Observer

Home Study Course

Observer
Familiarization and Preparatory Training Course

Introduction
Purpose

Welcome to the Observer Familiarization and Preparatory Training course! The Mission Observer has a key role in CAP missions, and has expanded duties that mainly pertain to assisting the Mission Pilot. This assistance will be in the planning phase, handling radio communications, assisting in navigation, maintaining a flight log and crew management (i.e., mission commander). The proficient Observer makes it possible for the pilot to perform his duties with a greater degree of accuracy and safety by assuming these aspects of the workload. However do not forget: if you and the pilot are the only occupants in the aircraft, **your role is to be a Scanner, and a limited Observer.**

This course sets forth the academic preparation required for the pursuit of the Civil Air Patrol (CAP) Mission Observer operational specialty rating as set forth in CAPR 60-3.

Prerequisites

- **Be GES Qualified**
- **Be at least 18 years of age**
- **Be a qualified Mission Scanner**
- **Have a Unit Commander or authorized designee's signature attesting that all prerequisites have been completed.**

Instructions

In this course, the subject matter is developed in a series of sections. At the end of each section are review questions with their answers at the end of the course. You will be asked to demonstrate your knowledge of the subjects by completing an on-line test. The test will include questions from this course and the matters pertaining to Observers from the other references. Two Observer Table Top Exercises must be completed for the Observer Training Sortie Evaluation Form to be complete. The Trainee is fully qualified when the Sortie Evaluation Form is complete.

You are encouraged to print out course sections and attachments for your personal use. You will need the following items for this course.

- Pencil and paper.
- Manual E6B type computer.
- Air navigation plotter.
  (The last two items may be borrowed.)

References

- CAPR 60-1
- CAPR 60-3
- Equipment check lists/references for downloading can be found on CAWG web site under, Members Service/Operations/Emergency Services/Aircrew Training.
- Any corrections or recommendations for this course should be forwarded to CAWG DOT for consideration.

Questions

1. What are the prerequisites to start Observer Training?

Observer Responsibilities
Duties

The Observer has duties that mainly pertain to assisting the mission pilot. However, their primary responsibility while in the search area is visual search. How much assistance they provide to the mission pilot depends on how much the mission pilot wants. Normally the Observer is expected to:

- Report with the mission pilot for the sortie briefing.
- Assist in planning the mission.

- Assist in setting up and operating CAP radios.
- Assist in setting up and operating the aircraft navigational equipment (e.g., VORs and GPS).
- Monitor the electronic search devices aboard the aircraft and advise the pilot to make course corrections in response to ELT signals.
- Coordinate scanner assignments and ensure proper breaks for the scanners (including yourself).
- Maintain a chronological flight log of all observations of note, including precise locations, sketches and any other noteworthy information.
- Report with the mission pilot for debriefing immediately upon return to mission base. The applicable portions on the CAWGF 104 should be completed prior to debrief.

Once team members have been briefed on the mission and accomplished the necessary planning, Observers determine that all necessary equipment is aboard the airplane. Checklists help ensure that all essential equipment is included, and vary according to geographic location, climate, and terrain of the search area. Items on the Observer's checklist should include CAP membership and specialty qualification cards, current charts and maps of the search area, flashlights, notebook and pencils, binoculars, and survival gear (prohibited items, such as firearms, should be listed too, to ensure none is included). A camera may be included to assist in describing the location and condition of the search objective or survivors. Unnecessary items or personal belongings should be left behind. The mission Observer also assists the pilot in ensuring that all equipment aboard the search aircraft is properly stowed. An unsecured item can injure the crew or damage the aircraft in turbulence.

Once airborne, the Observer provides navigation and communication assistance, allowing the pilot to precisely fly the aircraft with a greater degree of safety. The Observer also assists in enforcing "sterile cockpit" rules when necessary. In flight, particularly the transit phase, the Observer maintains situational awareness in order to help ensure crew safety.

The Observer divides and assigns scanning responsibilities during the crew mission briefing, and ensures each scanner performs their assigned duty during flight. The Observer monitors the duration of scanner activity, and enables the scanners to rest in order to minimize fatigue.

Observer Log

The Observer must become proficient in maintaining an in-flight navigational log. A complete log maintained from take-off until landing is important. Keep in mind that the log is where all events and sightings are recorded as they occur with the geographical location of the search aircraft at the time. This information is the basis of CAWGF 104, which is used by the Incident Commander (IC) and general staff after the debriefing. CAWGF 104ws can be used as a guide to log information but any paper and format may be used. Remember, <u>it is better to log too much information than to not log a vital piece of information.</u>

Questions

1. The Observer’s primary duty while in the search grid is to __________ __________.
2. It is important for the Observer to keep a complete log because it is the ____________ for subsequent actions.
3. How much assistant the Observer gives to the pilot is dependent on what?

Communications

Airmen use several means to communicate, whether they are flying, taxiing, or stranded after an accident. Aerial communication has grown from simple techniques of dropping messages from airplanes to the use of highly sophisticated transceivers. In order to fulfill communication responsibilities involving the aircraft radio, Observers must study basic communication techniques that are applicable to general aviation.

Electronic Communications

The radio is the primary means of communication in aviation. To effectively use the radio, Observers must be knowledgeable not only of *how* to communicate, but *when* communication is required during CAP missions. Necessary communication should never be delayed while mentally searching for the appropriate terminology or phrase. If in doubt, always use plain language. Keep your radio transmissions clear, simple, and accurate, and practice using the radio so that you will be ready to go into action when the situation arises.

A very important mission you may have as an Observer is being in a “high bird”. “High birds” are radio relay aircraft that orbit above a set location. They provide the only communication between the search aircraft at low altitudes and the mission base or ground teams. The Observer copies and relays all message to and from these groups usually using the CAP FM radio. A log is kept of all messages relayed and the “operational normal” messages from search aircraft. These messages are a safety message assuring the search aircraft has not been lost.

The aircraft radio

To establish radio communications, tune the communications radio to the required frequency obtained from the pilot or other documents. Almost all general-aviation aircraft transmitters and receivers operate in the VHF frequency range 118.0 MHz to 136.975 MHz. Civil Air Patrol aircraft normally have 760-channel radios, and the desired frequency is selected by rotating the frequency select knobs until that frequency appears in the readout or window. Figure 1 is a typical aircraft radio with large tuning knobs to set the frequencies. The left frequency is the one being used for transmissions and receptions. The right frequency is a setting/standby position and its numbers will change when you move the tuning knobs. The white button switches the two frequencies (standby to current use). In this manner the last frequency is retained for reference or the next needed frequency can be preset.

Communication Radio Navigation Radio

Figure 1

Before transmitting, first listen to the selected frequency. An untimely transmission can "step on" another transmission from either another airplane or ground facility, so that *all* the transmissions are garbled. Next, mentally prepare your message so that the transmission flows naturally without unnecessary pauses and breaks (remember "Who, What, Where, When and How"). You may even find it helpful to jot down what you want to say before beginning the transmission. Some radios have a design limitation that causes a slight delay from the instant the microphone is "keyed" until the radio actually starts transmitting. If you begin to speak before the radio has actually started to transmit, the first few syllables of the transmission will be lost. Until you become familiar with the characteristics of the individual radio, you may find it desirable to make a slight pause between keying the microphone and beginning to speak. When you are prepared to transmit, place the microphone close to your mouth and speak in a normal voice.

CAP aircraft have been authorized to use FAA call signs, just like the major airlines and commuter air carriers. Our FAA authorized call sign is "Cap Flight XXX," where the numbers are those assigned to each Wing's aircraft. There are a few exceptions to this rule when you will use the aircraft 'N' number or pilot’s name as your call sign.

The initial transmission to a station starts with the name of the station you’re calling (e.g., Amarillo Ground), followed by your aircraft call sign. You almost always identify yourself using your aircraft's CAP flight designation. Once you’ve identified the facility and yourself, state your position and then make your request.

CAP aircraft should use the word "Rescue" in their call sign when priority handling is <u>critical</u>. From the example above, this would be "Cap Flight four three niner rescue." DO NOT abuse the use of this word; it should only be used when you are on a critical mission <u>and</u> you need priority handling. NEVER use the word "rescue" during training or drills.

Stuck Mike

Occasionally, the transmit button on aircraft radio microphones gets stuck in the transmit position, resulting in a condition commonly referred to as a “stuck mike.” This allows comments and conversation to be unintentionally broadcast. Worse yet, it also has the effect of blocking all other transmissions on that frequency, effectively making the frequency useless for communication by anyone within range of the offending radio. You may suspect a stuck mike when, for no apparent reason, you do not receive replies to your transmissions, especially when more than one frequency has been involved. Also, with experience you may notice a different sound quality to the background "silence" of the intercom versus the "silence" heard when the microphone is keyed but no one is talking. Often the problem can be corrected by momentarily re-keying the microphone. If receiver operation is restored, a sticking microphone button is quite likely the problem

Code words

Because the frequencies CAP normally uses are not secure, code words and phrases are sometimes used to prevent unauthorized parties from obtaining the information and possibly compromising mission integrity. The incident commander may assign code words and phrases for mission members to use when transmitting important mission information, such as the sighting of the target aircraft, its location, and whether there are survivors.

CAP FM radio

All CAP aircraft have an FM radio separate from the nav/comm radios. This radio is dedicated to air-to-ground communications, and is normally operated by the Observer. One type of CAP FM radio is seen in Figure 2 and is normally set to 148.150HZ. You can learn more about this radio at the CAWG web site under “Member Services, Communications.” A quick reference guide on how to use the radio is available on the CAWG web site for you to print out for your use.

Figure 2

The radio is normally used for communications with the mission base and ground teams. The aircrew normally must report the following to mission base; radio check (initial flight of the day), engine start, times entering and exiting a search area, and operations normal ("Ops Normal"), at intervals briefed by mission staff.

Audio Control Panel

The standard CAP aircraft audio control panel is the PMA 7000M-S, Figure 3. It selects the radios you listen to and transmit on. This CAP audio control panel permits reception and transmission on three radios. The Split Com Mode permits two people to transmit at the same time on two different frequencies. The pilot can listen

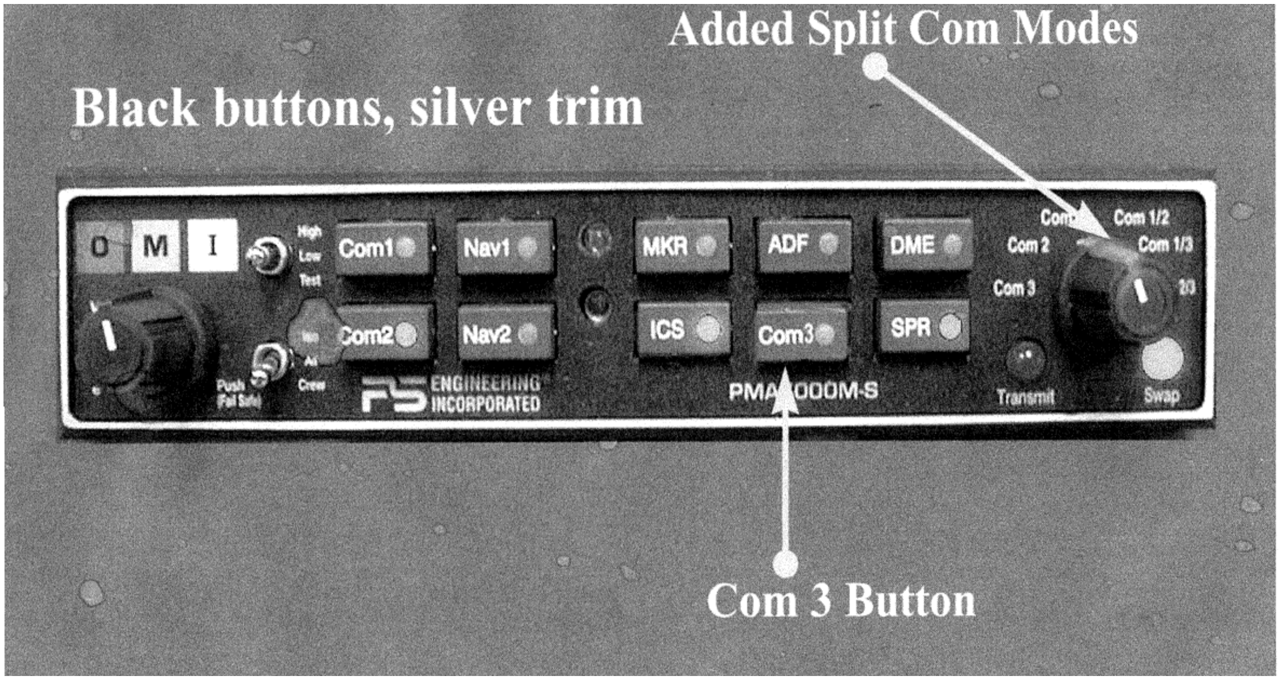

Figure 3

and talk to air traffic control and the Observer to CAP headquarters. Note the Com 1/3 mode for example. You can learn more about this radio at the CAWG web site under “Member Services, Communications.” A quick reference guide on how to use the control panel is available on the CAWG web site for you to print out for your use.

Non-Electronic Communications

As a Scanner, you learned about different signals used to communicate with people on the ground from the aircraft without radios. You also discovered that there were hand signals used to guide the aircraft on the ground. There are additional signals used if the radio in your aircraft fails.

Light gun signals

It is still very important for you to follow instructions from the tower at a controlled airport even if your radio is not working. In this case, you may have to rely on light gun signals from the control tower in order to receive the necessary landing and taxi clearances previously described. Figure 4 shows each light gun signal, followed by its meaning.

Color and Type of Signal	On the Ground	In Flight
Steady Green	Cleared for takeoff	Cleared to land
Flashing Green	Cleared to taxi	Return for landing
Steady Red	Stop	Give way to other aircraft and continue circling
Flashing Red	Taxi clear of runway area	Airport unsafe—Do not land
Flashing White	Return to starting place on airport	Not applicable
Alternating Red and Green	General warning — exercise extreme caution	

Figure 4

Questions

1. The audio control panel determines which electronic communications the Observer can _____________ and ________________ on.
2. List the six times the Observer will normally report to mission base over the FM radio.
3. What is the effect of a “stuck mike’?

4. Before transmitting on a frequency, ________________ for other transmissions and ____________ __________ your message.
5. The CAP call sign is used on most CAP missions. The additional word "rescue" should only be used when priority air control handling is _____________.
6. What is the mission of a "High Bird"?

Navigational Equipment

This equipment is usually located on the instrument panel between the pilot and Observer where both can easily reach it. Navigational equipment is used to help locate the aircraft's position above the earth's surface. They are always an aid to map reading, which is locating your position by visually referring to a chart. The equipment becomes the primary method for fixes on night and possibly electronic searches.

Global Positioning System (GPS)

The global positioning system, Figure 5, will probably be the most used aid to navigation. It is extremely accurate and versatile. You can enter the "waypoints" (positions on the ground you want to fly over) for a flight plan and it will determine what directions to fly, how fast you are going and how long it will take to get to the waypoint.

Figure 5

The GPS will show you what navigation aids; airports with all their information, and airspace restrictions are relative to your position and the waypoint. It can present a moving map display passing under an aircraft symbol. In the search mode, it can show your assigned grid and set up, if desired, a search pattern for covering the grid. You can also determine your present position at any time. This is just a sample of what the GPS can do for you. In fact, you may tend to become over reliant on it and forget what to do without it! The best way to learn how to use this invaluable piece of equipment is to use it. A GX55 downloadable simulator is available for you to practice on. Instructions on how to obtain this simulator and quick reference guides for in-flight use of the GPS are available on the CAWG web site for you to print out for your use.

VHF Omni Directional Range (VOR-DME)

The VOR station transmits radials/bearings that are referenced to magnetic north not true north. Some VOR stations also have Distance Measuring Equipment (DME) that indicates how far from a station the aircraft is. The station frequency, station identifier and Morse code identifier can all be found on the sectional chart. Figure 6 shows a VOR station and the compass rose with the radials. The radials/bearing shown on the chart are transmitted by the station and do not need calculations by aircraft equipment. To find your position with a VOR station, set the station frequency into the Navigation radio, Figure 1, with the large knobs. The Navigation radio operation is the same as the Communication radio.

Figure 6

The VOR Indicator, Figure 7, displays the information obtained from the ground VOR station. When the needle is centered, the radial the aircraft is on will be indicated above the arrow. Keeping the needle centered will fly you to or away from the station. The words “to” or “from” will appear in a window to indicate which you are doing. You use the selector knob to enter the desired radial to fly to or away from the station on. The distance (if you have DME) may be displayed on a separate instrument.

You normally locate (fix) your position by plotting the radial and distance indicated by the VOR. Use the selector knob to center the needle and read the VOR radial opposite the arrow. Note the distance (if you have DME) and time. This information is then plotted on a chart to determine your position. If reception of multiple VORs is possible and there is no DME, fixes using multi-radials could be used. If DME was available from multiple VORs and no radial information is available, fixes using multi-distances could be used. At search altitudes reception from more then one VOR is usually not possible.

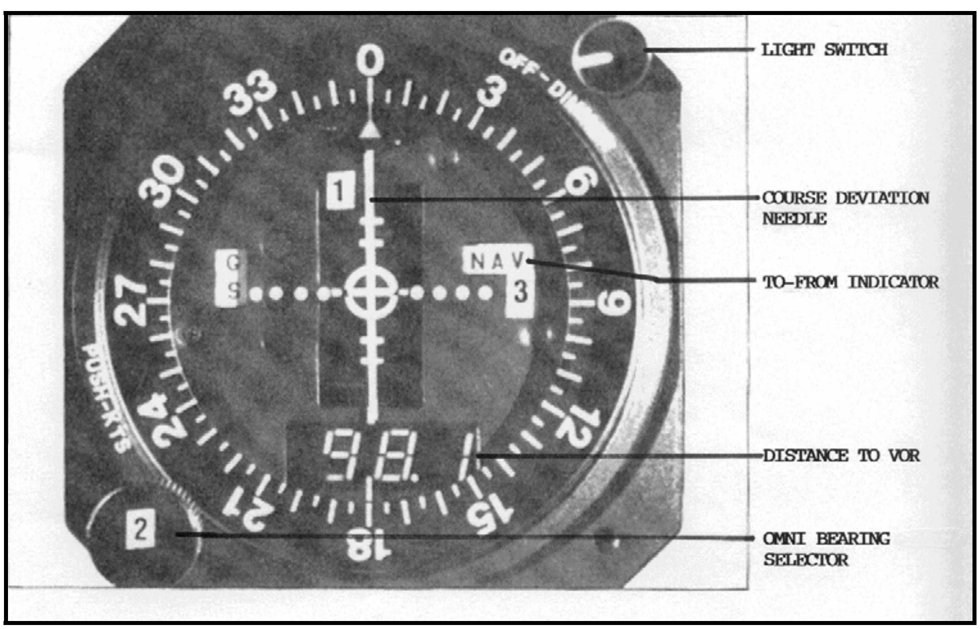

Figure 7

Clock

An important navigational instrument often overlooked is a clock, whether in the aircraft or on your wrist. If you flight planned to enter the grid in 15 minutes and you have been flying only 10 minutes, you are probably not at the grid yet. Conversely, if you have been flying 20 minutes you are probably past the grid. A clock, or time, is always a good back up or check on your navigation.

Questions

1. How can you practice with the GPS?
2. The VOR radials are referenced to ____________ North.
3. What piece of equipment is a good back up to your navigation?
4. What is the most common way to obtain a VOR fix?

Electronic Search Patterns (ELT Searches)

Electronic equipment and procedures are used in general searches to focus the search and rescue effort in a specific area, or as an alternative to visual searches when visibility is reduced by weather or other atmospheric conditions. The primary equipment in these type searches is an emergency locator transmitter (ELT) and ELT reception device known as a DF for Direction Finding Equipment. The success of this type of search depends on the life of the battery of the ELT, the survivability of the entire ELT unit and whether the unit was activated or not. These ideals seldom exist. Therefore, the effectiveness of electronic searches depends heavily on the experience and expertise of the search crews employing them and the survivability of the ELT. Through practice, you will understand the difficulties caused by ELT signals reflected from obstructions, the adaptability of electronic search methods to overall conditions, and the monitoring of radio equipment to ensure proper operation.

ELT and SARSAT

The Federal Aviation Administration (FAA) requires most US-registered aircraft to have operable ELT installed, which activate automatically when sensing acceleration forces during an accident. An active ELT transmits a continuous radio signal on a specific frequency of 121.5 or 243.0 (for the military) until it's either deactivated or its battery discharges.

Emergency Position Indicating Radio Beacons (EPRIB; primarily for maritime use) and Personal Locator Beacons (PRB; currently illegal for general use but used by some government agencies) also transmit on the same frequency (121.5 MHz, 243 MHz and 406 MHz or a combination). Those that transmit on the newer 406 MHz are specifically designed to operate with the Cospas-Sarsat satellite system, and transmit data that contains a unique identifier number that links them to a database containing information on the vessel or aircraft and emergency points of contact. Space-based monitoring of 121.5 MHz is expected to cease on 1 FEB 09.

In a cooperative effort among several nations, search and rescue-dedicated satellites (SARSATs) orbit the earth and receive ELT transmissions. Upon receiving an ELT signal, the SARSAT derives the approximate lat/long coordinates of the ELT's position, and the coordinates are passed through rescue channels to the incident commander. Aboard the search aircraft, a radio receives the ELT signal, and converts it into an audible tone and a signal that's processed by the direction finder. The direction finder (DF) provides the crew with relative direction to the transmitter.

Before you can use any technique to locate an ELT, you must first be able to pick it up on your radio. The aircraft conducting an electronic search will normally begin the search at or near the last known point (LKP) and fly a search pattern at altitudes from 5,000 to 10,000 feet above the terrain if possible. At this altitude, the aircraft can usually intercept the ELT signal, as well as recognize or distinguish the downed aircraft. Maximum track spacing should be used initially to provide a rapid sweep of the probability area. Successive sweeps should have a track spacing one-half the size of the initial spacing. For example, if the track spacing is 60 nautical miles during the initial sweep of the area, then the track spacing for the second sweep of the area should be 30 nautical miles.   A third sweep of the area, if needed, should have track spacing of 15 nautical miles. This method of gauging the track spacing applies to both a track line (route) and a parallel track search. In mountainous terrain the initial search pattern should be arranged to cross the ridgelines at right angles, if possible. Subsequent search coverage of the area should be at right angles to the first coverage tracks to compensate for blockage of the ELT signal due to the shape of the terrain.

Once the searchers are in a position to receive the ELT signal, they may use one of several methods to locate the transmitter and the accident scene.

Aircraft Direction Finder (DF)

The L-Tronics LA series Aircraft Direction Finder, the most common DF unit found in CAP aircraft, consists of VHF and UHF receivers, two- or three-element yagi antennas and circuitry. The controls consist of a frequency selector switch, an alarm toggle switch (works like a light switch), and a dual-knob control switch for volume (inner knob) and sensitivity (outer knob). There are two indications: a DF meter and a signal Strength meter, Figure 8.

The tone-coded squelch circuit, called the Alarm mode, permits continuous, annoyance-free monitoring for Emergency Locator Transmitters (ELTs) and Emergency Position Indicating Radio Beacons (EPIRBs) on 121.5 MHz.

The DF unit is normally connected to the aircraft audio system. This connection allows an audible as well as a visual alarm when an ELT signal is detected in ALARM mode.

The three-whip antenna array provides for dual band operation. The performance of the DF is absolutely dependent on the antenna installation and the antennas must be parallel to each other. The whip antennas and the aircraft structure work together to form the directive antenna patterns necessary to the operation of the DF set.

Figure 8

There is considerable interaction between DF and communications antennas. The DF switching may put a strong tone on communications receiver signals from some directions. The DF may have to be turned off or the aircraft heading changed for good communications intelligibility. In particular, the DF receiver may cause interference to communications on 132.3 MHz when operating on 121.5 MHz (126.85 MHz when using 243.0 MHz).

A functional check for this equipment is available on the CAWG web site for you to print out for your use.

<u>Normal Operations</u>

The Alarm mode is the normal mode for routine conditions. It enables the pilot to monitor the emergency frequency (121.5 MHz) without dedicating a communications radio to the task. DO NOT USE THIS MODE DURING A DF SEARCH because the DF function is disabled in the Alarm mode.

To select the Alarm mode, place the Alarm toggle switch on (up). Set the SENS (sensitivity) so that the needle just comes on-scale and the VOL (volume) to a comfortable level (the ear will detect a weak signal far sooner than the alarm). [Note: The Alarm mode is designed to work with weak signals; if an ELT is transmitting nearby and the unit is set to full sensitivity, the receiver may overload.]

If an ELT activates the Alarm, turn the Alarm toggle switch off (down). This activates the DF function and allows you to track the signal.

The alarm unit automatically rejects false signals. The ELT signal must remain at sufficient strength for 5-20 seconds before the alarm light (flashing red LED) is activated.

<u>DF Operations</u>

An ELT check list for this method is available on the CAWG web site for you to print out for your use.

Climb to an altitude of at least 3000 feet AGL, higher if possible. Fly to the area of the reported ELT signal. If the ELT cannot be heard in the expected area, climb to a higher altitude. If this fails to acquire the signal, start a methodical search (e.g., area or expanding square).

Unless the beacon is known to be a 406 MHz EPIRB (which doesn't transmit on 243 MHz) or a military beacon (which doesn't transmit on 121.5 MHz), switch between 121.5 and 243 MHz at least once each minute until a signal is heard. All civil beacons except 406 MHz EPIRBs and some military beacons transmit on both frequencies. Undamaged ELTs can usually be heard further on 121.5 MHz than they can on 243 MHz; the reverse is often true for damaged ELTs.

Initial Heading

When first heard (write down the time and your location), the ELT signal will probably be faint and will build slowly in strength over a period of several minutes. Continue flying until a reasonable level of signal is acquired. The DF needle should deflect to one side and the Strength needle should come on-scale. Resist the urge to turn immediately and follow the needle; instead, make a 360° turn at no more than a 30° bank to ensure you get two needle centerings (approximately 180° apart) to verify the heading. When the turn is complete, center the DF needle and fly toward the ELT. Note your heading (write it down) for reference.

If the ELT is heard on both 121.5 and 243.0 MHz, compare the headings. If they differ by more than 45° or if the turn produces multiple crossovers, try a new location or climb to a higher altitude to escape from the reflections.

While flying toward the ELT the DF needle may wander back and forth around center at 10- to 30-second intervals. This is caused by flying through weak reflections and should be ignored. Fly the heading that keeps needle swings about equal in number, left and right.

Signal Fade

Don't become concerned if the signal slowly fades out as you fly towards the ELT. If this happens, continue on your heading for at least six minutes. If you are still headed toward the ELT the signal should slowly build in strength in three or four minutes and be somewhat stronger than before the fade. If the signal does not reappear, return to where the signal was last heard and try a different altitude.

Getting Close

As you get close to the ELT the signal will get stronger, and you will have to periodically adjust the SENS control to keep the signal strength needle centered (do not decrease the VOL control as this could overload the receiver). You also need to do this if the DF needle gets too sensitive. Periodically yaw the aircraft and observe the DF needle respond (left and right).

Passing Over

A "station passage" is often seen as a rapid fluctuation in signal strength and confused DF readings. Have the pilot yaw the aircraft to see if the course has reversed (needle goes in the direction of the aircraft turn). If the course has reversed, continue on your heading for a few minutes. Then turn and make several confirmation passages from different angles while continuing your visual search.

A checklist for this method can be found with the Observer Attachments for you to print out for your use.

Homing Method

An ELT check list for this method is available on the CAWG web site for you to print out for your use.

Tune the direction finder (DF) to the ELT operating frequency; the pilot will then fly the aircraft to the transmitter by keeping the left/right needle centered. The first step in homing is to tune the receiver to the ELT frequency and listen for the warbling tone of the ELT signal. Fly directly toward the signal with the left/right needle centered. A simple, quick maneuver is used to determine if you are going toward or away from the signal.

Starting with the left/right needle centered, the pilot turns the aircraft in either direction, so that the needle moves away from center. If he turns left, and the needle deflects to the right, the ELT is in front of the aircraft. Turn back to the right to center the needle and proceed to the ELT.

If, in the verification turn, the pilot turns left and the needle swings to the extreme left, then the ELT is behind you. Continue the left turn until the needle returns to the center. You are now heading toward the ELT.

Flying toward the ELT, maintaining the needle in the center of the indicator *is* the actual homing process. If the needle starts to drift left of center, steer slightly left to bring the needle back to the center. If it starts to drift right, turn slightly back to the right. Once you have completed the direction-verification turn, you will not need large steering corrections to keep the needle in the center.

When passing over the ELT or transmission source, the left/right needle will indicate a *strong* crossover pattern. The needle will make a distinct left-to-right or right-to-left movement and then return to the center. This crossover movement is *not* a mere fluctuation; the needle swings fully, from one side of the indicator to the other and then returns to the center.

During homing you may encounter situations where the needle *suddenly* drifts to one side then returns to center. If the heading has been steady, and the needle previously centered, such a fluctuation may have been caused by a signal from a second transmitter. Another aircraft nearby can also cause momentary needle fluctuations that you might not hear, but the needle in the DF will react to it. Signal reflections from objects or high terrain can also cause needle fluctuations at low altitudes in mountainous terrain or near metropolitan areas.

Wing shadow method (signal null)

The signal null or wing shadow method is based on the assumption that the metal skin of the search aircraft's wing and fuselage will block incoming ELT signals from the receiving antenna during steep-banked turns. The Observer can make simple estimates of the magnetic bearing to the transmitter by checking the aircraft heading when the signal is blocked.

Once the search aircraft completes several signal-blocking turns in different sectors of the search area, the Observer can establish the approximate location of the ELT by drawing magnetic bearings, or "null vectors," on the sectional chart. The ELT and accident scene will be at or near the intersection of the null vectors.

To use the null method, the search aircraft must be equipped with a properly installed antenna with a 45° bend. On a low-wing airplane, the antenna should be mounted on the underside of the fuselage, in line with the wings. On a high-wing airplane, the antenna should be mounted on the top of the airplane, again in line with the wings. The wings must be made of metal so that the ELT signal can be blocked. Aircraft having fabric or plywood covered wings are not suitable for the null search method, because the wings may not block the signal well enough for the method to work properly.

Procedure

First, verify the receiver is tuned to the proper ELT frequency and that you can hear the warbling tone. Mark your position on the sectional chart, preferably over a small but significant feature. Then the pilot will make a 360° steeply banked turn to allow you to determine the signal's direction. As the airplane turns, the ELT tone will break, or null, at the point when the aircraft wing comes between the transmitter and the antenna. For a brief instant you will not hear the tone. The absence of the audible tone is referred to as the *null*.

On low-wing aircraft, with the antenna installed on the underside, the wing inside the turn, or the "down" wing of the banking airplane, points toward the ELT when the tone nulls. On high-wing aircraft, with the antenna installed on the top surface, the wing on the outside of the turn, the "up" wing, points toward the ELT when the null is heard. To estimate the magnetic bearing from the search airplane to the ELT, the Observer makes simple calculations. In high-wing airplanes, if you're turning left, add 90° to the aircraft heading when you hear the tone null. If you're turning right, subtract 90° from the heading at the instant you hear the tone null. In low-wing airplanes, when you're turning left, subtract 90° from the aircraft heading, and when making right turns, add 90° to aircraft heading. See Figures 9 and 10.

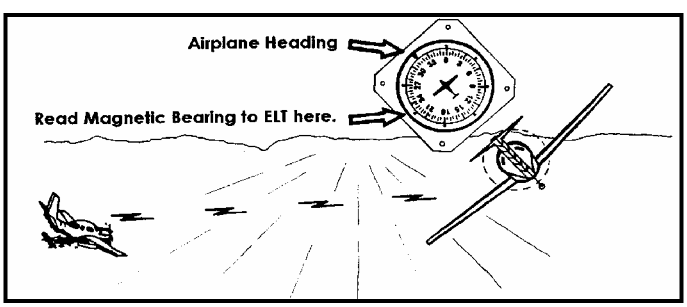

Figure 9

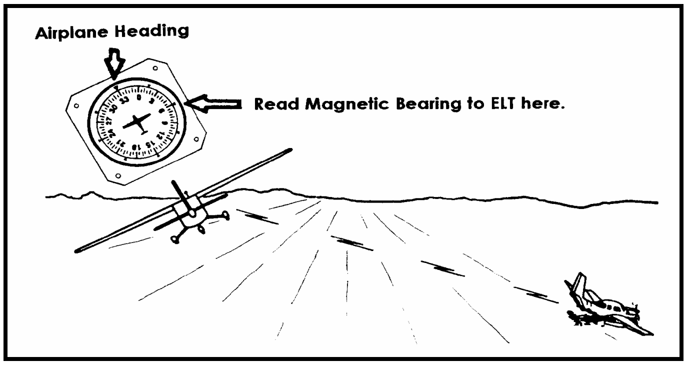

Figure 10

You may find it simpler to make these bearing estimates using the face of the heading indicator. Imagine an aircraft silhouette on the face of the search airplane's heading indicator. The silhouette's nose points up toward the twelve o'clock position, and the tail points toward the bottom or six o'clock position. Some heading indicators actually have this silhouette painted on the instrument face, as shown in Figures 9 and 10. Upon hearing the null, the Observer should quickly look at the heading indicator. If the search aircraft is a low-wing aircraft, look for the number adjacent to the imaginary aircraft's low wing, as shown in Figure 9. If the search plane is a high-wing, look for the number adjacent to the imaginary plane's high wing, as shown in Figure 10. That number is the magnetic bearing from the search aircraft's present position to the ELT transmitter.

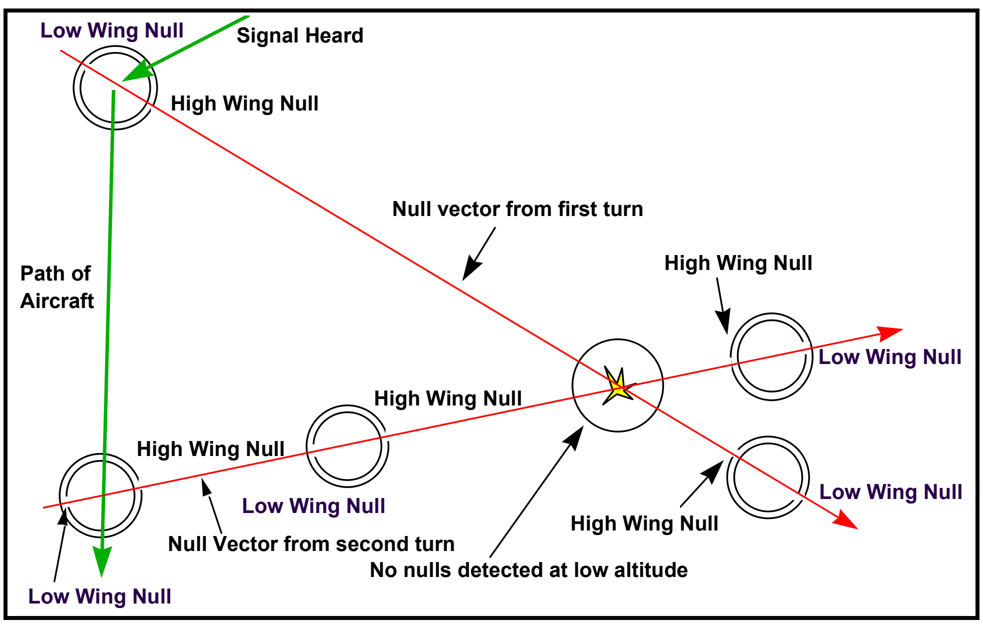

Figure 11

Regardless of the method used to determine the ELT's magnetic bearing, the next step is to convert that magnetic bearing to a true bearing by adding or subtracting the published magnetic variation for that area. Then draw a line on your chart from the search aircraft's known position in the direction of the calculated true bearing. You now have one null vector, or line of position, to the ELT. The ELT is somewhere along that line, but it isn't possible to tell exactly where. To narrow the focus, simply repeat the process starting from another known position over a different geographical point. Don't pick your next geographical point near to or along the initial null vector. The accuracy of this technique improves if you select geographic points well away from each other. If the points are well separated, the null vector lines will intersect at a larger angle, and the position will be more accurate. Figure 11 shows an entire null signal search. Notice that several fixes may be taken before deciding the limits for the subsequent visual search. Finally, fly to the area indicated by the null-vector intersection and attempt to pinpoint the ELT.

Upon reaching the area, the pilot can descend to a lower altitude and execute similar steep turns. If you are very close to the ELT, you can expect to hear no null, due to the higher signal strength near the transmitter and the inability of the wing to block the signal. When an ELT tone is continuous through a full 360° turn, the ELT transmission is very likely in the area beneath the search aircraft. You can then chart the probable location of the missing aircraft or transmitter to within a small area.

If descending to a lower altitude brings the aircraft within 1,000-2,000 feet above the terrain, you should discontinue null procedures. Instead, you should descend to an appropriate lower altitude and begin a visual search.

Special Considerations in Signal Null Searches

The most important consideration is crew ability. Maintaining altitude throughout turns requires skill and extensive practice. The pilot must be skilled in executing steep-banked turns.

You must have positive knowledge of the aircrafts actual position when the null is heard. By constantly monitoring the search aircraft's position in the turn, you can plot each null vector more precisely.

The search crew must know what to do if the signal is lost during a search. If you lose the signal, return to the position and altitude of the last contact with it. The Observer's chart is a useful record of each position where successful procedures were performed.

Finally, as you approach the suspected ELT location you need to be more alert for other aircraft

Aural (or hearing) and Metered searches

These are based on a comparison of hearing levels or meter readings from the ELT but are not normally used. A full description can be found in the CAP Mission Aircrew Reference Text for those interested.

Night and IFR electronic search

Darkness and poor weather reduces your ability to precisely determine your position, and that impacts the effectiveness of all electronic search procedures. The accuracy of the null vectors depends on your ability to accurately fix your position over the ground. Even when you've successfully homed to an ELT, unless you can accurately determine your position, you've only succeeded in narrowing the general area for ground search efforts that follow.

Other considerations relate to safety and qualifications. Instrument flight imposes a higher workload on the crew and demands a higher level of training, especially for the pilot. As discussed earlier, the ability to fly steep-banked turns and other maneuvers without losing altitude is demanding for even the most proficient IFR trained pilot. If the search is conducted at night or in instrument conditions, use DF or homing techniques to avoid the vertigo-inducing maneuvers required by other techniques.

Signal Reflection and Interference

Radio signals reflect off terrain and manmade objects, and this can be a problem for search and rescue teams. In an electronic search, it is vitally important to know if the equipment is reacting to reflected signals and what you can do to overcome the problem. Although tracking a signal is the best means of locating an ELT, actually isolating the signal can occasionally become a problem. The following scenario illustrates one approach to a signal reflection problem.

> Upon reaching the designated search area, the Observer picks up an ELT signal. The crew notes that keeping the left/right needle centered requires a 60° turn. This turn causes the crew to conclude the signal is being reflected for two reasons. First, it is highly unlikely that the aircraft wreckage moved, causing a change in direction. Second, if sufficient crosswind was present to cause the change, it should have been noticeable.
>
> The Observer can have the pilot climb to a higher altitude to eliminate or minimize the effects of reflected signals. Reflected signals are usually weaker than those coming directly from the transmitter, so climbing can help the stronger direct signals come through. Also, depending on the terrain, a higher altitude may result in more time available for the crew to detect the transmitter.

False Alarms

Ninety seven percent of all received ELT transmissions are false alarms. On frequency 121.5, 1 out of a 1,000 is an actual emergency. Why is a False Alarm a big deal? SARSAT can only monitor 10 ELTs at once so it is very easy to overload the system. Thus emergency communications from real emergency situations are blocked. However, all ELT signals must be treated as a real emergency since it isn't known which is real or false.

Questions

1. When conducting an ELT search at night the _________ ___________ technique should be used.
2. The approximate lat/long coordinates of the ELT's position are derived from __________ and the coordinates are passed through rescue channels.
3. After receiving a reasonable strength signal on a DF method search, the crew should make a 360º turn at no more than a 30° bank to ensure you get two needle centerings (approximately 180° apart) to verify the ____________________.
4. Flying _______________can minimize reflected or blocked signals in mountainous terrain.
5. You are homing an ELT signal and in the verification turn, the pilot turns left and the needle swings to the extreme left, then the ELT is ______________ you.
6. A high wing aircraft will have a signal null point when the __________ wing is pointing to the ELT.
7. The effectiveness of electronic searches depends heavily on the ______________ and ____________of the search crews employing them.
8. The Alarm switch must be turned ______ to DF the ELT.
9. All ELT search methods end with a ___________ ___________.

Crew Limitations

You learned about and have experienced personal mental and physical limitations as a scanner. You now know what your limitations are. The IC may initiate more limitations due to the unique conditions of the search mission or only to insure those limitations in CAP Regulations (CAPR) are being followed. The two main CAPRs that affect the crewmembers are CAPR 60- and 60-3.

CAPR 60-1

CAPR 60-1, specifically paragraph 2-14, affects pilots directly but the limitations are relevant to other crewmembers also.

2-14. Flight Time and Duty Limitations. Pilots will not be scheduled for more than 8 hours and will not, under any circumstances, exceed 10 hours flight time during a 14-hour crew duty day. The crew duty day begins when reporting for work or CAP duty (which ever occurred first) and ends at engine shutdown at the completion of the flight activity. At least a 10-hour rest period should be provided between duty days.

CAPR 60-3

CAPR 60-3, specifically paragraph 1-23, affects all crewmembers.

1-23. Prevention of Fatigue. Incident commanders will ensure that personnel performing operation mission activities, particularly flight operations, have had sufficient rest to enable them to safely complete the proposed assignment. CAP mission managers and flight crews should refer to CAPR 60-1 for flight time and duty limitations. CAP flight crews and ground teams will make a conscientious effort to avoid or reduce fatigue by:

a. Periodic separations from duty station;
b. Periodic light refreshments of moderate amounts of hot foods, soup, fruit juice, etc.;
c. Avoidance of excessive smoking;
d. Periodic sleep prior to sorties; and
e. Refraining from alcohol within 24 hours of reporting for the mission.

Questions

1. Which regulations specify crew limitations?
2. How many hours in a 14-hour duty day can a pilot fly?
3. CAP flight crews will make an effort to avoid or reduce ______________.

Flight Planning Tools

Flight planning is determining, on the ground, what altitudes and directions the aircraft must be flown to accomplish the desired mission: based on available weather, surface and aircraft information. Additionally, the amount of time for and fuel used on the mission can be determined. The following tools are needed to prepare a flight plan; paper, pencil, current chart (normally a sectional), flight computer and plotter. Often a simple flight plan to a nearby grid can be completed without the flight computer and plotter.

Plotter

The flight plotter is used to measure directions and distances from the chart. Look at your plotter. There are multiple mileage scales, often on both sides of the plotter. Be sure to use the correct one for the chart being used. Also note whether the mileage start/zero point is at the end of the plotter. A degree scale, to measure angles, is part of the plotter. On some plotters, the degree scale can be rotated. Course line arrows may be at the compass base or the plotter's edge and indicate what direction you want to fly. A grommet (hole) is located at the center of the compass.

Computer

The hand computer is used to solve the simple mathematical flight navigation problems such as direction, speed, time, and fuel consumption. While electronic flight computers are available, hand ones are cheaper and will satisfy CAP needs.

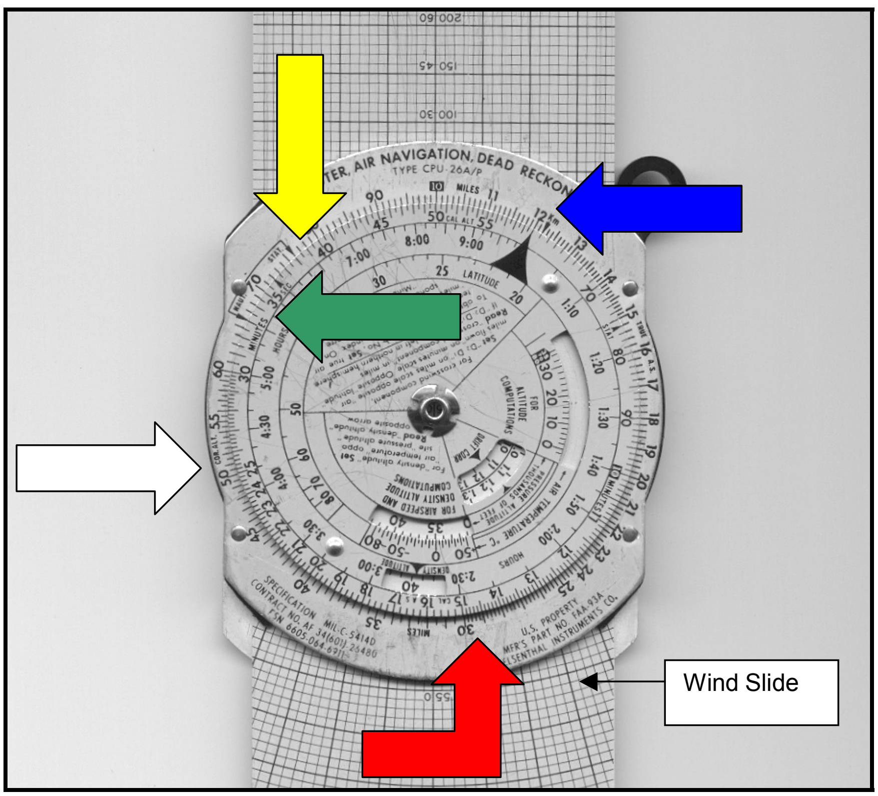

Figure 12

Look at your computer. Note that the distance on the on the inner and outer scales between 1 and 2 is much greater than the distance between 9 and 10/ 0. This is a logarithmic scale. Also note that the 9 can be .9, 9, 90 or 900. You must use common sense to correctly place the decimal point.

Normally, you will only use the computer to determine how long it will take to get to a grid. The outer non-moving scale is used for miles. The inner movable scale is used for reading time and has two time scales, one in minutes and the other in hours. The large black arrow on the inner scale indicates 60 minutes or 1 hour. To use the computer, set up a simple proportion. Suppose you are flying at 120 nautical miles per hour (Kts). Rotate the inner scale until the black arrow representing 1 hour is opposite the 12 (120 with correct decimal place) (blue arrow in Figure 12). For instances, look opposite 30 nautical miles to find it will take 15 minutes to fly that distance (red arrow). Conversely, you can look above any time on the inner scale to see how far you will fly for that given time. Of course, 120 Knots is 2 nautical miles a minute for a mental check on your answer.

There are two other things you may use the computer for fuel used and converting mileage. The method to find fuel usage is the same as finding how far you can fly. If your aircraft uses 12 gallons of fuel per hour, how much fuel will it use in 25 minutes? Move the black arrow hour indicator to be under the 12 for 12 gallons per hour (blue arrow, Figure 12). Look above 25 minutes on the inner scale to read 5 gallons (white arrow). Remember to mentally place the decimal point and use common sense to check the answer.

To convert nautical miles to statute miles, rotate the inner scale until the nautical mileage is under the small "Naut." arrow. Read the statute mileage under the small "Stat." arrow. For example, 33 nautical miles (green arrow, Figure 12) equals 38 statute miles (yellow arrow). Of course, you can also convert the mileage using the scales on a plotter or sectional chart.

The wind slide, for use with the backside of the computer, and the various windows on the computer front are not used on a normal search mission. At search altitudes the winds are usually calm or so small they basically have no effect on the aircraft's flight path. The same is true of the temperature that affects the altitudes calculated in the windows. If you are interested in these calculations, have a pilot explain them to you.

<u>Computer Practice Problems</u>

Use your computer to do the following problems. Set up the computer to find the underlined answer. Your answers may be off a little because of different computer alignments.

Speed, time and distance:

Speed	Time	Distance
<u>90 Kts</u>	40 Min	60 NM
135 Kts	1 Hr 20 Min	<u>180</u> NM
110 Kts	<u>11½ Min</u>	21 NM

Mileage Conversion

Nautical Miles	Statute Miles
60	<u>69</u>
<u>28</u>	32
13	<u>15</u>

Fuel consumption:

Rate of Consumption	Time	Fuel (available or used)
6 GPH	<u>198 Min</u>	20 Gals
10 GPH	40 Min	<u>6.7 Gals</u>
<u>15 GPH</u>	1 Hr 40 Min	25 Gals

Questions

1. When using the flight computer, you must provide the_____________ __________ to have the correct answer. The answer should always be checked with ___________ ___________.
2. The plotter is used to determine the ________________ to fly and the _____________ that will be flown.
3. The computer uses a simple _________ to calculate speed, time, distance and fuel problems.

Flight Planning

Flight planning a mission fully, and flying the plan, will make the actual flight easier, simpler, safer and more likely to succeed. The actual flight is flown using the plan as a starting point and correcting the flight based on actual in-flight weather, surface and aircraft information. The most common flight plan you will complete will be one to and from a search/area grid from the mission base. The tools you have been introduced to will be used to determine the directions, distances and times for the flight plan. Additionally, you will be shown alternate methods to determine the flight plan that is adequate for the mission. Practice problems are located after the questions for this section.

Suppose your crew is at the mission base of Los Banos and has been assigned grid SF381C. First, where is grid SF381C? Refer to your gridded chart (San Francisco in this case) to find the location of the grid. This location should be transferred, in pencil, to the current sectional chart that will be used for navigation. Standard procedure requires you to fly to and identify the four corners of the grid. You and the pilot should evaluate the grid to determine what search pattern you will use in the grid, where you will start it and which corners you will enter and exit the grid at. Note the latitude and longitude of each grid corner for future reference.

A heavier pencil line is drawn connecting the mission base to the grid entry corner and from the grid exit corner to the mission base. You now know where you must fly over the ground. Take some time to study the route and its area. Look for emergency airfields, obstacles, and recognizable points on the ground to be used to check that your flight is on course. This sortie is fortunate to have a nearby VOR that will provide coverage for the route and grid. For example, the grid's SE corner is located on the VOR's 184° radial at 14 NMs.

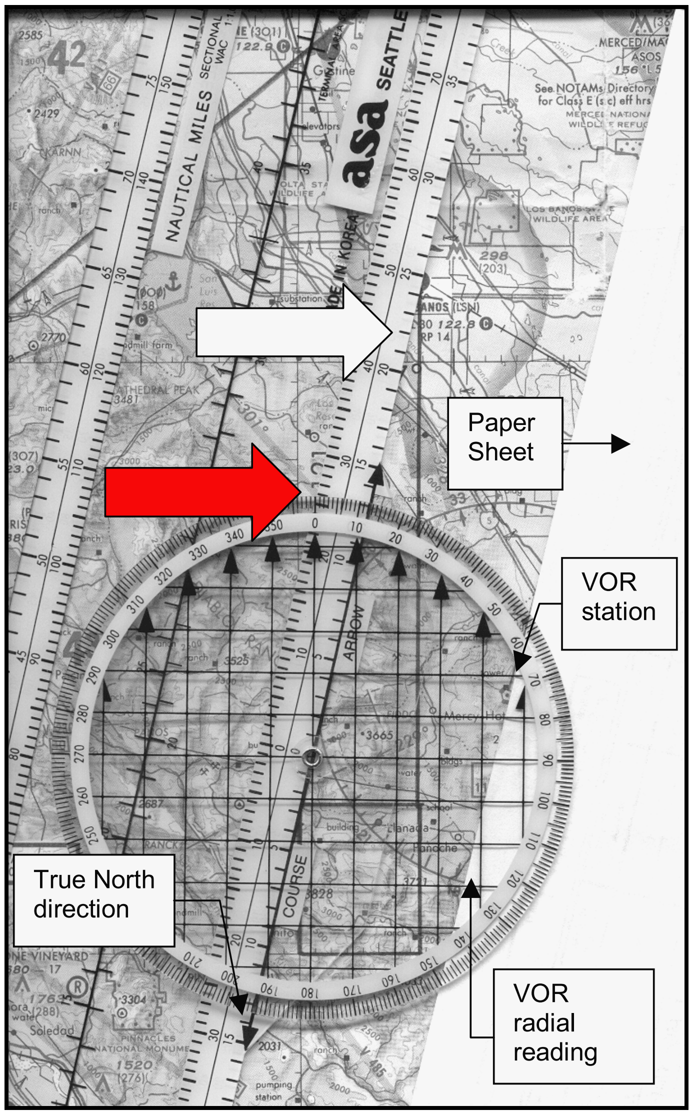

Figure 13

Next the heading to the NW corner of the grid is determined. The plotter is laid down with the edge and grommet over the penciled course line drawn on the chart (white arrow in Figure 13). The plotter is slid along the line until the grommet is over a meridian/longitude line or the rotating degree scale arrows are aligned with the longitude line and 0° is at the top (red arrow). The direction to fly is read at the black arrow on the plotter pointing in the correct direction. In this case, 193° which agrees with common sense that you want to travel SW not NE. Plotters without a movable degree scale read the course above the longitude line at the red arrow with the grommet correctly placed. Don't forget to subtract the variation of 15° to make the heading 178°. The course direction can also be measured by moving a straight edge (paper sheet), keeping it parallel to the course line, over the center of the VOR station. The direction is read at the radial ring of the VOR and is about 178°. Remember that the VOR radials are referenced to Magnetic North so the variation has already been subtracted.

The plotter can now be used to measure the distance from the mission base to the NW corner of the grid. Zero on the plotter's scale is placed over the airport symbol and aligned with the course line. Los Banos to the grid corner is 27 NM. Distance can also be obtained without a plotter. Distance can be measured along the course line by laying a pencil down on it or a piece of paper with tick marks. Then the pencil length or marked paper can be measured using the scale at the top of the chart or the minute marks on the longitude lines.

The only thing left to determine is how long the flight is estimated to last. A normal planned time in the grid for searching is 2 hours. The flight times to and from the grid have to be calculated and added to the grid time. You ask the pilot what airspeed he will use to fly to the grid. He states 110 Kts. The distance to the grid was measured at 27 NM. Set your computer up for the 110 Kts and look on the outer scale at 27 NM. The time for the example is about 15 minutes.

Actual time may take a minute or two longer as the aircraft has to accelerate to the 110 Kts. This is not a significant factor on this type sortie. It can be seen on Figure 13 that the leg from the grid to mission base has about the same mileage as the leg to the grid. Therefore, 15 minutes can be estimated for the return to base (RTB). The entire flight is estimated to last 2 hours and 30 minutes after takeoff.

You can mentally estimate the leg time when no computers are available. 120 Kts is 2 NM per minute. 27 NM divided by 2 NM per minute equals a little less then 14 minutes. Another minute or so should be added since 110 Kts is slower.

This sample flight plan is suitable for a sortie to a nearby search grid at low altitude under visual conditions. Indeed, it will also suffice for many cross-country flights at a medium altitude for an hour or two duration. A more precise and detailed flight plan is usually needed for longer or more complicated flights. That type of flight plan requires the use of the computer that has not been covered in this course.

Questions

1. The radials from VOR stations are referenced to ____________ North.
2. The plotter's _____________ is laid down on the course line to measure direction from True North.
3. The assigned grid location should be transferred to a _____________ chart for navigation.
4. Plotters without a rotating angle measurer must place the ____________ over a meridian/longitude line.
5. What are some items to look for along the planned route?

<u>Course and Distance Practice</u>

These coordinate sets are on the Los Angeles and San Francisco Sectional charts and are those used for practice in the Scanner Course. They are paired for your practice in measuring courses and distances. A ground speed is provided so that enroute time can be calculated. Your results should be within 2 and 1 minute.

	SETS					ANSWERS			
Los Angeles Sectional Coordinates						True Course	Magnetic Course	Distance	Time Minutes
From	35° 08.5'N 116° 06.5'W	to	34° 55.5'N 117° 22.5'W	at	110 Kts	258º	244º	64	35
From	34° 22.5'N 117º 18.5'W	to	35° 31.5'N 116° 26.0'W	at	130 Kts	032º	018º	82	38
From	34° 37.0'N 117º 34.0'W	to	35° 40.0'N 117° 21.0'W	at	120 Kts	010º	356º	64	32
From	35º 31.0'N 119° 03.5'W	to	35° 22.5'N 120° 02.0'W	at	120 Kts	260º	246º	48	24

From	36° 01.0'N 120° 03.0'W	to	35º 11.0'N 120° 05.0'W	at	100 Kts	181º	167º	50	30

San Francisco Sectional Coordinate

From	36° 20.0'N 118° 00.0'W	to	36° 58.0'N 119° 13.5'W	at	110 Kts	303º	288º	70	38
From	36° 23.0'N 121° 40.0'W	to	36° 43.0'N 120º 46.5'W	at	100 Kts	065º	050º	47	28
From	36° 57.5'N 122º 01.0'W	to	36° 02.0'N 120º 04.0'W	at	140 Kts	121º	106º	109	47
From	39° 07.0'N 121° 53.0'W	to	39° 44.0'N 122° 11.0'W	at	120 Kts	340º	324º	40	20
From	38° 35.0'N 121° 53.0'W	to	38° 40.0'N 123° 17.0'W	at	120 Kts	275º	259º	66	33

Question Answers

Introduction

1. Be GES Qualified.
   Be at least 18 years of age.
   Be a qualified Mission Scanner.
   Have a Unit Commander or authorized designee's signature attesting that all prerequisites have been completed.

Observer Responsibilities

1. Visual search.
2. Basis.
3. How much the pilot wants.

Communications

1. Transmit and receive.
2. Radio check (initial flight of the day), take off time ("wheels up"), times entering and exiting a search area, landing time ("wheels down"), and operations normal ("Ops Normal").
3. Blocking all transmissions on the frequency.
4. Listen, mentally prepared.
5. Critical.
6. To relay radio messages.

Navigational Equipment

1. Download the GX55 simulator.
2. Magnetic.
3. A clock.
4. Plot the radial and distance.

Electronic Search Patterns

1. DF, Homing.
2. SARSAT.
3. Heading.
4. Higher.
5. Behind.
6. Up.
7. Experience, expertise.
8. Off.

Crew Limitations
1. CAPR 60-1 and 60-3.
2. 10.
3. Fatigue.

Flight Planning Tools
1. Decimal place, common sense.
2. Direction, distance.
3. Ratio.

Flight Planning
1. Magnetic.
2. Edge.
3. Current.
4. Grommet.
5. Emergency airfields, obstacles and ground check point.