SMIO and journalists should set up a watch schedule coordinated with the SMC. During watch periods journalists perform SMIO duties.

C. Photographers may travel with SRUs to take photographs of SAR operations, wreckage sites, or survivors. On scene photographs not only enhance news releases but also provide additional information to SAR personnel and accident analysis investigation boards. Photographic coverage should begin as soon as possible. Photographers should be knowledgeable of the SAR system.

1320 RELEASES

News releases should be written following the time-proven format of "who, what, where, when, why, and how." Most of these items should be covered in the first paragraph, all within the first two paragraphs. Subsequent paragraphs provide additional information concerning one or more of these areas. This allows the news media to cut portions of the release to meet space requirements without damaging the overall story. A good news release will be well written, factual, and newsworthy. It should not contain personal opinion, judgments, elaboration, coloring, or classified material.

1321 Release Types

The four main types of news releases are spot news, feature news, advance news, and memorandum or fact sheet. Releases may be written or oral. An oral release is any public statement made by a member of the SAR system. Oral releases made by the SMIO should be recorded when possible and verbatim copies retained by the command. Copies should be serially numbered and placed in the SAR mission log.

A. Spot news releases are issued immediately when a news event of interest occurs. When urgency demands, a spot news release may be provided in a bulletin form as facts become available and need not be complete information concerning the event. Spot news is always "for immediate release."

B. Feature news releases provide information to media concerning significant events. A feature release does not have the immediacy of a spot news release and may not carry a specific release date and time.

C. Advance news releases provide advance information concerning scheduled events. It may be used to publicize planned events such as demonstrations of SAR equipment or SAR exercises.

D. Memorandum release or fact sheets provide news media with a brief factual account of events or occurrences considered of significant public interest. They may inform media of future events and may include an invitation for reporters to attend.

1322 Release Format

A. All typewritten copy should be double spaced on only one side of the page. The top third of the first page should be left open. All other pages are full and numbered at the bottom.

B. The full name of the service, address of the place of origin, day and date the information may be published, SMIO telephone number and extension, and, if desired, the full name of an individual authorized to discuss the released information, along with the serial number of the release, is shown at the top of the first page. At the left hand bottom corner of the first page, the initials of the person preparing the release and the date in numeral form, such as "CCH 6/1/85", are typed.

C. If the release is longer than one page, the word "MORE" should be placed at the bottom of all pages except the last. The last page should carry the word "END" and the notation of the releasing service.

1323 News and Photograph Pool

A news and photograph pool may be formed when a situation prevents all interested media personnel from making first-hand reports. In such cases, the media decides who will represent them and agrees to share equally in pictures, video, or other information obtained. Wire service or newspaper facilities may be used to speed processing and distribution of SAR mission photographs. Where a pooling arrangement is used, the SMIO or authorized representative should ensure constant control of the release and distribution of the photographs. These photographs should be impartially released and carry an official credit line.

1324 Joint Mission Releases

A joint Service agreement on news releases provides that, when only one Service is involved in a SAR mission, release of information to news media follows that Service's directives. When two or more Services are involved, the policies of the joint agreement apply and should include the following:

A. Inquiries made to one Service concerning the activities of another Service should be referred to the joint commander.

B. In missions involving a military mishap, the first announcement of the incident should be made by the parent Service if a representative is available. If representatives of the parent Service are not immediately available and certain facts are obvious, any other Service directly involved in the incident may provide assistance to the news media. This assistance may include a statement that an accident or incident has occurred, the location and time, and information concerning the queried Service's own SAR operations and accomplishments after the incident. A statement that a board of officers may be appointed to investigate and determine the exact cause of the incident should also be made.

C. After an official release of information by the parent Service, other Services participating in the SAR mission may release a full description of their own SAR operations and accomplishments.

1325 Release of Names

A. Casualties

1. Names of military casualties should be released only by the Service to which the casualties belong, and release should follow Service directives. These directives are specific and require notification of next of kin before the names are released. Where facts of the incident are obvious to the public, another Service participating in the mission may release the number of deceased, the number of survivors, and the number of injured survivors. When circumstances permit, such queries should be referred to the parent Service.

2. The SMIO should use good judgment in releasing the names of civilian casualties. Every reasonable effort should be made to notify the next of kin as soon as possible. This can usually be accomplished with the assistance of local police or the American Red Cross.

B. Survivors

1. Names and addresses of survivors should not be released until positive identification has been accomplished. Generally, survivor information should not be released prior to release of casualty information, although circumstances may permit exceptions.

2. Survivors should be encouraged and assisted in contacting their families as soon as possible. However, SMIOs should tactfully brief survivors on releasing information and possible reasons for withholding information.

C. SRU Crews. Unless prohibited by the parent Service, names of personnel assigned to SRUs may be released.

GLOSSARY

A-probability: Percentage representing probability that the "A" rather than the "B" solution represents a real position.

A-solution: Of the two solutions derived from single satellite pass data, the one more likely to be related to the real position.

Active Site: Position retained in the MCC data base for potential correlation with other data.

Advanced SAR Staging Base: A suitable preselected location with the SMC near possible SAR incidents for staging SRUs, and supporting personnel.

Advisory Area: A designated area within a flight information region where air traffic advisory service is available.

Aerodrome: A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft. Airport.

Aeronautical Fixed Service (AFS): A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aerospace Drift (Da): Drift caused by bailout trajectory or aircraft gliding distance.

Aerospace Position: Initial position of a distressed aircraft at the time of reentry, engine failure, aircrew ejection or bailout.

Airborne Warning and Control System (AWACs): USAF Boeing E-3 airborne radar system. Records primary and secondary radar targets. System capabilities classified. Recorded data is retained for a period not exceeding 10 days by the 552nd AWAC Wing (TAC), Tinker AFB, Oklahoma.

Aircraft Glide: Maximum ground distance an aircraft could cover during descent.

Air Route Traffic Control Center (ARTCC): An FAA facility providing air traffic control service principally during en route flight to aircraft operating on IFR flight plans within controlled airspace.

Air Traffic Control (ATC): A service operated by an appropriate authority to promote the safe, orderly, and expeditious flow of air traffic.

ALERFA: ICAO equivalent to Alert phase.

Alert: COSPAS-SARSAT report of an apparent distress routed to the search and rescue system.

Alert Notice (ALNOT): A message sent by an FSS or an ARTCC that requests an extensive communications search for overdue, unreported, or missing aircraft.

Alert Phase: An emergency phase assigned when apprehension exists for the safety of a craft or person because of information that serious difficulties may exist which do not amount to a distress, or because of continued lack of information concerning progress or position.

Alerting Post: Any facility other than a coast radio station designed to serve as an intermediary between a person reporting an incident or other emergency and an RCC or RSC.

Area Control Center: An ICAO term for an ATC facility responsible for providing enroute IFR services. The U.S. Equivalent is ARTCC.

Assistant RCC Controller: A person assigned to assist an RCC controller.

Automated Mutual-Assistance Vessel Rescue System (AMVER): A worldwide vessel-reporting system for SAR, operated by the Coast Guard for maintaining estimated position and other data of merchant vessels that voluntarily participate.

Automated Radar Tracking System (ARTSIII/IIIa): FAA terminal ATC radar tracking system, usually associated with a single radar sensor or antenna with a 60 nautical mile range. Some ARTSIIIa computers located at major metropolitan area record from multiple radar sensors. ARTSIII records secondary radar targets only. ARTSIIIa records both primary and secondary radar data. Data is retained for 15 days.

Awareness Range: Distance at which a search scanner can first detect something different from its surroundings but not yet recognize it.

Awareness Stage: A period during which the SAR system becomes aware of an actual or potential incident.

B-probability: Percentage representing probability that the "B" rather than the "A" solution represents a real position.

B-solution: Based on single satellite pass data, the solution least likely to represent a real position.

Beacon: Device operating on 121.5, 243, or 406 MHz intended solely for distress signaling.

Beacon Alarm: Alert determined to result from a beacon signal.

Beacon Protocol: One of seven formats defined for a beacon ID, i.e., maritime/location, radio call sign, orbitography, aviation, maritime, serialized, or test.

Beacon Type: One of four types of serialized beacons, i.e., air, maritime, survival or personal locator.

Buffer Zone: Area of defined width overlapping adjacent search and rescue regions for which alerts will be provided to the Rescue Coordination Centers responsible of both regions.

Captain: Master of a ship, commanding officer of a warship, or an operator in charge of any other craft.

Captain of the Port (COTP): Operational Coast Guard command which monitors vessel entries, exits and inspections within their area of control.

Closed Site: Site which has been deleted from the active site data base.

Commence Search Point (CSP): Point normally specified by the SMC for an SRU to begin its search pattern.

Composite Solution (Composite): Computer generated position based on merging two or more matched single pass solutions.

Note: A first composite is based on the first two matching single pass (elemental) solutions, and is sometimes referred to informally as a "double hit"; a second composite is based on the first three matching single pass solutions, etc. While all past elemental solutions are used to determine the most recent composite, only the most recent elemental solutions are shown in the alert message.

Computer-Aided Search Planning (CASP): A computer search planning system which uses simulation techniques to produce multiple datum points that are displayed as a map of all possible locations.

Confidence Factor (CF): Value, normally 0.3, applied to account for errors in assumed initial distress position, sea current, wind current, and leeway. Used to determine drift error (de).

Confidence Factor (COSPAS-SARSAT): International measure of estimated solution accuracy as follows:

Precision (NM):	< 5	< 20	< 50	> 50
Common Description:	Good	Medium	Poor	
ICAO/ITU Class:	A	B	C	D

Continuous Data Recording (CDR): Data extraction terminology associated with FAA ARTSIII/IIIA and E-ARTS tracking systems.

Coordinated Search Pattern: Multiunit pattern using vessel(s) and aircraft.

Coordinator Surface Search (CSS): A vessel, other than an SRU, designated to coordinate surface SAR operations within a specified search area.

Core Frequency: Estimate of the primary frequency of a signal detected by COSPAS-SARSAT.

Coriolis Force: The effect of earth rotation upon wind-driven currents.

COSPAS: Cosmicheskaya Sistyema Poiska Avariynych Sudov - Space System for Search of Distressed Vessels. U.S.S.R. segment of COSPAS-SARSAT satellite system. See Search and Rescue Satellite-Aided Tracking.

Country of Registration: Country identified in coding of a 406 MHz beacon.

Course: The intended horizontal direction of travel of a craft.

Coverage Factor (C):

1. A measure of search effectiveness or quality.
2. Intermediate calculation when developing Probability of Detection (POD).

3. Ratio of sweep width to track spacing (C = W/S).

Coverage Factor, Mean (Cm): The average of all coverage factors. Used to obtain Cumulative Probability of Detection.

Craft: Any vessel, submersible, or aircraft of any kind and size.

Cumulative Probability of Detection: The likelihood of finding a target as determined from the mean coverage factor together with the appropriate curve for the number of searches.

Datum: The most probable location of the search object, corrected for movement over time.

Datum Area: Area in which the search object is initially assumed to be located with equal likelihood throughout the area.

Datum Line: Line connecting two or more datum points computed for the same specified time, along which the search object is assumed to be located with equal likelihood.

Datum Marker Buoy (DMB): Droppable floating beacon used to determine actual sea current, or to serve as a location reference.

Datum Minimax: Datum point established midway between the resultant minimum drift position (dmin) and the resultant maximum drift position (dmax).

Dead Reckoning (DR): Determination of position by advancing a previous position for courses and distances.

DETRESFA: ICAO equivalent to Distress phase.

Digital Selective Calling (DSC): System primarily used in GMDSS for transmitting distress alerts from ships and associated acknowledgements from coast stations, and for relaying alerts from ships or coast stations.

Direction of Current: Direction toward which a current is flowing. Also see set.

Direction of Waves, Swells, or Seas: Direction from which the waves, swells, or seas are moving.

Direction of Wind: Direction from which the wind is blowing.

Disabled: Term describing a surface craft that has lost propulsion or steering and needs assistance.

Distress Alarm: Alarm confirmed to be for an actual distress situation.

Distress Alarm Rate: Ratio of distress alarms to beacon alarms.

Distress Incident: Situation in which life, limb or property is imperiled.

Distress Phase: An emergency phase assigned when immediate assistance is required by a craft or person because of threat of grave or imminent danger, or because of continued lack of information concerning progress or position after procedures for the Alert phase have been executed.

Ditching: Forced landing of an aircraft on water.

Douglas Sea State: A wave height scale, similar to WMO code 75 and Beaufort Scale, used in determining radar detection capabilities under certain sea conditions.

Drift: The movement of a search object caused by external forces.

Drift Compensation: A correction used to account for target motion during a search.

Drift Error (De): See Total Drift Error.

Effort (Z): A measure of area SRUs will actually search within the limits of search speed, endurance, and sweep width.

Elemental Solution: Single satellite pass solution upon which a composite solution is based.

Emergency Locator Transmitter (ELT): Aeronautical distress beacon for alerting and transmitting homing signals. May be referred to as Emergency Location Beacon (ELBA), or Crash Position Indicator (CPI).

Emergency Phase: Any of the phases into which SAR incidents and subsequent SAR missions are classified. See Uncertainty phase, Alert phase, and Distress phase.

Emergency Position-Indicating Radio Beacon (EPIRB): Maritime distress beacon for alerting. It may also transmit homing signals.

En Route Automated Radar Tracking System (E-ARTS): ARTCC tracking computer similar to the terminal ARTSIII systems. E-ARTS facilities are located at San Juan, PR, Anchorage, AK, and Honolulu, HI. Records primary and secondary radar data from multiple radar sensors or antennas.

Recorded data is retained for 15 days.

Ephemeris Data: Information from which the location of a COSPAS-SARSAT satellite relative to the earth may be determined for any time within a specified time interval.

Extended Communications Search (EXCOM): Comprehensive communications search to find information or clues about the location of missing persons. Normally conducted after a PRECOM has yielded no results, or when the mission is upgraded to the Alert phase.

False Alarm: Term used in various ways to indicate lack of alarm reliability which includes hoaxes, inadvertent alarms and those unknown number of unresolved alarms that are not related to a distress incident.

False Alert: Term used in various ways to indicate lack of alert reliability which includes non-beacon alerts and those unknown number of unresolved alerts that did not result from a beacon signal (unresolved alerts may include some unknown beacon signals).

Fetch: The distance the waves are driven by a wind blowing in a constant direction, without obstruction.

First Alert: First signal detection notification with "A" and "B" solutions.

First RCC: RCC affiliated with the shore station that first acknowledges a distress alert, and which should assume responsibility for all subsequent SAR coordination unless and until responsibility is accepted by another RCC better able to take action.

Fix: A geographical position determined by visual reference to the surface, referencing to one or more radio navigation aids, celestial plotting, or other navigation device.

Fleet Area Control and Surveillance Facility (FACSFAC): USN computerized radar tracking facilities located along CONUS coastlines and Hawaii. Recores primary and secondary data from coastline out to sea. Recorded data is retained for 15 days.

Flight Information Region (FIR): An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight Information Service (FIS): A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Flight Service Station (FSS): An air traffic facility that provides en route communications and VFR SAR services, assists lost aircraft and aircraft in emergency situations, and originates Notices to Airmen.

Forward-Looking Airborne Radar (FLAR): Any aircraft-mounted radar designed to detect targets on or near the ocean surface by scanning a sector typically centered in the direction of aircraft heading. FLAR may also perform weather-avoidance/navigation in support of aircraft operations.

Forward-Looking Infrared Radar (FLIR): An imaging system, mounted on board surface vessels or aircraft, designed to detect thermal energy (heat) emitted by targets and convert into visual display.

Global Maritime Distress and Safety System (GMDSS): A system established to provide distress and safety communications between ships at sea and rescue coordination centers using a wide variety of existing and technologically advanced communications.

Great Circle: Line between two points on a gnomonic projection chart.

Ground Speed (GS): The speed an aircraft is making relative to the earth's surface.

Ground Track: See Satellite Ground Track.

Heading: The horizontal direction in which a craft is pointed.

Hoax: Beacon alarm determined to result from a beacon activation or any other distress signal intended for deceptive purposes.

Hypothermia: Abnormal lowering of internal body temperature (heat loss) from exposure to cold air, wind, or water.

IFF: Outdated recognized term, "Identification, Friend or Foe," for radar interrogation of aircraft.

Image (mirror image): Of the two positions associated with a single satellite pass, the one from which a signal is not emanating.

Inadvertent Alarm: Unintentional beacon alarm determined to result from an improperly conducted beacon test or accidental beacon activation.

Inadvertent Alarm Rate: Ratio of inadvertent alarms to beacon alarms.

INCERFA: ICAO equivalent of the Uncertainty Phase.

Incident Command System (ICS): An on-scene Management-By-Objectives system for any type of incident.

Individual Drift Error (de): Individual Drift multiplied by Confidence Factor.

Information Request (INREQ): A message request for information about an unreported or overdue aircraft in United States domestic airspace. Corresponds to the declaration of the Uncertainty phase.

Initial Action Stage: A period during which preliminary action is taken to alert SAR facilities and obtain amplifying information.

Initial Position Error (X): The assumed error of the initially reported position of a SAR incident.

International Maritime Satellite Organization (INMARSAT): A system of telephone direct-voice communications via geostationary satellites.

Instrument Flight Rules (IFR): Rules governing the procedures for conducting instrument flight. Also a term used by pilots and controllers to indicate type of flight plan.

Instrument Meteorological Conditions (TMC): Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima specified for visual meteorological conditions.

Interagency Committee on Search and Rescue (ICSAR): Established to oversee the National Search and Rescue Plan and to act as a coordinating forum for national SAR matters.

Interferer: Non-beacon radio signals on beacon frequencies.

Knot (kt): A unit of speed equal to one nautical mile per hour.

Last Known Position (LKP): Last witnessed, reported, or computed DR position of a distressed craft.

Leeway (LW): The movement of a search object through water caused by winds blowing against exposed surfaces.

Local Base SAR Officer: An officer, appointed by the commanding officer of an operational military base, to coordinate the use of local resources with the regional RCC.

Local User Terminal (LUT): Ground station receiving, processing and relaying data from COSPAS-SARSAT satellites.

Location: Exact geographical position of a beacon or other search object.

Locating: Process of pin-pointing the location of a beacon or search object by homing or other means.

Maritime Assistance Request Broadcast (MARB): A relay request for assistance made by Coast Guard units for vessels needing non-emergency assistance.

Match: Determination that solutions from different satellite passes likely emanate from the same signal source. (Matched solutions are merged to produce composite solutions. Unmatched positions are designated "images".)

MAYDAY: Spoken international distress signal, repeated three times.

Mean Coverage Factor (Cm): The average of all coverage factors. Used to obtain Cumulative Probability of Detection.

MEDEVAC: Evacuation of a person for medical reasons.

MEDICO: Medical consultation. Exchange of medical information and recommended treatment for sick or injured persons where treatment cannot be administered directly by prescribing medical personnel.

Merchant Ship Search and Rescue Manual (MERSAR): Published by the International Maritime Organization to guide masters of vessels at sea during emergency situations.

Merge: Process of developing composite solutions by combining matched single pass (elemental) solutions.

Meteorological Visibility: The maximum range at which a large object, such as land masses or mountains, can be seen. Also referred to as Meteorological Range.

Military Assistance to Safety and Traffic (MAST): An Army and Air Force program to assist in serious civilian medical emergencies by providing transportation.

Military Direct Access Radar Channel (M-DARC): Computerized radar tracking system operated by the 6521st Test Squadron at Edwards AFB, CA. Records primary and secondary radar data from 10 radar sensors located in south central California. Recorded data is retained for 30 days.

Minimax Solution: A means of obtaining datum and drift error, when one or more drift variables cannot be accurately determined, by calculating a minimum and maximum drift.

Mission Conclusion Stage: A period during a SAR incident when SAR facilities return to their regular location and prepare for another mission.

Mission Control Center (MCC): Ground system element of COSPAS-SARSAT which receives data from Local User Terminals, exchanges information with other Mission Control Centers, and distributes alerts and other COSPAS-SARSAT information primarily within its associated service area.

Narrow Band Direct Printing (NBDP): A single channel synchronous radiotelegraph system that uses a 7-unit code, 170 Hz frequency shift with a modulation rate of 100 baud.

National Airspace System Computer (NAS computer): Terminology associated with ARTCC ATC tracking coputers.

National SAR Plan (NSP): An interagency agreement providing a national plan for the coordination of SAR services to meet domestic needs and international commitments.

National Track Analysis Program (NTAP): An FAA system for retrieval of computer-stored radar data to locate a missing aircraft's last position.

NAVAREA Warning: Long-range warning broadcasts issued by an area coordinator of the World-Wide Navigational Warning Service for the associated area. Broadcast is made with sufficient power to cover the entire area for which the area coordinator is responsible.

NAVTEX: Direct printing telegraphy system for transmission of navigation and meteorological warnings and urgent information to ships.

Non-Beacon Alert: Alert determined to result from other than a beacon activation.

On Scene: The search area or the actual distress site.

On Scene Commander (OSC): Commander of an SRU assigned to coordinate SAR operations within a specified search area.

Operations Center: Multi-mission Coast Guard Centers which may function as Rescue Coordination Centers.

Operations Stage: A period during a SAR incident when SAR facilities proceed to the scene, conduct search, rescue survivors, assist distressed craft, provide emergency care for survivors, and deliver survivors to a suitable facility.

Overlap Zone: Area of predetermined width common to two or more service areas.

PAN: The international radio-telephony urgency signal. When repeated three times indicates uncertainty or alert, followed by nature of urgency.

Parachute Drift (dp): The combined drift of parachute glide ratio and its displacement due to winds aloft.

Planning Stage: A period during a SAR incident when an effective plan of operations is developed.

Position: Either of two alert solutions representing a geographical place normally expressed in degrees and minutes of latitude and longitude.

Positioning: Process of determining a position which can serve as a geographical reference for conducting a search.

Preliminary Communications Search (PRECOM): Initial limited communications check, normally directed by the SMC during the Uncertainty phase, of areas where the missing persons may be.

Primary Radar Return: Radar signal (RF) energy reflected off of skin or surface of an aircraft.

Primary RCC: Rescue Coordination Center with an associated Search and Rescue Region into which a position falls.

Primary Swell: The swell system having the greatest height from trough to crest.

Probability of Detection (POD): The probability that the search object will be detected provided it is in the area searched. Measures search results.

Probability of Success (POS): The probability the search object is in the search area and that it will be located. Measure of search effectiveness.

Probability Area: Area in which it is believed a distress case may be located.

Radarfind (RADF): Computer program designed to rapidly locate available recorded radar data to assist in the location of missing/downed aircraft.

RCC Controller: The SAR Coordinator's duty officer in the RCC.

Real Position: Position from which a signal is emanating.

Repeated Expansion: Successive enlargement of the search area.

Rescue Coordination Center (RCC): A unit responsible for promoting efficient organization of SAR services and coordinating conduct of SAR operations within a Search and Rescue Region (SRR).

Rescue Sub-Center (RSC): A unit subordinate to an RCC established to complement the latter within a specified Sector within a Search and Rescue Region.

Rescue Unit (RU): A unit composed of trained personnel and provided with equipment suitable for expeditious conduct of rescue operations.

Rhumb Line: Line between two points on a mercator projection chart.

Right of Assistance Entry (RAE): The right to enter a foreign territorial sea to engage in bona fide efforts to render emergency assistance to those in danger or distress from perils of the sea.

Safety Factor (fs): A factor used to enlarge the search area to increase the chance of the target being in the search area.

SAR Airspace Reservation: Temporary airspace reservation to prevent non-SAR aircraft from interfering with SAR operations.

SAR Briefing Officer: An officer appointed, usually by the SMC, to brief departing SRUs and debrief returning SRUs.

SAR Case: Any potential or actual distress about which a unit opens a documentary file, whether or not SAR resources are dispatched.

SAR Coordinator (SC): The agency or official responsible for the SAR organization and coordination of SAR operations in a given area or region.

SAR Facility: Any unit, command, device, or system used for SAR operations.

SAR Incident: Any situation requiring notification and alerting of the SAR system and which may require SAR mission(s).

SAR Liaison Officer: An officer assigned to promote coordination during a SAR mission.

SAR Mission: Any SAR situation involving dispatch of SAR resources.

SAR Mission Coordinator (SMC): The official assigned by the SAR Coordinator to coordinate and control a SAR mission.

SAR Mission Information Officer (SMIO): The official designated by the SMC for coordinating, controlling, and disseminating news releases, or other information, concerning a specific SAR mission.

SAR Plan: Description of SAR resources, procedures, and areas of responsibility.

SAR Points of Contact (SPOC): Rescue Coordination Centers and other established and recognized national points of contact that can accept alert data to enable the rescue of persons in distress.

SARSAT: See Search and Rescue Satellite-Aided Tracking.

SAR Stage: Standard steps in the orderly progression of SAR missions, normally Awareness, Initial Action, Planning, Operations, and Mission Conclusion.

Satellite Ground Track: Path on the earth's surface directly below a satellite's orbit.

Sea: Condition of the surface resulting from waves and swells.

Sea Current (SC): The residual current when currents caused by tides and local winds are subtracted from local current. It is the main, large-scale flow of ocean waters.

Search Action Plan: Message, normally developed by the SMC, for passing instructions to SRUs and agencies participating in a SAR mission.

Search and Rescue (SAR): The use of available resources to assist persons and property in potential or actual distress.

Search and Rescue Region (SRR): A defined area with an RCC, within which SAR services are provided.

Search and Rescue Satellite-Aided Tracking (SARSAT): International system of satellites and ground network for distress alerting, positioning, and using of emergency beacons. Combined with U.S.S.R. segment, COSPAS, to form the COSPAS-SARSAT system.

Search and Rescue System: An arrangement of components activated as needed to efficiently and effectively aid persons or property in actual or potential distress.

Search and Rescue Unit (SRU): A specialized unit for SAR.

Search Area: Area assigned by competent authority to be searched.

Searchmaster (SM): Canadian term for an individual appointed to coordinate and direct a specific SAR operation.

Search Pattern: A trackline or procedure assigned to an SRU for searching a specified area.

Search Radius (R): Radius of a circle centered on a datum, having a length equal to the Total Probable Error (E) plus an additional safety length to help ensure the target is in the search area.

Secondary Radar Data Only (SECRA): Indicates radar sensor or antenna records secondary or transponder data only.

Secondary Radar Return: A radio signal received from an aircraft equipped with an airborne radar beacon system. More commonly referred to as a transponder or beacon return.

Secondary RCC: Rescue Coordination Center other than a Primary RCC receiving a copy of an alert.

Secondary Swells: Swell systems of less height than the primary swell.

Sector: A defined area with an RSC, within which SAR services are provided.

Set: The direction in which water or an object moves under the influence of wind or current.

Service Area: Geographic area for which a Mission Control Center accepts responsibility to forward alerts to SAR Points of Contact.

Side-Looking Airborne Radar (SLAR): Aircraft-mounted radar designed to detect targets on or near the ocean surface by transmitting signals perpendicular to the aircraft flight track. Signal coverage of an area is achieved by aircraft motion alone, without antenna rotation.

Single Pass: Portion of a satellite orbit during which it is within view of a given position.

Single Pass Position: Position obtained from a single pass solution.

Single Pass Solution: One of two positions equidistant on each side of a ground track, one position corresponding to a real location and the other being its image, computed using doppler data from a single pass, sometimes referred to informally as a "single hit".

Site: Position identified by a site ID.

Site ID: Alphanumeric code assigned to each single pass solution. For beacons operating on 121.5 and 243 MHz, the code gives frequency, specifies whether the solution is an "A" or a "B" solution, and assigns a sequential solution number; for 406 MHz beacons, the site ID is the beacon ID.

Situation Report (SITREP): Reports, from the OSC to the SMC or the SMC to interested agencies, to keep informed of on scene conditions and mission progress.

Small Boats: Coast Guard marine SRUs under 65 feet in length.

Solution: Position determined by COSPAS-SARSAT ground processing using doppler data.

Sortie: Individual movement of a resource in rendering assistance.

Speed of Advance: Speed a surface vessel is making relative to the earth's surface.

Spurious Solutions: Solutions generated due to causes other than beacon signals.

SRU Error (Y): Search craft error based on navigation accuracy.

Strike Team (ST): A unit of resources with a leader and communications.

Surface Drift (d): Vector sum of average sea current, local wind current, and leeway. Sometimes called Total Drift.

Surface Picture (SURPIC): A printout from the AMVER computer of predicted position information on participating vessels within a defined area.

Surface Position: The position of the search object on the earth's surface at the time of initial distress, or its first contact with the earth's surface.

Sweep Rate: Number of repetitions per second of the audio modulation frequency.

Sweep Width (W): The distance on both sides of the SRU where the probability of detecting a target outside of the sweep width is equal to the probability of missing a target inside the distance. Measures detection capability based on target characteristics, weather, and other factors.

Swell: Condition of the surface caused by a distant wind system. The individual swell appears to be regular and smooth, with considerable distance between rounded crests.

Swell Direction: The direction from which a swell is moving. The direction toward which a swell is moving is called the down swell.

Swell Face: The side of the swell toward the observer. The backside is the side away from the observer. These definitions apply regardless of the direction of swell movement.

Swell Height: The height between crest and trough, measured in feet.

Swell Length: Horizontal distance between successive crests, measured in feet.

Swell Period: Time interval between the passage of two successive crests.

Swell Velocity: Velocity with which the swells advance with relation to a fixed reference point, measured in knots.

Tactical Air Navigation (TACAN): An air navigation aid used by suitably equipped aircraft.

Target: Craft or personnel missing or in distress for which a search is being made.

Terminal Radar Approach Control Facility (TRACON): FAA terminal ATC facility usually equipped with an ARTSIII/IIIa tracking computer with one or more radar sensors.

Tidal Current (TC): Current influenced predominantly by reversing currents, coastal rotary currents, or river currents.

Time of Closest Approach (TCA): Time during a satellite pass when the satellite is closest to a signal source.

Total Drift Error (De): Sum of the individual drift errors from the time of the incident until datum. Used when determining Total Probable Error (E).

Total Probable Error (E): The assumed error in datum. It is the square root of the sum of the squares of the total drift error, initial position error, and SRU error.

Total Water Current (TWC): The vector sum of currents affecting search objects.

TPX-42 Direct (Altitude and Identity Readout) (TPX-42 (DAIR)): USN and Marine Corps terminal ATC tracking computer. Normally associated with a single radar sensor with a 60 nautical mile range. Records secondary radar only. Recorded data is retained for 15 days.

Track Spacing (S); The distance between adjacent parallel search tracks.

Triage: The process of sorting survivors and assigning them priorities for emergency care, treatment, and evacuation.

True Air Speed (TAS): The speed an aircraft is making through the air.

Uncertainty Phase: An emergency phase which is assigned when doubt exists about the safety of a craft or person because of knowledge of possible difficulties, or because of lack of information concerning progress or position.

Underwater Position: The position of a sunken search object when it first makes contact with the bottom.

Unified Command: A command with a broad continuing mission under a single commander and composed of significant assigned components of two or more Services.

Universal Time Coordinated (UTC): International term for time at the prime meridian (once called "Greenwich Mean Time").

Unresolved Alert: Alert for which the cause remains undetermined.

Unresolved Alarm: Alert known to result from a beacon activation, but for which the cause of activation remains undetermined.

Unresolved Alarm Rate: Ratio of unresolved alarms to beacon alarms.

USMER: System implemented under MARAD's authority to collect vessel information for national emergency purposes; AMVER reports on USMER vessels are released to MARAD when the reporting vessel includes the word "MAREP" on the "x" line of the AMVER reports.

Vector: A graphic representation of measurement having both magnitude and direction.

Visual Flight Rules (VFR): Rules governing procedures for conducting flight under visual conditions. The term "VFR" is also used in the United States to indicate weather conditions equal to or greater than minimum VFR requirements. In addition, used by pilots and controllers to indicate type of flight plan.

Wave (or Chop): The condition of the surface caused by local wind and characterized by irregularity, short distance between crests, whitecaps, and breaking motion.

Wind-Corrected Heading: The actual heading an aircraft is required to fly to make good an intended course.

Wind Current (WC): The water current generated by wind acting upon the surface of water over a period of time.

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APPENDIX A. NATIONAL SEARCH AND RESCUE PLAN - 1986

1. POLICY

It is the policy of the signatory agencies to provide a national plan for coordinating search and rescue services to meet domestic needs and international commitments.

2. PURPOSE

This Plan continues by interagency agreement, the effective use of all available facilities in all types of search and rescue missions. The National Search and Rescue Plan-1981 is superseded by this Agreement.

3. DEFINITIONS

a. Search and Rescue (SAR) is the use of available resources to assist persons and property in potential or actual distress.

b. Rescue Coordination Center (RCC) is a unit responsible for promoting efficient organization of SAR services and coordinating conduct of SAR operations within a Search and Rescue Region.

c. Rescue Sub-Center (RSC) is a unit subordinate to an RCC established to complement the latter within a Sector.

d. Search and Rescue Region (SRR) is a defined area in which SAR services coordinated by a single RCC are provided.

e. Search and Rescue Sector (SRS) is a specified area within an SRR in which SAR services coordinated by a single RSC are provided.

4. OBJECTIVE

This Agreement provides a National Search and Rescue Plan integrating into a cooperative network available United States SAR facilities which can be coordinated in any one Area by a single Federal agency. This affords greater protection of life and property and ensures greater efficiency and economy. It is not the intent for the Plan to conflict in any way with SAR responsibilities agreed to by contracting states of the Convention on International Civil Aviation, the International Convention on Maritime Search and Rescue or other appropriate international instruments to which the United States is or may become a party.

5. SCOPE

This Plan is solely intended to provide internal guidance to all signatory Federal agencies. State organizations may wish to retain established SAR responsibilities within their boundaries for incidents primarily local or intrastate in character. In such cases, appropriate agreements are made between SAR Coordinator(s) and respective State organizations.

6. PARTICIPATING AGENCIES

a. The agencies of the Department of Transportation carry out broad responsibilities in transportation safety. The United States Coast Guard develops, establishes, maintains and operates rescue facilities for the promotion of safety on, under and over the high seas and waters subject to the jurisdiction of the United States. The Coast Guard also conducts safety inspections of most merchant vessels and investigations of marine casualties. The Federal Aviation Administration has air traffic control and flight service facilities available to assist in SAR operations. The Maritime Administration operates a fleet of merchant ships for government use and promotes a safe Merchant Marine.

b. Department of Defense components provide SAR facilities for their own operations. These facilities may be used for civil needs on a not-to-interfere basis with military missions.

c. The Department of Commerce participates in or supports SAR operations through the National Oceanic and Atmospheric Administration (NOAA) which provides nautical and aeronautical charting; information on tides and tidal currents; marine environmental forecasts and warnings for the high seas, and coastal and inland waterways; and satellite services for detecting and locating aircraft, ships or individuals in potential or actual distress.

d. The Federal Communications Commission promulgates rules and regulations for non-government use of wire and radio facilities for promoting safety of life and property, and cooperates in SAR operations through its long-range direction finder network.

e. The National Aeronautics and Space Administration (NASA) has aircraft, spacecraft and world-wide tracking, data acquisition and communications networks which can assist in SAR operations. NASA supports SAR objectives through research and development or application of aerospace technology to search, rescue, survival, and recovery related equipment such as location tracking systems, transmitters, receivers, and antennas capable of locating aircraft, ships, spacecraft, or individuals in potential or actual distress.

f. Land managing components of the Department of the Interior (DOI) can provide SAR services on lands and waters administered by DOI and may assist in operations in adjacent jurisdictions. The degrees of responsibility assumed in each DOI field area depends upon the legislative and jurisdictional character of the bureau and field area. Responses range from support of law enforcement authorities or other local units to primary SAR coordination and execution. Similarly, components assume varying degrees of responsibility for preventative measures to protect the visiting public.

g. The Federal Emergency Management Agency (FEMA) establishes Federal policies for, and coordination of, all civil defense and civil emergency planning, management, mitigation and assistance functions of executive agencies. FEMA assists State and local governments in coordinating civil emergency preparedness, response and civil recovery activities, and develops and operates telecommunication, warning and electronic systems for civil emergency assistance. FEMA supports SAR activities within this framework.

h. Certain State and local governments and civil organizations have facilities which contribute to the effectiveness of the over-all SAR network.

7. PLAN

a. Coordination of Agencies

The Interagency Committee on Search and Rescue, consistent with applicable laws and executive orders, coordinates implementation of the Plan. It reviews SAR matters affecting more than one agency, including recommendations of participating agencies for revision or amendment of the Plan, and makes appropriate recommendations. It encourages Federal, State, local and private agencies to develop equipment and procedures to enhance national SAR capability, and promotes coordinated development of all national SAR sources.

b. SAR areas

To help assign United States SAR coordination responsibilities, three SAR Areas are identified. Federal agencies are assigned overall responsibility for coordinating SAR within each Area. The Inland and Maritime Areas include aeronautical and maritime SRRs for which the United States has primary SAR coordination responsibility. These SRRs are established in coordination with the International Civil Aviation Organization and the International Maritime Organization. The Overseas Area helps provide for SAR interests beyond the limits of the Inland and Maritime Areas, and does not generally include internationally recognized SRRs for which the United States is primarily responsible. SAR Areas are as follows:

(1) Inland Area. Continental United States, except Alaska, and waters under the jurisdiction of the United States.

(2) Maritime Area. Waters subject to the jurisdiction of the United States; Hawaii; portions of Alaska south of 58 degrees north latitude and east of 141 degrees west longitude; and the high seas and those commonwealths, territories and possessions of the United States lying within the "Maritime Area" as designated on the attached chart. The Maritime Area has two parts, the Atlantic Area and the Pacific Area.

(3) Overseas Area. The inland area of Alaska and all other portions of the globe not included within the Inland Area or Maritime Area.

c. Area SAR Coordinators

(1) The Federal agencies named below are the designated SAR Coordinators for the various SAR Areas:

Inland Area. United States Air Force
Maritime Area. United States Coast Guard
Overseas Area. Appropriate overseas unified command or Alaskan Air Command

(2) An Area SAR Coordinator may subdivide the

Area for the advantageous execution of this Plan and designate an appropriate officer as SAR Coordinator for each subdivision or combination of subdivisions as appropriate. Each subdivision will be served by an RCC, and its boundaries should coincide with pertinent international SRR boundaries. Where this is impossible or impracticable, changes to international boundaries should be proposed to the appropriate international organization through proper channels by the agency primarily concerned. Similarly, an Area SAR Coordinator may establish Sectors, each with an associated RSC. A SAR Coordinator for an SRR is usually also the SAR Coordinator for any Sector within the SRR.

(3) It is not intended that SAR Coordinators have primary responsibility for SAR in foreign territory or areas of the high seas which have not been accepted by the United States for international SAR responsibility. However, it is intended that an appropriate SAR Coordinator or designated subordinate act as the United States official for overseeing coordination of all United States SAR interests in such areas.

d. SAR Network

(1) SAR Coordinators should, consistent with applicable laws and executive orders, organize existing agencies and their facilities through suitable agreements into a basic network to (a) assist military and non-military persons and property in potential distress or actual distress, and (b) carry out SAR obligations under international instruments to which the United States is a party.

(2) Agreements between a SAR Coordinator and the Army, Navy, Air Force, JCS Unified Command, or Coast Guard should provide for the fullest practicable use of facilities of such agencies in SAR missions under the SAR Coordinator, consistent with statutory responsibilities and authorities and assigned agency functions, and delegation of authority by such agencies to the SAR Coordinator for coordination of their facilities committed to such missions.

(3) Agreements between a SAR Coordinator and civil agencies of the Federal Government should provide for the fullest practicable cooperation of such agencies in SAR missions under the SAR Coordinator, consistent with statutory responsibilities and authorities and assigned agency functions, and for such coordination by the SAR Coordinator of their facilities committed to such missions as may be necessary and practicable.

(4) Agreements between a SAR Coordinator and State, local, and private agencies should provide for the fullest practicable cooperation of such agencies in SAR missions under a SAR Coordinator, consistent with the willingness and ability of

such agencies to engage in SAR, and for such coordination by the SAR Coordinator of their facilities committed to such missions as may be necessary and practicable.

(5) Each SAR Coordinator should maintain files of such agreements, and lists of such agencies and of the locations of their SAR facilities.

e. SAR Operations

(1) SAR Coordinators should develop plans and procedures for effective use of all available SAR facilities within their SRRs, and to carry out the objectives of this Plan if military forces are withdrawn because of a military emergency or change in military missions.

(2) SAR Coordinators may be assisted by, or may request assistance from, interested Federal agencies having SAR capabilities.

(3) RCCs having international responsibilities conform to SAR procedures established as standards or requirements by international conventions to which the United States is a party, unless differences or reservations have been filed by the United States.

(4) SAR Coordinators should, through an appropriate RCC, coordinate and, as appropriate, direct operations of SAR facilities committed to any SAR mission, consistent with the provisions of this Plan, and plans of the Area SAR Coordinator.

(5) On scene coordination and direction may be delegated to any appropriate unit participating in a particular incident under the cognizance of the SAR Coordinator.

(6) SAR Coordinators of adjacent subdivisions of the same or different SAR Areas should

maintain liaison with and support each other in SAR operations as appropriate.

(7) SAR Coordinators should maintain liaison and cooperate with SAR forces of other nations as appropriate and feasible.

f. General Provisions

(1) SAR Coordinators should encourage development and maintenance of proficiency in SAR techniques and procedures by participating agencies and assist as appropriate.

(2) SAR Coordinators should encourage the continued development of State and local SAR facilities as appropriate.

(3) Boundaries of SAR Areas or Area subdivisions established by or under this Plan are not to be construed as barriers to effective SAR operations, initiative or judgment.

(4) No provision of this Plan or any supporting plan is to be construed as an obstruction to prompt and effective action by any agency or individual to relieve distress whenever and wherever found.

(5) No provisions of this Plan or any supporting plan are to be construed in such a way as to contravene responsibilities and authorities of any participating agency as defined by statutes, executive orders or international agreements, or established responsibilities of other agencies and organizations which regularly assist persons and property in distress resulting from incidents of a local nature.

(6) This Plan does not encompass SAR for salvage operations.

(7) This Plan does not encompass SAR for such activities as military undersea rescue, special or unusual operations of the Armed Forces, rescue of persons or property in outer space, emergencies affecting the public welfare resulting from enemy attack, insurrections, civil disturbances, public disasters or equivalent emergencies which endanger life and property or disrupt the usual process of government. However, the SAR organization and its facilities should be used to the maximum extent feasible in connection with these activities.

(8) Although Federal leadership in SAR is generally recognized, the Federal Government does not compel State, local, or private agencies to conform to a national SAR plan. The desires of State and local agencies to direct and control their own facilities in SAR missions resulting from intra-State or local activities within their boundaries is respected. Cooperation should be pursued through liaison and agreements.

Signature: Elizabeth Hanford Dole
Title: Secretary of Transportation
Date: September 11, 1986
For the Department of Transportation

Signature: E.C. Aldridge, Jr.
Title: Secretary of the Air Force
Date: June 26, 1986
For the Department of Defense

Signature: Malcolm Baldrige
Title: Secretary of Commerce
Date: July 21, 1986
For the Department of Commerce

Signature: Ann McLaughlin
Title: Acting Secretary of Interior
Date: September 15, 1986
For the Department of the Interior

Signature: James C. Fletcher
Title: Administrator
Date: October 16,1986
For the National Aeronautics and Space Administration

Signature: Mark S. Fowler
Title: Chairman
Date: June 13, 1986
For the Federal Communications Commission

Signature: Julius W. Bectons
Title: Director
Date: September 11, 1986
For the Federal Emergency Management Agency

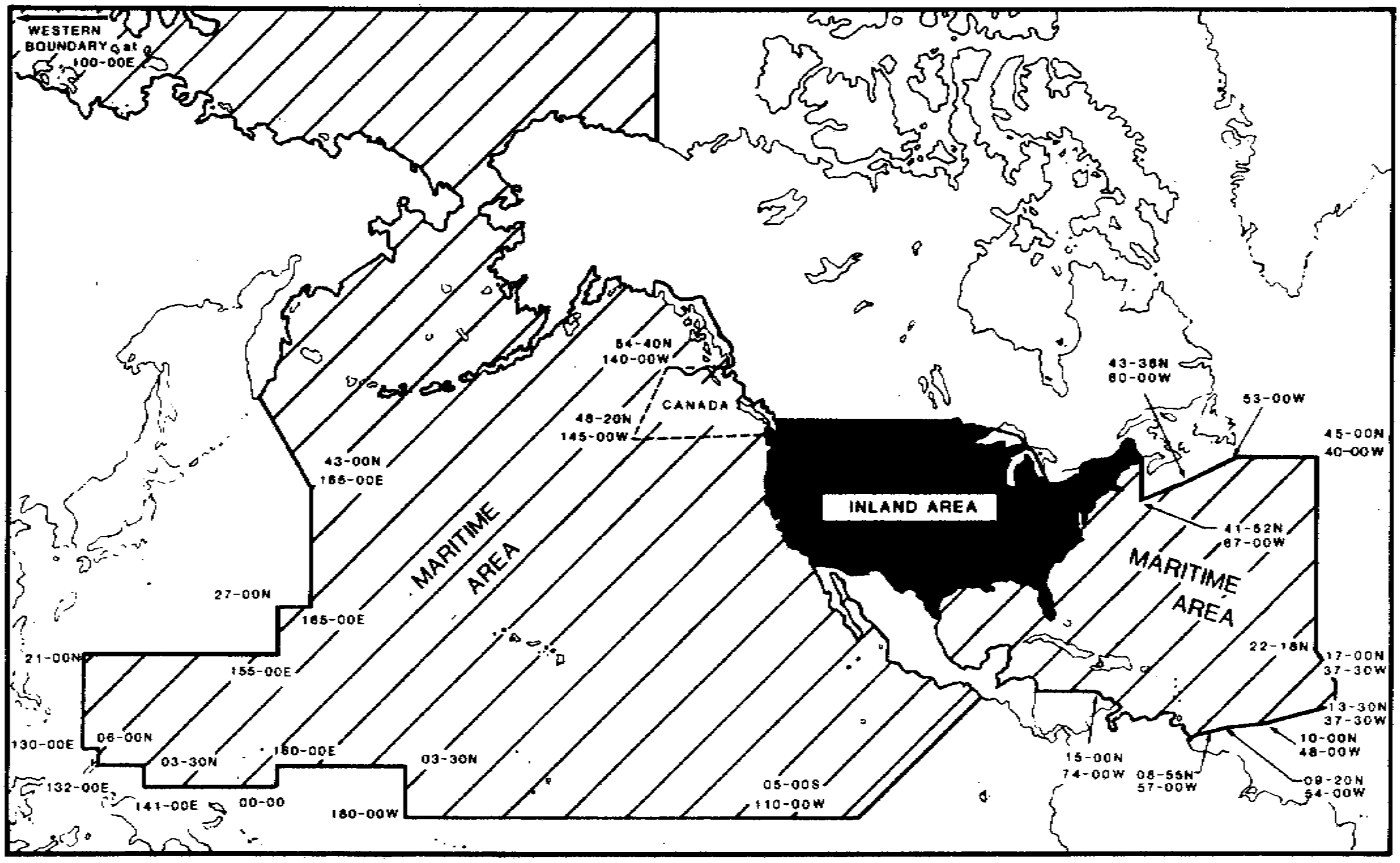

Figure A-1. United States Search and Rescue Areas
(Overseas Area includes all portions of the globe outside of the Maritime and Inland Areas)

APPENDIX B. SAR TREATIES AND INTERNATIONAL INSTRUMENTS

MULTILATERAL AGREEMENTS

Convention on International Civil Aviation December 7, 1944 (61 Stat. 1180; TIAS 1591)

Under Article 25, each contracting party "Undertakes to provide such measures of assistance to aircraft in distress in its territory as it may find practicable, and to permit, subject to control by its own authorities, the owners of the aircraft or authorities of the State in which the aircraft is registered to provide such measures of assistance as may be necessitated by the circumstances." That article also provides that "Each Contracting State, when undertaking search for missing aircraft, will collaborate in coordinated measures...".

Article 37 provides that the International Civil Aviation Organization (ICAO) shall adopt international standards and recommended practices and procedures, including "(K) Aircraft in distress and investigation of accidents. States finding it impracticable to comply in all respects with any such standard or procedure shall notify the Organization to that effect, as provided in Article 38.

ICAO has from time to time adopted and amended various International Standards and Recommended Practices, including those on SAR printed as Annex 12 to the Convention. That annex is "applicable to the establishment, maintenance and operation of SAR services in the territories of Contracting States and over neighboring seas, and to the coordination of such services with those of neighboring States." The foreword also indicates standards or specifications "for physical characteristics, configurations, material, personnel, or procedures ... to which Contracting States will conform in accordance with the Convention. In the event of impossibility of compliance, notification to the Council is compulsory under Article 38."

Under the Standards in Annex 12, contracting States are required to provide assistance to aircraft in distress and to survivors of aircraft accidents, regardless of their nationality. They must also permit immediate entry of aircraft, equipment, and personnel (subject to their control) necessary to search for aircraft in distress or rescue survivors of aircraft accidents, and coordinate their SAR organizations with those of neighboring Contracting States. They are required to delimit, either separately or jointly, SAR areas and establish in each an RCC equipped with rapid and reliable communications. They are to designate rescue units and provide them with equipment suitable for the region. Procedures for RCCs and SAR are specified.

International Convention on Maritime Search and Rescue, 1979

This is the primary international convention that applies to personnel involved in maritime SAR in the United States. The objectives of this Convention are to standardize SAR worldwide, facilitate intergovernmental direct contact, ensure cooperation between surface and air SAR units, and provide guidance where needed for development of national SAR services. The Convention and its technical annex apply to parties to the Convention. Certain conference resolutions applicable to all maritime nations are also published with the Convention. Implementation of the Convention should result in fewer delayed rescue attempts, more economical use of resources, and minimized duplication of effort.

One article provides that the Convention will not interfere with, or otherwise prejudice, other laws of the sea or national jurisdictions; that is, provisions of other conventions are preserved.

The technical annex has six chapters, one each on terms and definitions, organization, cooperation, preparatory measures, operating procedures, and ship reporting systems. The IMO Search and Rescue Manual provides additional guidance for implementing the Convention.

Chapter 2 deals with the structure of national SAR organizations. Parties to the Convention are required to take urgent steps to assist any person in distress at sea, regardless of nationality, status, or circumstance. Information on national SAR resources is to be collected by IMO, which will publish it as part of a worldwide SAR plan. Parties should establish SAR regions by mutual agreement with their SAR neighbors, or provide for an equivalent way of coordinating SAR services internationally.

Chapter 3 embraces the key to success of the Convention, coordination with neighboring nations.

It discusses territorial issues and provides for development of bilateral and multilateral SAR agreements. RCCs are identified as having the key role in international SAR operational coordination.

Resolution 6 provides for IMO development of a global distress and safety communications system, another key to success of the Convention.

Convention with Respect to Assistance and Salvage at Sea
September 23, 1910 (37 Stat. 1658; TIAS 576)

This Convention contains the provision that "Every master is bound, so far as he can do so without serious danger to his vessel, her crew and passengers, to render assistance to everybody, even though an enemy, found at sea in danger of being lost." It also has provisions regarding remuneration in connection with assistance and salvage at sea.

Convention on the High Seas
April 29, 1958 (13 UST 2312; TIAS 5200; 450 UNTS 82)

Article 12 of this treaty provides that every State shall require the master of a ship sailing under its flag, insofar as he can do so without serious danger to the ship, to render assistance to any person at sea in danger of being lost, and to proceed with all possible speed to the rescue of persons in distress if informed of their need of assistance, insofar as such action may reasonably be expected of him. After a collision, he is to render assistance to another ship, her crew, and passengers, and where possible, to inform the other ship of the name of his own ship, her port of registry, and the nearest port of call. These provisions are codified in United States law at 46 USC 2304 and 2305.

The article also requires every coastal State to promote the establishment and maintenance of an adequate and effective rescue service and -- where circumstances so require -- to cooperate with neighboring States for this purpose through mutual regional regional arrangements.

International Convention for Safety for Life at Sea, 1974
(32 UST 49, TIAS 9700)

Regulation 10 of Chapter V of the regulations annexed to this Convention (TIAS 5780, p. 320) requires the master of a ship at sea, on receiving a message from any source that a ship or aircraft or survival craft thereof is in distress, to proceed with all speed to the assistance of the persons in distress, informing them, if possible, that he is doing so.

Regulation 15 of the same chapter requires each government party to the Convention to make the necessary arrangements for coast watching and rescue of persons in distress at sea and around its coasts. This should include establishing, operating and maintaining of such maritime safety facilities as are deemed practicable and necessary relative to the density of the seagoing traffic and navigational dangers, and should, so far as possible, afford adequate means of locating and rescuing persons in distress. Each contracting government undertakes to make information available concerning its existing facilities and plans.

Regulation 16 specifies life-saving signals that are to be used.

International Regulations for Preventing Collisions at Sea, 1972 (28 UST 3459, TIAS 8587)

Rule 31 of these regulations specifies the distress signals that are to be used or displayed by a vessel or seaplane in distress on the water and requires assistance from other vessels or shore. (Distress signals are also stated in Regulation 37 and Annex IV of the 1972 COLREGS.)

Recommendations of the First Antarctic Treaty Consultative Meeting Adopted at Canberra July 24, 1961 (13 UST 1349; TIAS 4780)

Recommendations I-X, along with other recommendations, were adopted in accordance with Article IX of the Antarctic Treaty signed December 1, 1959 (12 UST 794; TIAS 4780; 402 UNTS 71) and became effective on April 30, 1962. They provide as follows:

"The Representatives affirm the traditional Antarctic principle that expeditions render all assistance feasible in the event of an emergency request for help and recommend to their Governments that consideration be given to arranging consultations among them, and to the matter being discussed at the appropriate time at any meeting of experts qualified to discuss it."

International Telecommunications Convention October 25, 1973 (28 UST 2495; TIAS 8572)

Article 25 specifies that the international telecommunications services must give absolute priority to all telecommunications concerning safety of life at sea, on land, in the air, and in outer space, as well as to World Health Organization epidemiological telecommunications of exceptional urgency.

Article 36 specifies that "Radio stations shall be obliged to accept, with absolute priority, distress calls and messages regardless of their origin, to reply in the same manner to such messages, and immediately to take such action in regard thereto as may be required."

The radio regulations annexed to the Convention specify the communications procedures to be followed in distress and emergency cases.

Treaty on Principles Governing the Activities of States in the Exploration and use of outer space, Including the Moon and other Celestial Bodies
Signed at Washington, London, and Moscow January 27, 1967 (18 UST 2410; TIAS 6347)

Article V provides: "State Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

"In carrying out activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to astronauts of other State Parties.

"State Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the moon and other celestial bodies, which could constitute a danger to the life or health of astronauts."

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space
Done at Washington, London, and Moscow April 22, 1968 (19 UST 7570; TIAS 6599)

Article 2 of the agreement specifies: "If, owing to accident, distress, emergency or unintended landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party, it shall immediately take all possible steps to rescue them and render them all necessary assistance. It shall inform the launching authority and also the Secretary-General of the United Nations of the steps it is taking and of their progress. If assistance by the launching authority would help to effect a prompt rescue or would contribute substantially to the effectiveness of search and rescue operations, the launching authority shall cooperate with the contracting party with a view to the effective conduct of search and rescue operations. Such operations shall be subject to the direction and control of the Contracting Party, which shall act in close and continuing consultations with the launching authority."

Article 3 of the agreement specifies: "If information is received or it is discovered that the personnel of a spacecraft have alighted on the high seas or in any other place not under the jurisdiction of any State, those Contracting Parties which are in a position to do so shall, if necessary, extend assistance in search and rescue operations for such personnel to assure their speedy rescue. They shall inform the launching authority and the Secretary-General of the United Nations of the steps they are taking and of their progress."

BILATERAL AGREEMENTS

CANADA

Treaty Regarding Reciprocal Rights for the United States and Canada in the Matters of Conveyance of Prisoners and Wrecking and Salvage
Signed at Washington May 18, 1908 (35 Stat. 2035; TIAS 502)

Article II of this treaty permits vessels and wrecking appliances, either from the United States or from Canada, to salvage property wrecked and to render aid and assistance to any vessels wrecked, disabled, or in distress in that portion of the St. Lawrence River through which the international boundary line extends; on Lake Ontario, Lake Erie, Lake St. Clair, Lake Huron, and Lake Superior; on the Niagara, Detroit, St. Clair, and Ste. Marie Rivers, and Canals at Sault Ste. Marie; and on the shores and in the waters of the other country along the Atlantic and Pacific coasts within a distance of 30 miles from the international boundary on those coasts.

The reciprocal wrecking and salvage privileges include all necessary towing, and nothing in the Customs, Coasting or other laws or regulations of either country is to restrict in any manner the salving operations of vessels or wrecking appliances.

Vessels from either country employed in salving in the waters of the other are required, as soon as practicable afterwards, to make full report at the nearest custom house in the country in whose waters the salving takes place.

Agreement Regarding Air Search and Rescue Operations
Effected by exchange of notes signed at Washington, January 24 and 31, 1949 (63 Stat. 2328; TIAS 1882)

Under this agreement public aircraft of either country which are engaged in emergency air search and rescue operations may enter or leave either country without being subject to immigration or customs formalities normally required, provided that the RCC involved in the SAR assumes the responsibility for providing information, by telephone or telegraph on the intended operation to:

(a) The immigration office at the point of entry nearest the territory over which any SAR is to be conducted, furnishing details on purpose of the flight, identification marking of each aircraft, and number of persons in the crew; or

(b) The customs office nearest to the territory over which any SAR is to be conducted, giving details on the territory to be searched, the possible duration of the stay of the aircraft, the identification markings of each aircraft, and the number of persons in the crew.

In case such aircraft of one country land in the territory of the other country in the course of emergency SAR, a verbal or telephone report must be made to the nearest collector of customs so that he may assist in any way possible with entry requirements for SAR operations.

HONDURAS

Exchange of Notes Regarding Rescue Coordination Facilities in Honduras
Effected by exchange of notes at Tegucigalpa November 7 and 25, 1952

Under this exchange of notes before Honduras became a member of ICAO, the Honduran Government informed the U.S. Government that, regarding RCC activities at Albrook AFB, Panama, the Honduran Bureau of Civil Aeronautics had made provision for SAR flights to be allowed to enter their country without any requirement other than to request clearances from their Flight Control Center, to coordinate their activities with ours and to be able to provide more effective assistance for SAR missions.

JAMAICA

Authorization for Aircraft Engaged in SAR Operations to Fly Over and Land in Jamaica
Order issued March 21, 1950

The Governor of Jamaica authorized State aircraft of the United States, Colombia, and Venezuela while engaged in SAR operations and assigned for such purposes by the RCCs of the Caribbean Area, established by the Convention on International Civil Aviation, to fly over and land in the Island of Jamaica and its dependencies and the adjacent territorial waters. (Note No. 203 dated April 25, 1950 from the British Ambassador to the Secretary of State with an enclosed copy of the Jamaican "Colonial Foreign State Aircraft (SAR) Authorization, 1950").

This arrangement is considered to be continued in force after Jamaica, on August 6, 1962, attained a fully responsible status within the British Commonwealth. Jamaica adhered to the Convention on International Civil Aviation March 26, 1963 and thus became a separate member of ICAO.

MEXICO

Treaty to Facilitate Assistance to and Salvage of Vessels in Territorial waters
Signed at Mexico City June 13, 1935 (49 Stat. 3359; TIAS 905)

Under this treaty vessels and rescue equipment, public or private of either country, may assist vessels and crews of their own nationality which may be disabled or in distress on the shores or within the territorial waters of the other country:

(a) Within a radius of 720 nautical miles of the intersection of the international boundary line and the coast of the Pacific Ocean; or

(b) Within a radius of 200 nautical miles of the intersection of the international boundary line and the coast of the Gulf of Mexico (Article I).

The commanding officer, master, or owner of a vessel or rescue apparatus of either country entering or intending to enter the territory or territorial waters of the other to assist a distressed vessel is required, at the earliest possible moment, to send notice of such action to the authorities of that other country nearest the scene of distress. The vessel or apparatus may freely proceed to, and assist the distressed vessel unless the authorities advise that adequate assistance is available, or that, for any other reason, such assistance is not considered necessary (Article II).

Notification is necessary when a vessel or apparatus of one country departs from the territory or waters of the other country entered to render assistance. Private vessels which have so entered, a well as private distressed vessels and the cargo, equipment, stores, crew, and passengers thereof, are subject to the laws in force in the country in whose territorial waters such assistance is rendered.

"Assistance" in this treaty means any act necessary or desirable to prevent injury arising from a marine peril of persons or property, and "vessel" includes aircraft as well as every kind of conveyance used or capable of being used for transportation on water (Article III).

UNION OF SOVIET SOCIALIST REPUBLICS

Air Transport Agreement with Annex, and Supplementary Exchange of Notes Signed at Washington November 4, 1966 (17 UST 1909; TIAS 6135)

Article 11 of this agreement provides for the measures that may be taken and the procedures to be followed in the event of a forced landing, accident, or other incident involving an aircraft of the designated airline of one contracting party within the territory of the other contracting party.

Article I of the supplementary agreement requires, among other things, that each contracting party shall provide within its territory "search and rescue facilities."

Such provisions are not normally included in bilateral air transport agreements concluded by the United States, because other countries with which such agreements are concluded are members of ICAO which, as indicated under "Multilateral" above, has established SAR standards. The U.S.S.R. was not a member of the Organization in 1966 but is now.

GENERAL BILATERAL SAR AGREEMENTS

The following agreements provide for coordinated SAR activities in areas of mutual interest to the parties. Each agreement identifies its scope in terms of maritime SAR, aeronautical SAR, or both. Some agreements discuss lines separating SAR regions. Some of the agreements may also have implementing annexes.

Search and Rescue Agreement Between the Chief of Defence Staff, Canadian Forces and Commandant, U.S. Coast Guard
October 25, 1974

Agreement between the Government of the United States of America and the Government of Japan on Maritime Search and Rescue

December 12, 1986

Agreement Concerning Maritime Search and Rescue Cooperation between the Bureau of Harbour Superintendency of the People's Republic of China and the United States Coast Guard of the United States of America
January 20, 1987

Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Maritime Search and Rescue
May 31, 1988

Maritime Search and Rescue Agreement between the United States Coast Guard of the United States of America and the Federated States of Micronesia Department of External Affairs
June 10, 1988

Agreement between the Government of the United States of America and the Government of the Republic of Indonesia on Maritime Search and Rescue
July 5, 1988

APPENDIX C. EMERGENCY SIGNALS

By tradition and international agreement, certain signs and signals indicate distress or emergency. Common signals are listed in this appendix; however, this list is not all-inclusive. Other internationally accepted emergency signals are contained in the International Code of Signals (Defense Mapping Agency Hydrographic Topographic Center Pub 102). That publication also contains a color plate of the international flags and pennants. SRUs in maritime areas should carry a copy of that publication.

A. VISUAL/AURAL DISTRESS SIGNALS

1. Certain signals normally indicate distress.

a. A gun, or other explosive signal, fired at intervals of about a minute. Tracer bullets have been detected as far away as 6 miles, but it is difficult to pinpoint survivor location from that distance.

b. A continuous sounding with any fog-signaling apparatus.

c. Rockets or shells, throwing red stars, fired one at a time at short intervals.

d. The International Code signal of distress indicated by the code group NC. See the International Code of Signals (Defense Mapping Agency Hydrographic Topographic Center Pub 102) for other code groups with emergency significance.

e. A square flag having above or below it a ball or anything resembling a ball.

f. Flames on a vessel, as from a burning oil barrel. Fires are probably the most effective nighttime signal survivors may use. Fires have been sighted as far away as 50 miles, with the average range varying with the size of the fire and the absence of other light sources.

g. A rocket parachute flare or a hand flare showing a red light. Flares, star shells, and rockets have been sighted as far away as 35 miles, with an average of 10 miles. Pyrotechnic flares are effective at night, but during daylight their detectability ranges are reduced by 90 percent.

h. Orange smoke-generating signals. These have been sighted as far away as 12 miles, with an average distance of 8 miles. Smoke signals are most effective in calm wind conditions or open terrain. Effectiveness is reduced with wind speeds above 10 knots.

i. Slowly and repeatedly raising and lowering arms outstretched to each side.

j. Inverted United States flag (marine craft).

k. Flashes from a signal mirror. Mirror signals have been detected as far away as 45 miles and from as high as 16,000 feet, although the average detection distance is 5 miles.

l. Dye-stained water or snow, normally green or red. Fluorescent seadye markers have been sighted as far away as 10 miles, although the average detection distance is 3 miles.

2. The following pyrotechnic signals have specific meanings:

One red, or a
succession of reds .... I am in distress and require immediate assistance.
If from a submarine ...... Attempting emergency surfacing, keep clear.
If by pararescue .... Impossible to proceed as planned.

Two red
By pararescue .... Survivor injured, need doctor and medical kit.

One red, one green
By pararescue .... Radio inoperative, drop another.

One green
By aircraft (used
near airport) .... Request permission to land.
By submarine .... Have fired exercise torpedo.
By pararescue .... (Initial notification) all is well.

Two green
By pararescue .... Survivor ready for pickup as arranged.
By SRU .... I have sighted survivors.

One green every 5 to 10 minutes
By SRU .... Request distressed crew fire red pyro (interval halved when red pyro sighted).

Succession of green
By aircraft .... Have urgent message to transmit.

One white
By aircraft .... Submarine is below me.
By ship .... Man overboard.
By pararescue .... Ready for flotation kit or aero-kite drop.

Two white
By pararescue .... Ready for MA-1 kit drop.

Two whites, 3 minutes apart
By submarine .... Am surfacing, keep clear.

Series of whites, 10 seconds apart
By ship or aircraft ...... Alter your heading to avoid restricted area.

One white, one green
By pararescue .... Ready for raft drop.

One white, one red
By pararescue .... Flotation device damaged, drop another.

Two white, one green
By SAR aircraft .... Rescue successful.

Two white, one red
By SAR aircraft .... Rescue unsuccessful.

One yellow
By submarine .... Ascending to periscope depth.

3. The following smoke signals have specific meanings:

Orange smoke .... I am in distress and require immediate assistance.

Red smoke
By submarine .... Attempting emergency surfacing, keep clear.

Two orange smokes, few seconds apart
By SAR aircraft .... I have survivors in sight.

Two white or two yellow, 3 seconds apart
By submarine .... Am surfacing, keep clear.

Black or white smoke bursts, 10 seconds apart
By ship .... Alter your heading to avoid restricted area.

4. A surface-to-air visual code for use by survivors is shown in Figure C-1.

<table>
<tr><th>Message</th><th>IMO/ICAO
Visual Signals</th></tr>
<tr><td>Require Assistance</td><td>V</td></tr>
<tr><td>Require Medical Assistance</td><td>X</td></tr>
<tr><td>No or Negative</td><td>N</td></tr>
<tr><td>Yes or Affirmative</td><td>Y</td></tr>
<tr><td>Proceeding in this direction</td><td>/|\
|</td></tr>
</table>

Figure C-1. Surface-Air Visual Signal for Use by Survivors

B. ELECTRONIC DISTRESS SIGNALS

1. Radiotelegraph.

a. The group "SOS" in the Morse code.

b. The radiotelegraph alarm signal, which is designed to actuate the radiotelegraph auto-alarms of vessels so fitted. The signal consists of a series of 12 dashes sent in 1 minute, the duration of each dash being 4 seconds, and the duration of the interval between 2 consecutive dashes being 1 second.

2. Radiotelephone.

a. The spoken word "Mayday".

b. The radiotelephone alarm signal, consisting of 2 tones transmitted alternately over periods of from 30 seconds to 1 minute.

c. EPIRB and ELT signals. EPIRBs and ELTs indicate distress of an aircraft or surface vessel. They are activated by water immersion, excessive G-forces (aircraft crash), or manually. See Chapter 3 for EPIRB/ELT frequencies and characteristics.

3. Radar.

a. IFF/SIF code 7500 indicates hijacking.

b. IFF/SIF code 7600 indicates lost communications.

c. IFF/SIF code 7700 indicates distress.

d. Any chaff radar target.

C. INTERNATIONAL AIRCRAFT-TO-SURFACE CRAFT SIGNALS

1. The following maneuvers performed in sequence by an aircraft indicate the aircraft wishes to direct a surface craft toward an aircraft or a surface craft in distress:

a. Circling the surface craft at least once;

b. Crossing the projected course of the surface craft close ahead at low altitude and

(1) Rocking wings,

(2) Opening and closing throttle, or

(3) Changing propeller pitch; and

c. Heading in the direction in which the surface craft is to be directed.

2. Surface craft assistance no longer required is indicated by crossing the wake of the surface craft close astern at a low altitude and

a. Rocking wings,

b. Opening and closing throttle, or

c. Changing propeller pitch.

No.	*Message*	*Code Symbol*
1	Operation completed	LLL
2	We have found all personnel	$\underline{\text{LL}}$
3	We have found only some personnel	++
4	We are not able to continue. Returning to base	X X
5	Have divided into two groups. Each proceeding in direction indicated	
6	Information received that aircraft is in this direction	→ →
7	Nothing found. Will continue to search	NN

Figure C–2. Surface-Air Visual Signal Code for Use by Rescue Units

Figure C-2. Surface-Air Visual Signal Code for Use by Rescue Units

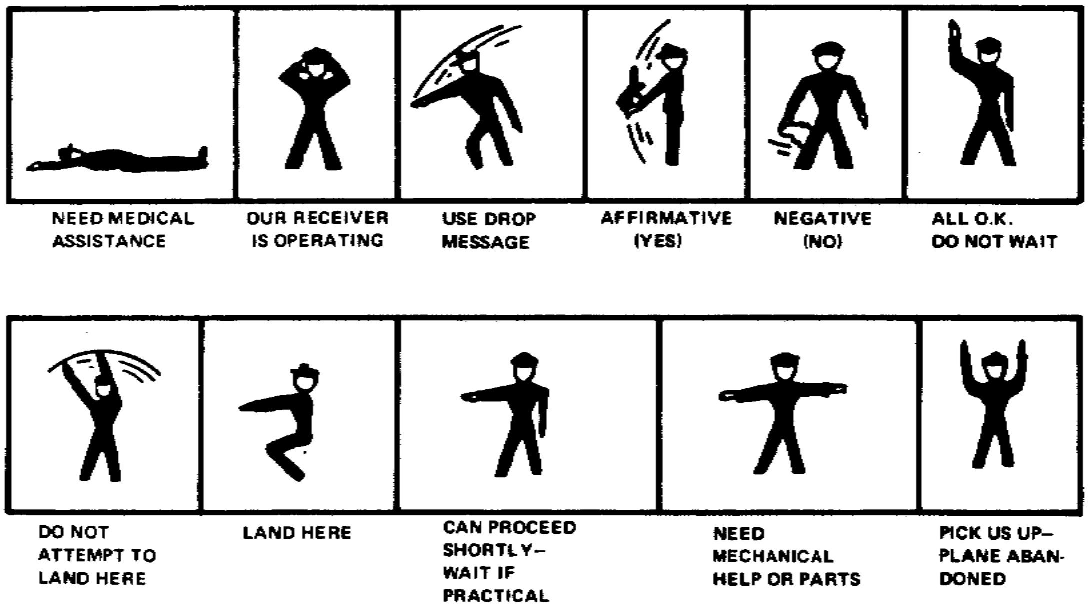

Figure C–3. Body Signals

Figure C-3. Body Signals

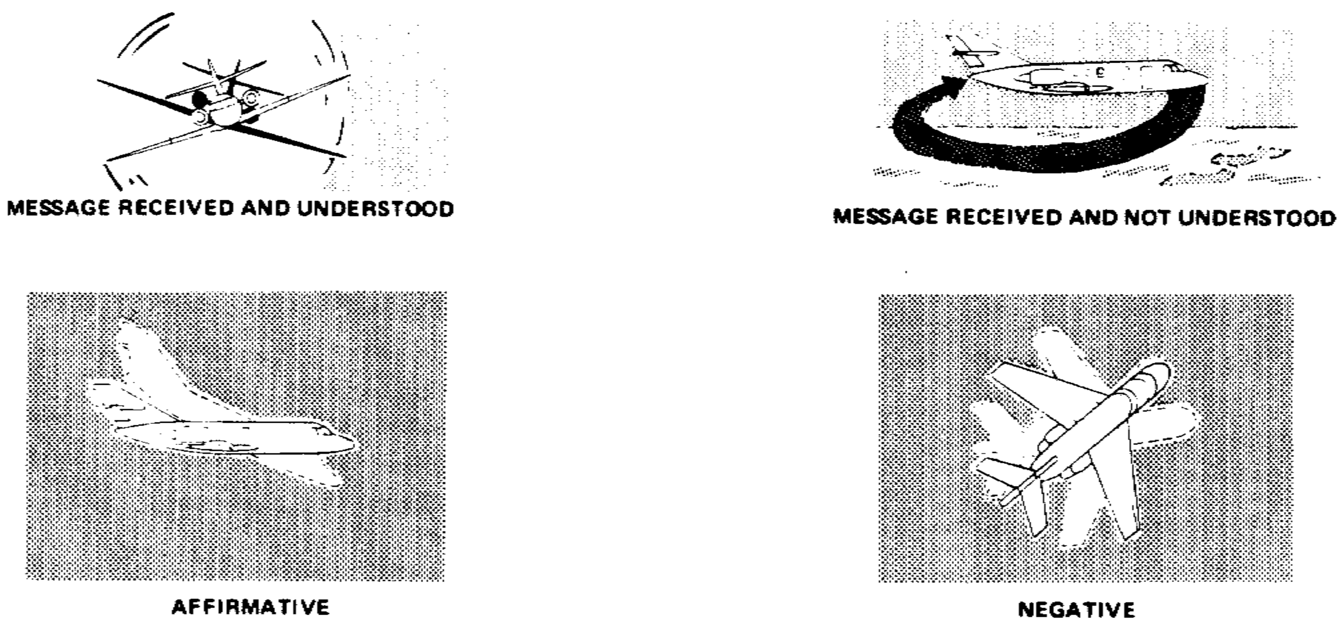

Figure C–4. Standard Aircraft Acknowledgment

Figure C-4. Standard Aircraft Acknowledgement

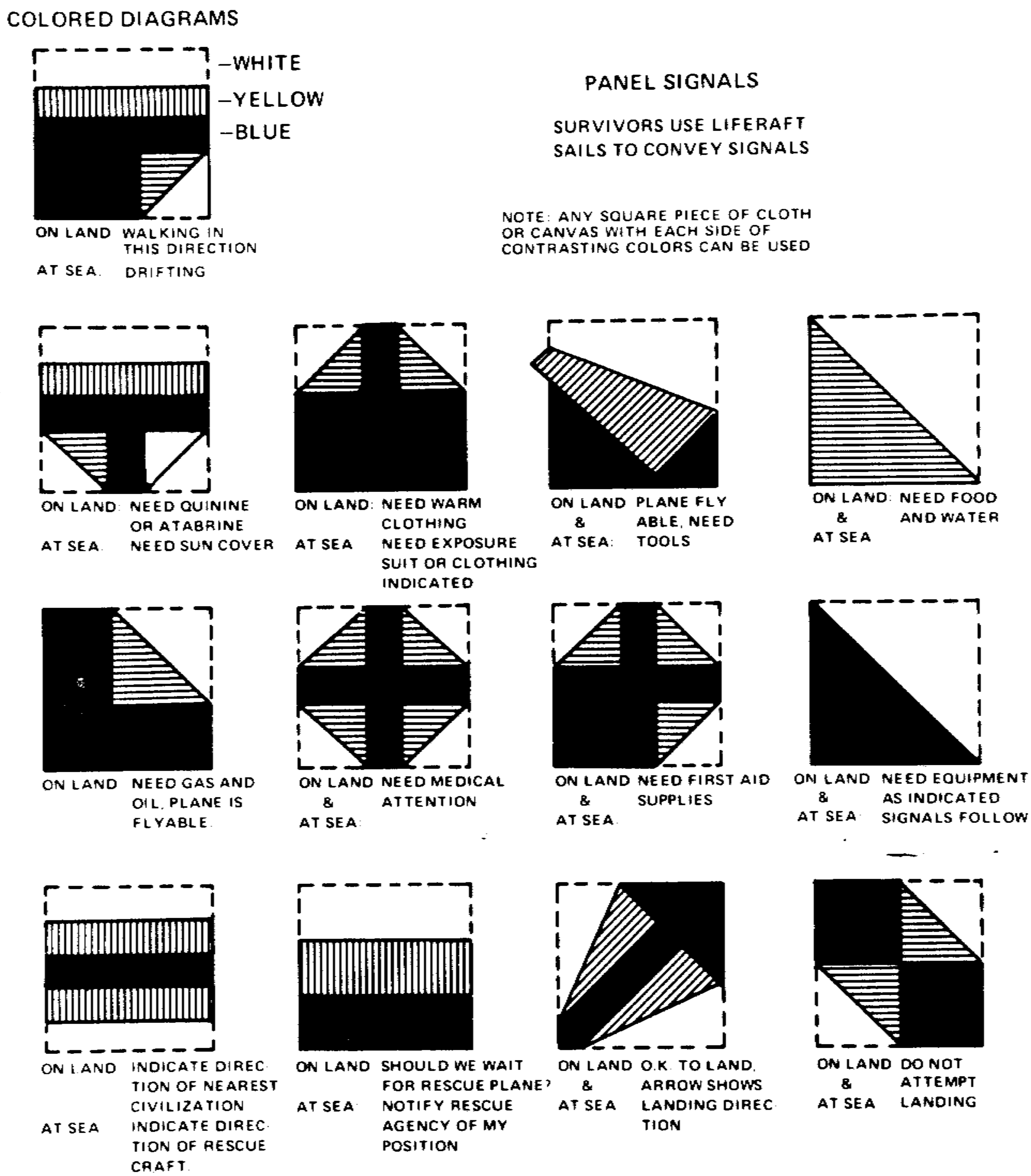

Figure C-5. Panel Signals

Figure C-5. Panel Signals

APPENDIX D. MARITIME SWEEP WIDTH FACTORS AND TABLES

A. Determining the Uncorrected Sweep Width. Locate the table in VOL. II, Chapter 4, for the type of SRU (fixed-wing, helicopter, vessel, or small boat). For aircraft, enter the column for the appropriate altitude and visibility. For surface craft, enter the column for the appropriate visibility. Read down this column to the target type that most closely describes the search object. This value is the uncorrected sweep width and should be adjusted for weather, fatigue, and aircraft speed. Interpolate as necessary.

B. Correcting for Weather. Weather has an impact on search effectiveness, and for small targets the reduction is substantial. Use Table D-1 to determine the weather correction factor (if conditions of both columns apply, use correction factor in right column).

TABLE D-1. Weather Correction Factor

Target Type	Winds > 15 Kts Seas 2-3 ft	Winds > 25 Kts Seas > 4 Ft
Person in water, or < 30-Ft Length Boat	0.5	0.25
Other Targets	0.9	0.9

C. Correcting for Fatigue. The sweep width tables are adjusted for a "normal" amount of crew fatigue. If feedback from on scene SRUs indicates search crews were excessively fatigued, reduce sweep width values by 10 percent (multiply by 0.9).

D. Correcting for Search Aircraft Speed. Enter the Speed Correction Table (Table D-2) with aircraft type (fixed-wing or helicopter) and the speed flown. Read down the column to the search object. This value is the speed correction. Interpolate as necessary. There is no speed correction for surface SRUs.

E. Calculating Corrected Sweep Width. The final sweep width is found as follows:

Corrected Sweep Width = (Uncorrected Sweep Width) x (Weather Correction) x (Fatigue Correction) x (Speed Correction)

Sweep Width Example: An SRU flown at 1000 feet and 150 knots is searching for a 26-foot sail boat. Winds are 20 knots with 2.5-foot seas. Visibility is 20 miles. The SRU commander determines that the crew is unusually fatigued.

Step 1: From the Fixed-Wing sweep width tables find the column for 1000-ft altitude and 20-mile visibility. Read down the column

TABLE D-2. Search Aircraft Speed Correction Table to the 26-foot sailboat row to obtain uncorrected value of 7.1.

Step 2: From the weather correction table use the column for Winds > 15 Kts/Seas 2-3 foot and the small target row to obtain a Weather Correction of 0.5.

Step 3: Since the SRU commander determined the crew was fatigued, use a Fatigue Correction of 0.9.

Step 4: From the aircraft speed correction table, find the column for Fixed-Wing speeds of 150 knots. Read down to the 26-foot sailboat row to obtain a Speed Correction of 1.1.

Step 5: Multiply the uncorrected sweep width from Step 1 by the three corrections to obtain the final sweep width of 3.5 miles (7.1 x .5 x .9 x 1.1).

APPENDIX E. COORDINATED SEARCH PATTERNS

A. Coordinated Patterns

This appendix provides OSCs with a guide for planning and executing coordinated search patterns. Teaming an aircraft with a vessel takes advantage of each SRU's best features. Aircraft provide rapid coverage of the search area from a good search platform. Vessels may provide better navigation, unless the aircraft is equipped with sophisticated navigational aids such as INS, and may be able to quickly rescue a survivor sighted from the aircraft.

B. Coordinated Search Symbology

The following symbols and definitions are used in computing and discussing aircraft search tracks.

Al is the search area length.

Aw (search area width) is the sum of one searchleg and one track spacing (Aw = L + S).

Awf is the search area width for faster aircraft in CMCS pattern.

Aws is the search area width for slower aircraft in a CMCS pattern.

C (course) is the intended path of travel by an SRU.

GS (ground speed) is the speed of an aircraft relative to the earth's surface.

H (heading) is the horizontal direction in which an SRU is pointing.

L (searchleg or searchleg length) is the sum of the searchleg straightaway (y) and the search craft's turn diameter (TD). Subscripts further define L.

L1 is the searchleg with the highest headwind component.

L2 is the searchleg with the highest tailwind component.

S (track spacing) is the distance between adjacent searchlegs.

t1 is the time required for a search aircraft to fly one-half of the straightaway length (Y1) of the searchleg with the highest headwind component (L1).

t2 is the time required for a search aircraft to fly one-half of the straightaway length (y2) of the searchleg with the highest tailwind component (L2).

t3 is the time required for a search aircraft to fly the full straightaway length (x) of the crossleg between two search areas.

TAS (true air speed) is the speed of an aircraft relative to the airmass it is in.

TD (turn diameter) is the diameter of a turning circle executed at a constant rate of turn, constant angle of bank (aircraft), or constant angle of rudder (vessel).

Tr (track) is the actual path of travel by an SRU.

TTT (time to turn) is the clock time specified for a searchcraft to begin a turn, usually onto the crossleg.

V (velocity or speed) denotes either rate of motion (speed), or both rate and direction of motion (velocity). Subscripts further define V.

V1 is the groundspeed of an aircraft flying on L1.

V2 is the groundspeed of a searching aircraft flying on L2.

V3 is the groundspeed of a searching aircraft flying on the crossleg between two searchlegs.

Va is aircraft TAS.

Vs is surface craft velocity.

X is the distance the vessel travels from the time the aircraft flying on searchleg L1 is above the vessel to the "time to turn" (TTT) onto crossleg. Time required = t1.

x is the straightaway length of the crossleg.

Y is the distance the vessel travels from the time the aircraft flying on searchleg L2 completes its turnoff of the crossleg until above the vessel.

y is the straightaway length of the searchleg.

Y1 is the straightaway length of the searchleg with the highest headwind component.

Y2 is the straightaway length of the searchleg with the highest tailwind component.

C. Coordinated Search Formulas

The formulas used to preplan or execute coordinated air/surface search patterns are summarized below and explained in subsequent paragraphs.

1. Ship speed:

$$Vs = \frac{SVa}{L + S}$$

2. Aircraft turn diameter:

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

3. General half searchleg timing:

$$t = \frac{60}{GS} \times \frac{L-TD}{2} \text{ (in minutes)}$$

4. Into the wind half searchleg timing:

$$t1 = \frac{30(L-TD)}{V1} \times \frac{30y1}{V1} \text{ (in minutes)}$$

5. Downwind half searchleg timing:

$$t2 = \frac{30(L-TD)}{V2} \times \frac{30y2}{V2} \text{ (in minutes)}$$

6. Crossleg timing:

$$t3 = \frac{3600(S-TD)}{V3} \text{ (in seconds)}$$

7. Bowtie solution:

$$X = \frac{LVs}{2V1}$$

$$Y = \frac{LVs}{2V2}$$

D. Coordinated Search Patterns

The coordinated search patterns are:

CSC - Creeping Line Single-Unit Coordinated.
CSR - Creeping Line Single-Unit Radar.

These patterns are variations of the Creeping Line Pattern. If the only available surface craft is a boat or larger vessel untrained in directing or coordinating aircraft, the CSC pattern is used. If the surface craft is a Navy vessel or a Coast Guard cutter, trained in directing or coordinating aircraft, the CSR pattern is normally used.

E. Search Pattern Vessels

1. Vessel heading and track. The vessel track will normally be the direction of creep specified in the SMC SAR action plan. If an ocean current set is present, vessel heading should be corrected to ensure the desired search track.

2. Vessel speed. The vessel speed (Vs) is adjusted so that the time required for the aircraft to fly along one complete searchleg and one crossleg is equal to the time required for the vessel to advance on crossleg.

3. Aircraft headings and speeds. After the vessel search speed has been determined, the aircraft wind-corrected headings and groundspeeds are computed. Most aircraft navigational computers can quickly provide the wind-corrected headings, groundspeeds, and times required to fly searchlegs. The aircraft pilot should be given the necessary information to allow a check of vessel computations.

4. Aircraft turn diameter. The formula for aircraft turn diameter (par. C2) is predicated on the aircraft making standard rate turns (3 degrees heading change per second). Unlike a surface vessel, aircraft do not experience a noticeable difference between advance and transfer during the first 90 degrees of turn. An aircraft starts its turn one-half turn diameter before the end of the searchleg, and rolls out of the turn one-half turn diameter down the new searchleg. The searchleg length equals the straightaway plus one full turn diameter (L = y + TD), and the crossleg equals the straightaway plus one full turn diameter (S = x + TD).

5. Aircraft crossleg time

a. The vessel should precompute the time required for the aircraft to fly the straightaway distance of the crossleg. This information is included in one of the early advisories passed to the aircraft after arrival.

b. The aircraft requires 30 seconds to execute a 90 degree standard rate turn. Since the aircraft will be making two 90 degree turns on each end of the crossleg straightaway in any creeping line pattern, all maneuvering onto and off of crosslegs requires 60 seconds plus t3. See Figure E-1.

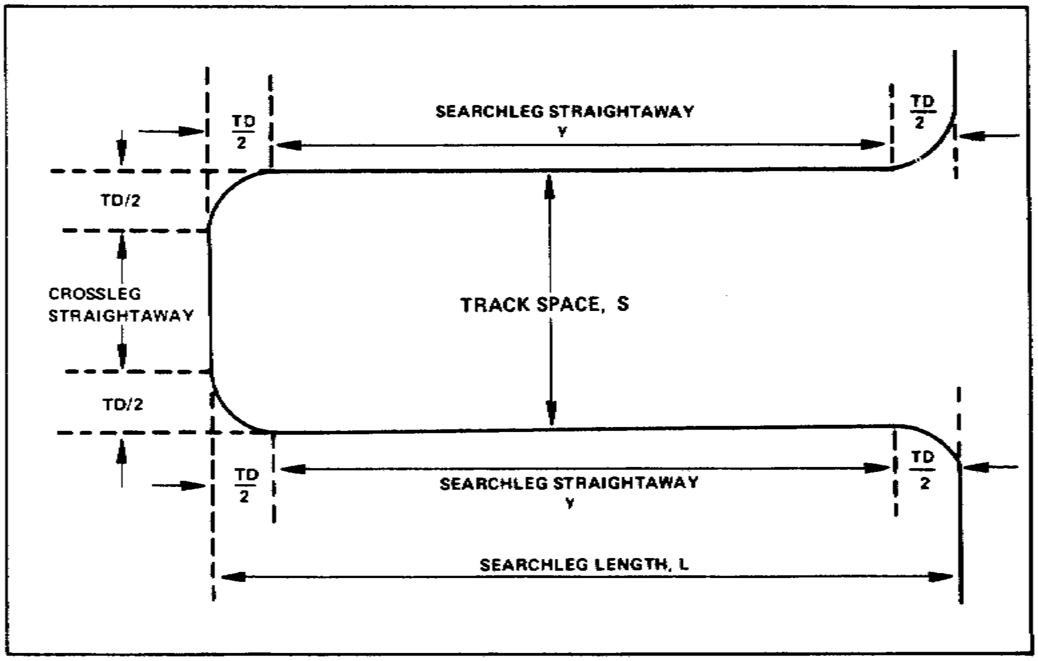

Figure E–1. Aircraft SRU Crosslegs

Figure E-1. Aircraft SRU Crosslegs

6. Aircraft searching time

a. Unless winds are calm or perpendicular to the searchlegs, times for flying the two directions will be different. The searchlegs will usually be designated "downwind" and "upwind". The formula for computing times required to fly one half of each searchleg is given in pars. C3, C4, and C5.

b. Times t1, t2, and t3 are given to the aircraft before beginning the pattern. If radar contact with the aircraft is lost during the search, these times may be used to determine time to turn for the aircraft.

7. Pattern timing

a. The aircraft and vessel should restart their elapsed time clock or stopwatch every time the aircraft passes over the vessel. The second half of each searchleg is timed by both the aircraft and vessel. When the computed time (t1 or t2) has elapsed, the aircraft should start its turn onto the crossleg.

b. In the CSC pattern, the aircraft uses this timing procedure to determine its own time to turn. The vessel may use the timing required for the aircraft to fly from overhead to overhead as a check on the aircraft's completion of full searchlegs on both sides of the vessel. The timing is t1 + t2 + t turning or t1 + t2 + 60 seconds.

c. In the CSR pattern, the actual commencement of the turn onto the crossleg is controlled by the radar/visual plots aboard the vessel. Timing of searchlegs by the vessel provides a backup control if radar fails. The air controller can tell the aircraft when to turn, but this has to be done while simultaneously shifting from the relative plot to the true plot for the information. Therefore, the aircraft should time itself in the event of radar problems aboard the vessel.

d. Crossleg timing is executed by the aircraft pilot independently of the vessel.

F. Surface plot-true plot

1. General. With known values for vessel course, searchleg length (L), and track spacing (S), the search pattern is laid out on the ship dead reckoning tracer (DRT) before the aircraft arrives on scene. When ready to begin the search, the ship takes position one-half track

spacing outside of the search area, and vectors the aircraft to the ship and then onto its initial "startup" searchleg. As the aircraft passes overhead the vessel and begins its initial searchleg, the DRT is started, with the ship search speed (Vs) set in. The mechanically controlled DRT produces a two-dimensional, lateral movement proportional to the headings and speeds of the ship. Aircraft and vessel positions are marked each minute on the DRT surface plot. The surface plot, or true plot, is used as a backup for the relative motion plot. Although most radar advisories to the aircraft are based on the relative motion plot, the plotted information is removed after each leg is completed. The surface plot provides the only permanent history of the search, so all sightings should be plotted on the surface plot. See Figure E-2.

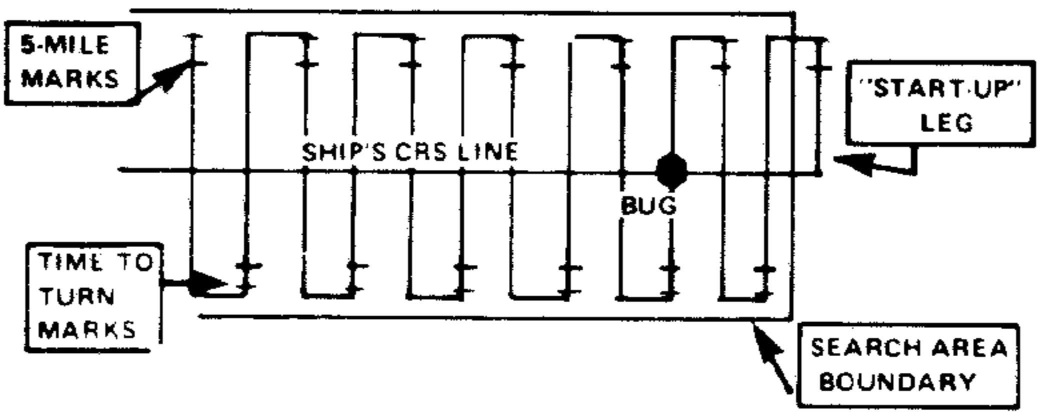

Figure E-2. Surface Plot / True Plot

Figure E-2. Surface Plot/True Plot

2. Surface plot data

a. Within the coordinated search area, using the largest scale possible, the following information is plotted on the surface plot: ship course, search pattern with searchlegs drawn at proper track spacing (each leg marked at 5 miles from its end and at TTT onto crossleg), coordinates of datum, and time and position of all sightings.

b. Plotted within the search areas adjacent to the coordinated search area, are the following: area designation, coordinate of centerpoint, major axis, searchlegs (direction of creep arrow - and the first two or three searchlegs), search altitude, type and call sign of SRU, vector from OSC position to commence search point (CSP), and IFF/SIF squawk and air-to-air TACAN channel assignment.

c. Plotted outside the coordinated search area but adjacent to it, are the following: aircraft radio call sign, aircraft assigned search altitude, assigned track spacing, type of pattern, and times required to fly t1, t2, and t3.

G. Air Plot/Relative Plot

1. General

a. Although a true plot may be used to plot and vector the search aircraft during coordinated search patterns, an easier method is to employ a relative motion pattern. The relative motion pattern is laid out on the vessel air plot or relative plot board, and is the primary source of information for the advisories furnished the aircraft by the vessel during the search.

b. The true plot, or surface plot, is laid out on the vessel DRT in the vessel Combat Information Center (CIC). The vessel relative plot or air plot board is close to the DRT. This board is usually edge-lighted or back-lighted, has permanently inscribed bearing lines and range circles similar to a maneuvering board, and is used to plot aircraft targets relative to vessel position.

2. Relative plot and true plot comparison

a. The vessel air controllers should thoroughly understand the difference between the true plot and the relative plot, as well as their relationship. The air controller may have to rapidly shift from using the relative plot to using the true plot if ship radar fails or radar contact with the aircraft is lost.

b. With known values for ship course and speed, existing wind direction and speed, length of searchlegs, and track spacing, the relative motion pattern may be computed and laid out by the vessel before the search aircraft arrives. The shape of the relative motion pattern, when executing any of the creeping line coordinated patterns, is similar to a bowtie.

c. Figure E-3 illustrates the common-time relative bearings of vessel and aircraft, and Figure E-4 is a simplified form of Figure E-3, showing the relationship between the true plot and relative plot patterns. Only four common time positions are shown for the vessel and aircraft, and aircraft turning diameter is ignored.

(1) The comparison is started with the aircraft in position ahead of the vessel, at position 1. The relative bearing of the aircraft from the vessel stays constant until the aircraft

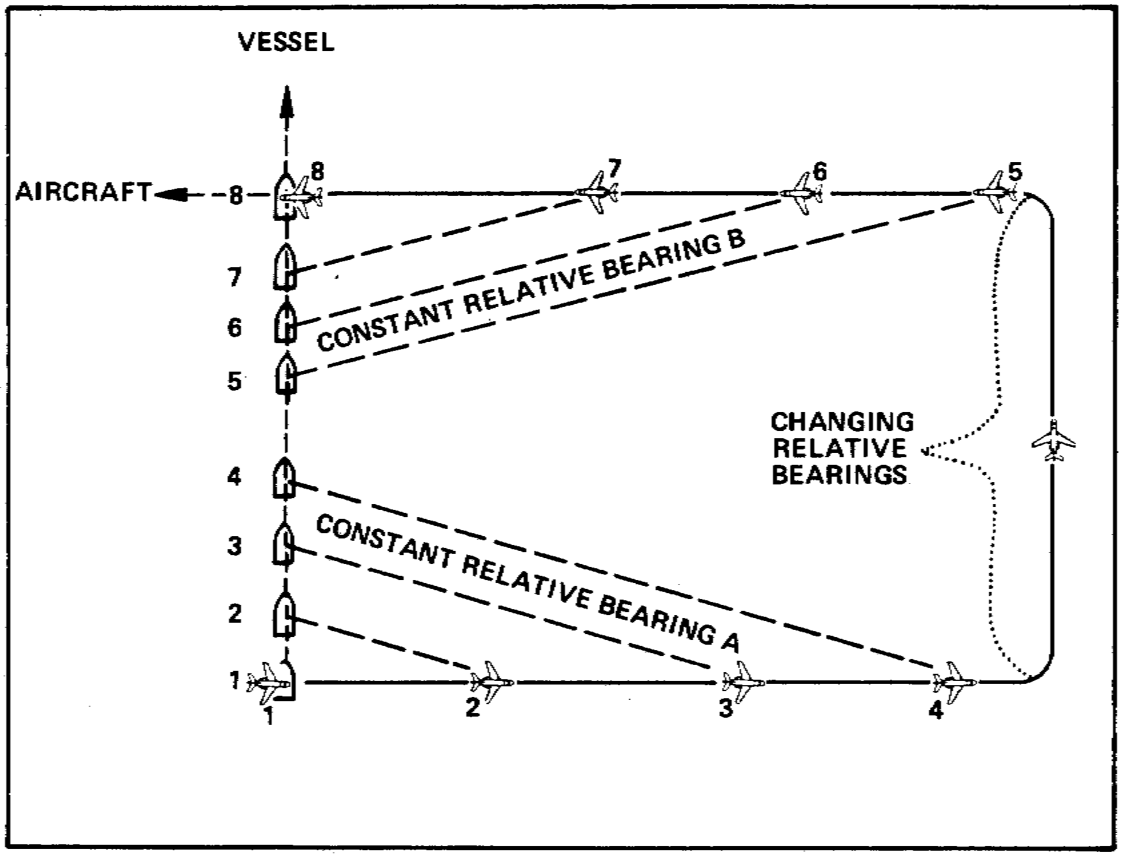

Figure E-3. Common-Time Relative Bearings

Figure E-3. Common-Time Relative Bearings

reaches position 2 at the end of searchleg L1, which has the greatest headwind component. To an observer on the ship, the aircraft has gradually moved from a position abeam of the ship (when overhead) to a position behind the beam position a distance equal to X (when at the end of searchleg L1).

(2) When the aircraft is on its crossleg, both the vessel and the aircraft are moving in the same direction, from position 2 to position 3. The distance the aircraft travels as the ship moves from position 2 to position 3 is not seen as relative motion by an observer on the ship.

(3) When the aircraft turns from the crossleg onto searchleg L2 at position 3, it appears to the observer to be forward of the beam a distance equal to Y. The aircraft will then gradually appear to move back toward the beam position during its inbound period, reaching the abeam position when again passing overhead the vessel at position 4 in Figure E-4.

d. If the shaded portions of Figure E-4 were brought together, they would be the upwind portion of the relative motion pattern on the starboard side of the vessel. The portion of the relative motion pattern on the port side or downwind side of the vessel is geometrically similar to the pattern on the opposite side, as shown in Figures E-5A and E-5B.

The relative movement crossleg may now be defined in two ways. In either definition, the relative motion crossleg is the sum of X and Y.

(1) It is equal to the track spacing minus the distance the ship travels while the aircraft is on its crossleg.

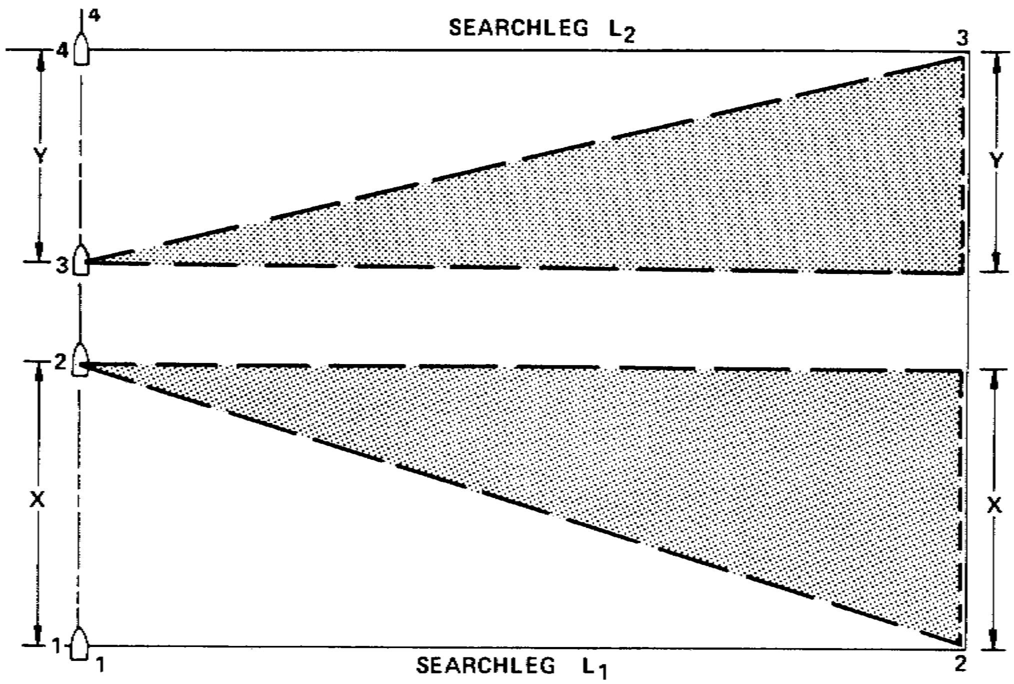

Figure E-4. Comparison of Relative Motion and True Motion Patterns

Figure E-4. Comparison of Relative Motion and True Motion Patterns

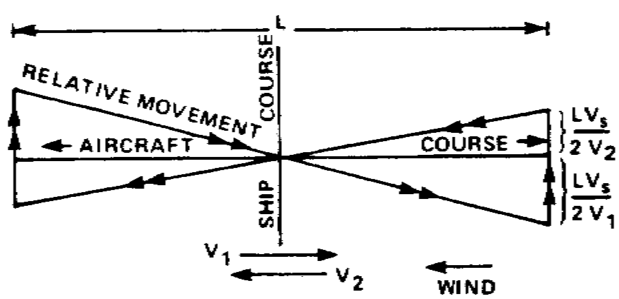

Figure E-5A.

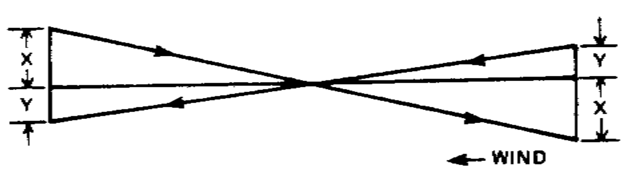

Figure E-5B.

Figure E-5. Full Relative Motion Pattern

(2) It is equal to the distance the ship travels while the aircraft is moving outbound into the wind (X) us the distance the ship travels while the aircraft is inbound with a tailwind component (Y).

3. Relative motion pattern solutions. The distances X and Y vary with the strength and direction of the wind at search altitude. X and Y may be derived either geometrically or algebraically. The geometrical solution is recommended.

a. Geometric solution. Referring to Figure E-6:

(1) Use 20:1 scale.

(2) Plot vector from center representing ship course and speed.

(3) Construct a line perpendicular to ship course through plot center.

(4) Mark off V1 on upwind side.

(5) Mark off V2 on downwind side.

(6) Lay out lines parallel to ship's course at distance L/2 on each side (2:1 scale).

(7) Construct:

(a) temporary line connecting the head of

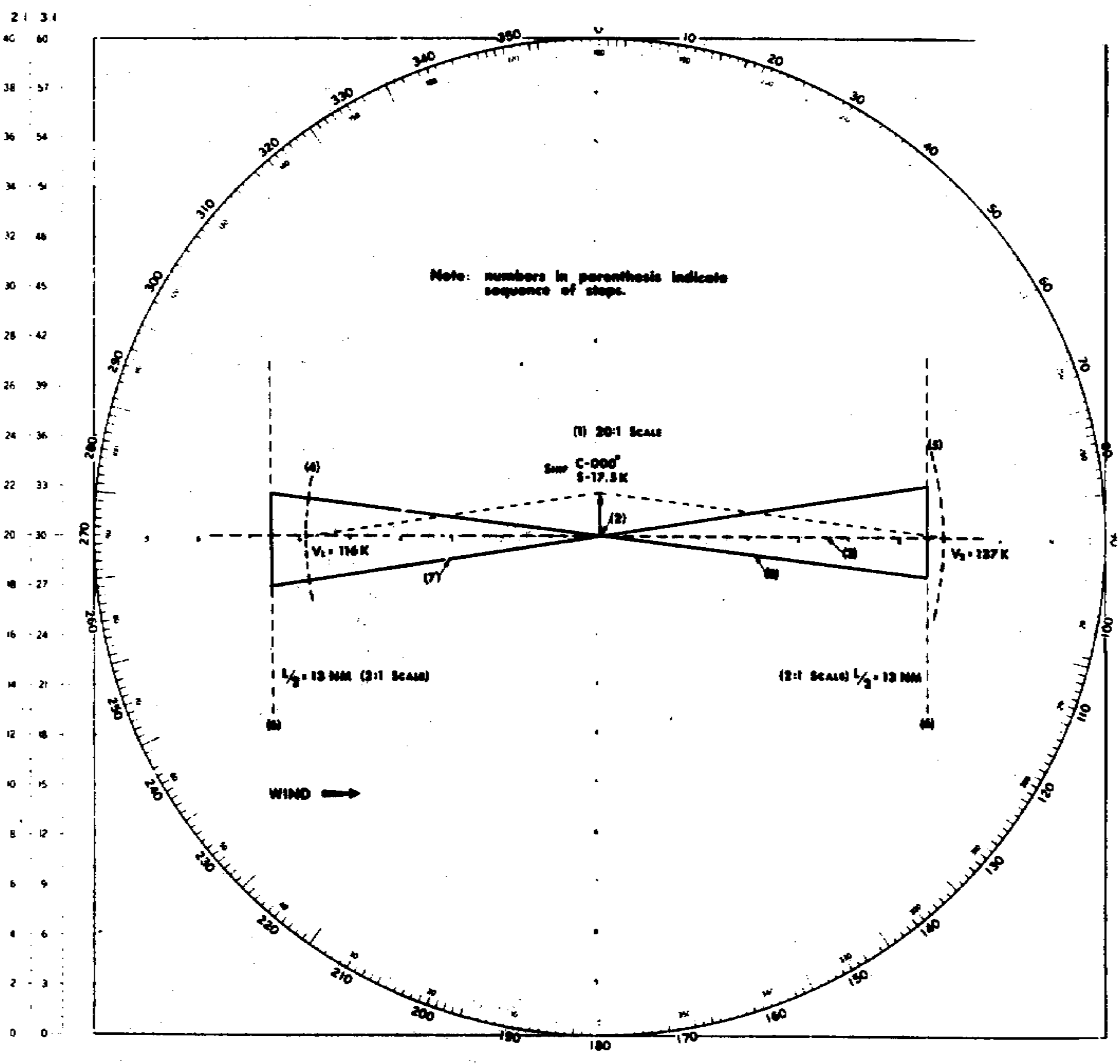

Figure E-6. Geometric Solution of Relative Motion Pattern

Figure E-6. Geometric Solution of Relative Motion Pattern

the ship vector and V1 where V1 intersects with the line drawn perpendicular to the ship course ((3) above).

(b) A line parallel to the line described above, but through the tail of the ship's vector (plot center). Extend this line out to L/2 on both sides of the ship.

(c) Erase all construction lines.

b. Algebraic solution. Magnitude of X and Y depend on aircraft groundspeed (GS) for a given leg and ship speed. Y is never greater than X.

(1) $X = \frac{LVs}{2V1}$ (V1 is GS on the leg with the headwind component)

(2) $Y = \frac{LVs}{2V2}$ (V2 is GS on the leg with the headwind component)

(3) Construct:

(a) Ship course from plot center.

(b) Line perpendicular to ship course through plot center.

(c) Line parallel to ship course on upwind side a distance L/2 from plot center.

(d) Line parallel to ship's course on downwind side a distance L/2 from plot center. Mark off X and Y reversed from upwind side.

(e) Connect points through center.

(f) Remove construction line.

4. Air plot data. After the relative motion pattern has been solved, it is laid out on the air plot. It should then be covered with transparent plastic tape in lieu of plexiglass, as the tape will not introduce any parallax errors. The following information is depicted upon the air plot:

a. Aircraft magnetic courses (box in, cover with transparent tape).

b. Aircraft wind-corrected headings (above or below box; do not cover).

c. Magnitude directions every 10 degrees around edge of plot.

d. Wind direction and speed.

e. Swell systems, labeled primary "P" and secondary "S".

f. Recommended ditch heading, large arrowhead labeled "DH".

g. Mark on each leg at 5 miles from end.

h. Mark on each leg at TTT leadpoint for turn onto crossleg.

i. Time on crossleg straightaway (t3).

j. Times for one half of each searchleg straightaway (t1 and t2).

H. Execution of the CSR Search Pattern

1. Basic sequence for vessel:

a. Position vessel one-half track spacing outside of the arc on the centerline.

b. Start aircraft outbound, in either direction, from overhead and get under way. Ship will lag pattern slightly on first leg due to need to accelerate to search speed.

c. Direct the aircraft to correct his track to pass overhead when within 1 mile of the vessel on each inbound leg.

Request the aircraft to report amount of correction needed.

d. Request pilot evaluation of pattern computations after one or two legs.

e. Obtain radar range of vessel from aircraft when aircraft turns inbound if vessel has no information.

f. Plot radar fixes of the aircraft directly on the air plot, and then keep aircraft corrected to track by use of the relative motion pattern.

g. Adjust times and headings if necessary. If other than minor changes are necessary, recheck wind, TAS, and computations, and replot the relative motion pattern (bowtie).

h. Replot bowtie only when the aircraft is overhead.

2. CSR computation sheets. It is recommended that ships which normally serve as SAR vessels prepare computation sheets for CIC in order to efficiently preplan for the air/surface coordinated search. The sheet requires that search data be recorded in a logical order and computed in the proper sequence, and that initial advisories are readied for delivery to arriving aircraft.

3. Aircraft advisories

a. Before the aircraft arrives on scene for a coordinated ship/air search, the ship should prepare several advisories for the aircraft, including "search information," "correction to course," "searchlegs," "crosslegs," and similar advisories needed for efficient execution of coordinated searches. All instructional types of advisories are passed to the aircraft before starting the search pattern, if possible. Directive advisories are passed to the aircraft as required during the search.

b. In order to give "off course" advisories to the aircraft as soon as the search pattern is begun, the vessel should furnish the aircraft with the "Correction to Course Table" for its search TAS (Table E-1) together with a brief explanation of its use, prior to starting the pattern.

c. The distance off course is given in quarter mile increments and should be based on the average of several plotted fixes. Upon being advised it is off course, the aircraft corrects back to course by turning the number of degrees

TABLE E-1. Correction to Course Table

Distance off Course (miles)	Degrees of turn for TAS110	TAS120	TAS130	TAS140	TAS150
0.25	24	23	22	21	20
0.50	42	40	38	36	34
0.75	56	52	50	47	44
1.00	68	64	61	57	55
1.25	78	74	71	67	65
1.50	86	82	79	76	73

prescribed in the "Correction to Course Table," and immediately reverses the turning direction to return to the searchleg heading. All aircraft correction turns are standard rate turns. The aircraft should be instructed to visually correct as necessary in order to pass over the ship on each inbound leg.

d. When the aircraft arrives where it should begin the turn onto the crossleg, the controller directs the pilot to turn. The aircraft turn point is short of the end of the searchleg by a distance of one-half its turn diameter, usually 15 seconds of flight time. The air controller must allow for the lag between the turn command and the actual turn, so most controllers mark the relative plot and true plot with TTT marks at a distance equal to one-half TD + 0.3 mile from the end of the searchleg. No position or off course advisories are passed to the aircraft while it is executing its crossleg.

e. If during the search the aircraft repeatedly drifts off the search course in the same direction, the wind at search altitude is different from that used to originally compute the aircraft headings. A more accurate wind should be estimated from the plot fixes, or obtained from the aircraft, and the aircraft headings replotted. The correct heading advisory is passed to the pilot.

f. If the aircraft breaks off the search to investigate a sighting, it is advised that the vessel will hold relative position in the pattern by either stopping or circling present position. If the report proves negative, the vessel will vector the aircraft back to the last position in the pattern.

4. Range and bearing information

a. The CSR search pattern is the same as the CSC pattern except that the vessel assists the aircraft with keeping on the proper search course by furnishing frequent advisories based on the ship's radar/visual plots of the aircraft. The vessel normally maintains a true plot and a relative plot. Both are a composite of information from air search radar, surface search radar, IFF/SIF interrogator displays, ECM information, TACAN/DME ranging displays, and visual bearings. When the aircraft is within visual range of the ship, visual bearings are taken and plotted with radar ranges. This provides a more accurate plot than one relying entirely upon electronic information. Radar bearings are susceptible to errors, although a constant error may also exist with radar ranges from a particular piece of equipment. Early in the search, radar and visual bearings should be compared for any difference that would reveal a radar bearing error. If a constant radar bearing error is detected, all subsequent radar bearings are corrected during the search.

b. Using a gyrorepeater and a pelorus, visual bearings are taken from a position on the wing of the vessel bridge by the "bearing taker" who has communications with the vessel "air plotter" in CIC.

5. Plotting standards

a. The following standard symbols should be used on both the air plot and the surface plot to visually indicate the source of the fix/DR data:

Air search radar

Surface search radar

Radar range and visual bearing

DR position

b. A fix or DR should be plotted:

(1) Initially, every 15 seconds on the air plot. This provides the air controller with the best presentation on the aircraft track and allows more precise control.

(2) Every 30 seconds on the air plot after wind drift correction is established.

(3) Every 60 seconds on surface plots.

6. Air controller procedures

a. Use the air plot as the primary means of coordination, to ensure that the aircraft will pass overhead the vessel on each searchleg.

b. Correct the aircraft back to the search course whenever it is off more that one-quarter mile.

c. Pin down drift as early as possible. Frequent corrections to track reduce search effectiveness, because the pilot is distracted from scanning, and the lowered wing obstructs visibility for that lookout while the upwing lookout can see only sky.

d. Base track corrections on the trend of several marks and determine new headings by inspection of aircraft drift, if consistently into or downwind. If a heading change of more than a couple of degrees is necessary to hold the aircraft on track, recheck computations for X and Y. If original computationS are correct, check for change in wind or aircraft TAS. Recompute X and Y with new values and replot bowtie.

e. Direct aircraft to "execute crossleg" when it reaches the lead mark (time to turn mark). The aircraft follows crossleg instructions passed previously and keeps its own time on straightaway. The vessel does not attempt to coordinate the aircraft on crosslegs. The air controller should correct recurring overshoots or undershoots by adjusting time on straightaway.

APPENDIX F. TEMPORARY FLIGHT RESTRICTIONS

Temporary Flight Restrictions (TFRs), issued by the FAA under Federal Aviation Regulations (FAR) Part 91, restrict aircraft operation over the site of disasters or other areas where rescue or relief operations are being conducted. TFRs are implemented by NOTAMs and issued only at the request of authorities responsible for disaster relief activities. For additional information refer to applicable FAA Advisory Circulars or FAR Part 91.

A. Objectives. TFRs are designated to:

1. Protect persons and property from a hazard when the presence of low-flying aircraft might increase the danger.

2. Provide a safe environment for the operation of disaster relief aircraft.

3. Prevent an unsafe congestion of sightseeing aircraft above an incident or event which may generate a high degree of public interest.

B. Authorization. The FAA has authority to implement TFRs.

1. When the conditions of paragraphs A.1. or A.2. are involved, the TFR NOTAM may be implemented only through the area manager at the Air Route Traffic Control Center (ARTCC) having jurisdiction over the area.

2. TRFs involving the conditions of paragraph A.3. may be established only at the direction of the regional air traffic division manager having oversight of the airspace.

3. In a hijacking, the TFR will be established through FAA Washington Headquarters Office of Civil Aviation Security. The FAA air traffic element receiving the request will establish TFRs under paragraph A.1.

C. Disaster Control Authorities

1. TFRs may be recommended or requested for the conditions under paragraph A.1. by major military command headquarters, regional directors of the Office of Emergency Planning, Civil Defense State directors, State governors, or similar authority.

2. TFRs may be recommended or requested for the conditions under paragraph A.2. by:

a. Military commanders serving as regional, subregional, or SAR coordinators.

b. Military commanders coordinating disaster relief air operations.

c. Civil authorities coordinating organized relief air operations.

3. TFRs may be recommended or requested for conditions under paragraph A.3. by the above authorities, and State, county, or city government agencies.

D. Degree of Restrictions. The number of TRFs should be kept to a minimum.

1. Requests for TFRs for conditions under paragraph A.1. must originate with the authorities in paragraph C.1., as resulting restrictions prohibit all flight in the designated area except for those in hazard relief activities. Such conditions include:

a. Toxic gas leaks or spills, flammable agents, or fumes which, if fanned by rotor or propeller wash, could endanger persons or property on the surface, or if entered by an aircraft could endanger persons or property in the air.

b. Imminent volcano eruptions which could endanger aircraft.

c. A nuclear incident.

d. A hijacking.

2. Requests for a TFR for conditions under paragraph A.2. are allowed for air rescue or air relief activities, such as:

a. Forest fires using aircraft releasing fire retardants.

b. Aircraft relief activities following natural disasters.

3. The restricted airspace needed can normally be limited to within 2,000 feet above the surface and a 5-NM radius.

4. Normally, incidents in an aircraft traffic area or terminal control area (TCA) should not require a TFR.

E. Coordination

1. Air traffic facilities coordinate assistance to relief agencies, relief aircraft, and OSCs. When requesting a TFR, the FAA needs:

   a. Name and organization of the person requesting or recommending the TFR.

   b. Brief description of situation.

   c. Estimated duration of restriction.

   d. Telephone number or other communications contact and agency name responsible for on scene activities.

   e. Description of area by reference to prominent geographical features depicted on aeronautical charts, or by geographical coordinates and VOR/DME fix.

   f. Description of material or activity posing hazard to persons or property in the air.

   g. Description of hazard that would be worsened by low-flying aircraft or rotor wash.

   h. Nature of airborne relief, aircraft operations, and location of relief aircraft base.

   i. Contact point or radio frequency for handling news media requests to operate at altitudes used by relief aircraft.

F. Coordination Facility Designation. ARTCC assigns the FSS nearest the incident as the "coordination facility" and forwards the information contained in paragraph E. to the station responsible for issuing the NOTAM. When FAA communications assistance is required, the designated FSS will function as the primary communication facility for coordination between the emergency control authorities and aircraft.

G. Revisions and Cancellations

1. When restrictions are necessary beyond the published termination date/time, ARTCC ensures that a revised NOTAM and cancellation are issued.

2. The agency requesting a TFR should notify ARTCC to cancel it when it is no longer needed. Such notices received by another facility should be immediately relayed to the appropriate ARTCC.

FOOTNOTES

CHAPTER 1:

1 IMO Merchant Ship and Rescue Manual (MERSAR). London, England: International Maritime Organization, 1986.

2 Various International Agreements.

3 IMO Search and Rescue Manual. London, England: International Organization, 1987.

CHAPTER 3:

1 COSPAS-SARSAT Terms and Acronyms Used in the United States: Adopted by the U.S. COSPAS-SARSAT Program Steering Group, June 1988.

CHAPTER 4:

1 Robe, R.Q. and Hover, G.L., Visual Sweep Width Determination for Three Visual Distress Signaling Devices. Report NO. CG-D-30-86. U.S. Coast Guard Research and Development Center, and Analysis & Technology, Inc., September 1986.

2 Hayward, J.S., B.Sc., Ph.D., The Physiology of Immersion Hypothermia, in The Nature and Treatment of Hypothermia, edited by Pozos, R.S., Ph.D. and Wittmers, L.E., Jr., Ph.D., Copyright (c) 1983 by the University of Minnesota. Reprinted by permission of the University of Minnesota Press.

CHAPTER 5:

1 Robe, R.Q. and Hover, G.L., Visual Sweep Width Determination for Three Visual distress Signaling Devices. Report NO. CG-D-30-86. U.S. Coast Guard Research and Development Center, and Analysis & Technology, Inc., September 1986.

2 Robe, R.Q., Lewandowski, M.J., Hover, G.L., and Searle, H.S., Preliminary Sweep Width Determination for HU-25A Airborne Radars: Life Raft and Recreational Boat Targets. Report NO. CG-D-11-88. U.S. Coast Guard Research and Development Center, and Analysis & Technology, Inc., Interim Report December 1987.
[Robe, R.Q., Lewandowski, M.J., Hover, G.L., and Searle, H.S., Sweep Width Determination for HU-25B Airborne Radars: Life Raft and Recreational Boat Targets. Report NO. (pends approval). U.S. Coast Guard Research and Development Center, and Analysis & Technology, Inc., Interim Report May 1989.]

CHAPTER 6:

1 Robe, R.Q. and Hover, G.L., Visual Sweep Width Determination for Three Visual Distress Signaling Devices. Report NO. CG-D-30-86. U.S. Coast Guard Research and Development Center, and Analysis & Technology, Inc., September 1986.

LIST OF EFFECTIVE PAGES

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