Urban DF Team

Home Study Course

1. General. Urban Direction Finding (UDF) Teams are teams of at least two qualified CAP members equipped and trained to locate and secure emergency transmitters (ELT or EPIRB) in urban settings. The decision to use UDF teams is made by the Incident Commander (IC) based on the mission information available, the training of the team members, and the anticipated location of the transmitter, with consideration given to potential weather and other hazards. Generally, UDF teams are used in urban, occupied areas where support from law enforcement and other agencies are available quickly.

2. **Qualifications.** UDF teams consist of at least one fully qualified member (standard ES rating as UDF team member or Ground Team Leader), and at least one additional member with the following ES credentials: Ground Team Leader (standard or trainee); Ground Team Member (standard or trainee); or UDF Team member (standard or trainee). While there is no specific ES rating for UDF team leader, the IC will designate one individual (normally the most qualified) to act as the UDF team leader. UDF team members must also have a minimum of basic communications user training (BCUT) certification, and valid drivers licenses (if driving a vehicle). All UDF team members must have their valid CAP membership card and ES qualification card with them while assigned on any ES mission.

3**. CAP and ICS Forms.** While virtually all UDF teams are launched remotely by the IC, UDF team members must still be familiar with standard CAP and CAWG forms so they can rapidly provide the information required by the IC during sign-in. Standard sign-in forms and formats are used for personnel and vehicle sign-in, specific information required for UDF teams are found on CAPF 109 (Ground Team Clearance), and ICS Form 214 (Unit Log). UDF team members are encouraged to have copies of these forms in their mission kit for reference, as needed.

A. CAPF 109 (Ground Team Log) (see attachment 1). The 109 is used to keep consolidate team member, vehicle, and assignment information. Specific information that must be given to the IC prior to launch include Vehicle ID, starting mileage, equipment, callsigns, team member cell phone numbers and any other information needed. The UDF team leader can use the form as a memory aid for the specific mission assignment information needed.

B. ICS Form 214 (Unit Log) (see attachment 2). The ICS 214 is a general purpose ICS form that can be used for recording any pertinent information on the assignment, including mileages, times, names and phone numbers of persons contacted, etc.

4. Mission initiation and activation. When a mission begins, the IC will typically either initiate a page using the CAP REDCAP paging system or by notifying the mission alerting officer for a specific CAP group. Information on the CAWG REDCAP paging system is available on the CAWG Web site (http://www.cawg.cap.gov). However you may get the notification, if you want to participate, you should first ask yourself if you're really available (the mission may take several hours or may be expanded to find other signals), if you have the skills, and if you have the equipment. If you decide that you do, you should contact the IC with an offer of service. The IC may team you with other members, or assign you directly.

You will also need to collect your equipment, and dress in an appropriate uniform (see below). If you're teamed with another person, you need to contact them and arrange to meet. It's an important safety feature that there should always be two people in a vehicle, especially at night, so that the driver doesn't fall asleep. If possible, meet the other person and proceed in one vehicle only.

Once you're assigned to the mission, the IC will give you the mission number, his callsign and phone number, repeaters to use, and any other specific mission information that might include SARSAT hits, etc. All of this should be written down, either on the CAPF 109 or ICS 214. The IC will also give you information on processing CAPF 108 (fuel reimbursement).

5. Clothing. While on any CAP ES mission, you should wear an appropriate CAP uniform for the mission and the conditions. Generally speaking, the CAP uniform should be CAP-specific (not a military style uniform), clean, and correct. Appropriate CAP uniforms include the ground team uniform (orange shirt), CAP Golf shirt, or jumpsuit – dressy uniforms, including the CAP aviator shirt shouldn't be worn since they will most likely get dirty. Military style uniforms should generally not be worn for the same reason, and camouflage BDU's should not be worn since they may present the wrong image when approaching someone. If camouflage BDU's are worn, they should be worn with an orange reflective vest, and field gear including LBE, packs, canteens, etc should **<u>NOT</u>** be worn when approaching non-CAP members. Appropriate outer gear for the conditions (jackets, rain gear, etc) should be available. Footwear should be appropriate for the conditions, for example if you're working an EPIRB in a marina deck shoes are more appropriate than combat boots. Headgear is optional, and should not be worn while on an airport operational area since it might be blown away.

6. Equipment. In addition to the appropriate CAP uniform, UDF teams need the appropriate equipment, which at a minimum includes a direction finding (DF) unit, communications equipment which may include a CAP handheld radio and / or cell phone, and personal safety and survival equipment. DF equipment will be discussed later.

<u>Communications equipment.</u> Depending on the mission, most UDF teams will use either CAP VHF-FM radios or cellphones. It's important that all members of the UDF team know how to use the CAP radio, including selecting simplex or the appropriate repeater, setting volume and squelch, and how to make a radio call. Mobile radios are installed in vehicles, and are higher powered than portable (hand held) radios. Which ever radio is available, a programming guide or sheet should be available to show which frequencies are available. Portable radios should have fully charged batteries, and possibly have spare battery packs available. Battery packs that use AA batteries are also a valuable extra, as are spare antennas, and speaker-microphones. Handheld radios should have belt clips or holsters so they can be carried without using your hands. If working with member-owned aircraft, an aircraft band radio can also be useful, but all corporate and many member-owned or flown aircraft have CAP VHF-FM radios.

<u>Cellphones</u> should also be fully charged, and have vehicle power cords. The IC's phone number should be available to everyone on the mission, and in an emergency everyone should be able to call the IC, the Rescue Coordination Ccnter (800-851-3051), or 911.

<u>Personal equipment.</u> By the nature of their operations and environment, UDF teams don't require all of the personal and safety equipment that ground teams do. Certain items should be available for safety and efficiency. These include:

<u>Spare Batteries</u>. In addition to spare battery packs for handheld radios, spare batteries should be available for any battery powered equipment, including flashlights, GPS receivers, the DF unit, etc. Ideally, members should standardize on a single size of battery (typically AA) for most of their equipment, that way they don't need to carry many different sizes of spares. Most DF units (including the L-Per and Tracker use 9 volt transistor batteries, have a spare pair for these too.

<u>Flashlight</u>. Every member should have a flashlight, with spare bulb and batteries, and a spare. The flashlight doesn't necessarily need to be large, a AA-cell, relatively water resistant flashlight is easier to carry than a 4 D-cell flashlight.

<u>Compass</u>. An orienteering style compass (see section on land navigation) is needed by all members.

Knife. A small, multi-purpose knife such as a Swiss army knife, multi-tool like a leatherman, etc. should be carried in case it's necessary to disassemble an ELT or DF unit. Knives should be small, have folding blades, and carried out of plain sight. Large knives are not needed or appropriate.

Notebook and Pencil. All team members should have a notebook or notepad, pencil, pen, etc. A container-type clipboard can be used to hold the mission forms, map, compass, etc. Members should also have a black ball-point pen in case it's necessary to leave a note with the aircraft or vessel, black ink won't fade as quickly or badly as other colors.

Signal mirror. During daylight hours a signal mirror can be used to attract the attention of CAP aircraft. Some compasses have mirrors as part of their sighting system, these can also be used as signal mirrors.

Watch. All team members should have a wrist watch or other means of telling time, such as a cellphone or pager with time display.

Money. Each team member should have enough cash on hand for any incidental expenses like refreshments, phone calls from pay phones, gas, etc. All members should have several quarters on hand at all times in case a phone call needs to be made; this is in addition to bills, credit cards, etc. Not all phones may take phone credit cards, and not all gas stations may accept your credit cards.

Water. Team members should have a water container of some sort, and drink sufficiently to prevent dehydration.

First Aid Kit. The team should have a first aid kit available, with minimal first aid supplies suitable for the level of first aid training of the members. In an urban setting, if anyone is seriously injured, calling 911 should be a priority.

Maps. The team should have appropriate maps available for the area. These include road / street maps, topographic maps (usually a DeLorme atlas), and perhaps aeronautical sectional charts. Refer to the section on land navigation for more information on maps.

GPS Unit. A GPS unit is a valuable accessory for the team to have, but it doesn't replace basic map and compass skills.

7. Safety. Safety is everyone's responsibility on any CAP activity. Any member can stop an operation if they feel it's unsafe, and discuss it with the other team members. All vehicles used on CAP activities must be operated in accordance with all state and local laws, and all members must wear seatbelts when the vehicle is in motion. Vehicles should be in good working order, and should be safety inspected prior to use for lights, tires, horn, wipers, etc. When stopping on a road (to take a DF bearing, etc) use safety flashers.

UDF members should also be aware of the environment, and watch out for heat and cold injuries. Wear sunscreen when appropriate, and dress for the environment. Be especially careful of cold, wet conditions.

If an accident occurs, render immediate lifesaving first aid, notify local law enforcement and emergency medical services, and notify the IC immediately. Notify the IC if any damage is done to vehicles or property.

8. Other sources of assistance. UDF teams have all the resources of CAP available to them to complete their assigned mission. During a mission if a team is unsure of anything, or needs additional help, a call to the IC will make them available – senior ground team leaders, incident commanders, help in calling law enforcement or airport operators, etc. Don't be afraid to call or ask for help, it's easier to shut it off than to get it quicker later.

9. Land Navigation. Land navigation is the most important skill for any searcher or rescuer. Even in an urban area, familiarity with land navigation is important for locating and securing an ELT, or determining that it's coming from a non-urban area and a different team is required.

Grid systems. In order to locate a point on earth, some sort of reference system is used. Grid systems are similar to a street address, in a standardized format and method that will work almost anywhere in the world. The standard latitude and longitude system is used in CAP and aviation, as well as other systems. Latitude is a measurement of how far north or south of the equator you may be, measured in degrees, minutes and tenths of a minute (or seconds, 1/60th of a minute), and longitude is the measurement east or west of a "prime meridian" located near London, England. Fortunately, all of CAP's operations are North latitude and West longitude. Coordinates should always be given with the latitude first, then the direction (north or south), and then the longitude and direction (west or east). These directions should ALWAYS be given in full, specifying the degrees, minutes and seconds, with the directions (North and West).

Latitude and longitude

Navigation begins with is a common reference system or imaginary grid "drawn" on the earth's surface by ***parallels of latitude* and *meridians of longitude.*** The numbers representing a position in terms of latitude and longitude are known as the coordinates of that position. Each is measured in degrees, and each degree is divided into 60 smaller increments called minutes. Each minute may be further divided into 60 seconds but more usually it is divided into tenths and hundredths of a minute.

Latitude

The equator is a great circle midway between the poles. Parallel with the equator are lines of latitude. Each of these parallel lines is a small circle, and each has a definitive location. The location of the latitude is determined by figuring the angle at the center of the earth between the latitude and the equator.

The equator is latitude 0º, and the poles are located at 90º latitude. Since there are two latitudes with the same number (two 45º latitudes, two 30º, etc.) the letter designators N and S are used to show which latitude is meant. The North Pole is 90º north of the equator and the South Pole is 90º South. Thus the areas between the poles and the equator are known as the northern and southern hemispheres. A written example of latitude is, "36º 5.5'N".

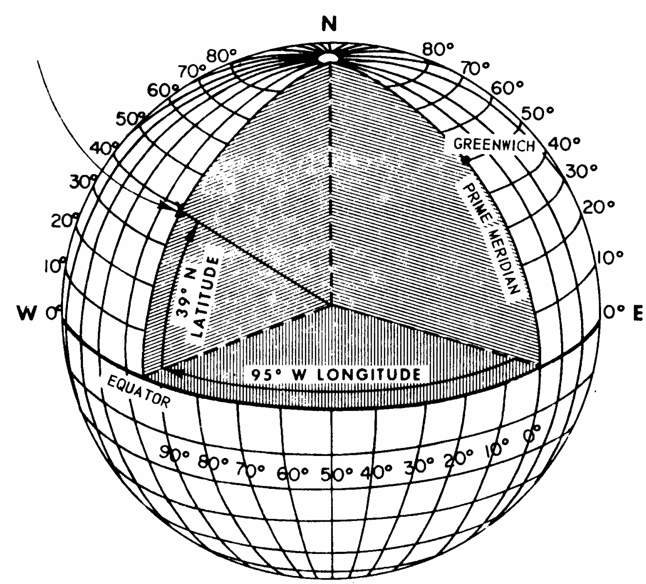

Figure 1 – Latitude and Longitude

Longitude

There is no natural starting point for numbering longitude. Therefore the solution was to select an arbitrary starting point. It is the meridian through the observatory in Greenwich, England. The meridian through Greenwich is sometimes called the first, zero, or prime meridian.

Longitude is counted east and west from this meridian through 180º. Thus the Greenwich Meridian is the zero degrees longitude on one side of the earth. After crossing the poles, it becomes the 180th meridian (180º east or west of the 0-degree meridian). Therefore we have all longitudes designated either west or east, for example, 140ºE or 90ºW. The E and W designations define the eastern and western hemispheres. A written example of longitude is, "119º 32.0'W".

Position location

This system is used to precisely locate any point on the earth's surface. When identifying a location by its position within this latitude-longitude matrix, you identify the position's coordinates, always indicating latitude first, and then longitude. When a search object is found, it has to be located on the chart by other means before the coordinates can be determined.
Map reading or other electronic aids will be used to locate it on a chart or map. The Ground Positioning System (GPS) simplifies the location process by reading out the latitude and longitude of the aircrafts location.

Plotting a Position

The United States is located in the North and West hemispheres. Therefore, in the United States, the latitude will always be north direction and the longitude will always be west direction. Referring to Figure 11-2, the parallels of latitude are horizontal on the chart and the lines of longitude are vertical. The entire square covers an area of 1 degree north and west as indicated by the black degree numbers in the four corners. This area would be described as 36º N and 123º W. Each vertical line of longitude is divided and marked in 1 minute units that measure the distance between the lines of latitude. For ease in counting each 5 units are indicated by a wider mark, 10 units by a mark going through the longitude line, and 30 units with a line through the entire area. There are 60 units from 36º to 37º N or 60 minutes in 1 degree.

CAP uses a grid system based on aeronautical sectional charts, dividing them into grids of 15 minutes of latitude and longitude. This results in an area of about 7 by 11 miles in California, an area that is too large to be useful for UDF or ground teams, but UDF teams should have a gridded sectional chart for their area, for reference. CAP grids are numbered, based on the sectional name (for example, LAX 123) and can be further divided into quarter grids (LAX 123 A)

As mentioned in the section on equipment, UDF teams should have several different kinds of maps available, including road maps, a topographic map such as a DeLorme atlas, and street maps. Maps that have some useable grid system (such as latitude and longitude) are much more useable than those that don't. Electronic maps are available, but require a computer to use, and therefore are more suitable for use at a search base or by the IC.

<u>Reading Topographic Maps</u>

Interpreting the colored lines, areas, and other symbols is the first step in using topographic maps. Features are shown as points, lines, or areas, depending on their size and extent. For example, individual houses may be shown as small black squares. For larger buildings, the actual shapes are mapped. In densely built-up areas, most individual buildings are omitted and an area tint is shown. On some maps, post offices, churches, city halls and other landmark buildings are shown within the tinted area.

The first features usually noticed on a topographic map are the area features such as vegetation (green), water (blue), some information added during update (purple), and densely built-up areas (gray or red).

Many features are shown by lines that may be straight, curved, solid, dashed, dotted, or in any combination. The colors of the lines usually indicate similar kinds or classes of information: brown for topographic contours; blue for lakes, streams, irrigation ditches, etc.; red for land grids and important roads; black for other roads and trails, railroads, boundaries, etc.; and purple for features that have been updated using aerial photography, but not field verified.

Various point symbols are used to depict features such as buildings, campgrounds, springs, water tanks, mines, survey control points, and wells.

Names of places and features also are shown in a color corresponding to the type of feature. Many features are identified by labels, such as "Substation" or "Golf Course."

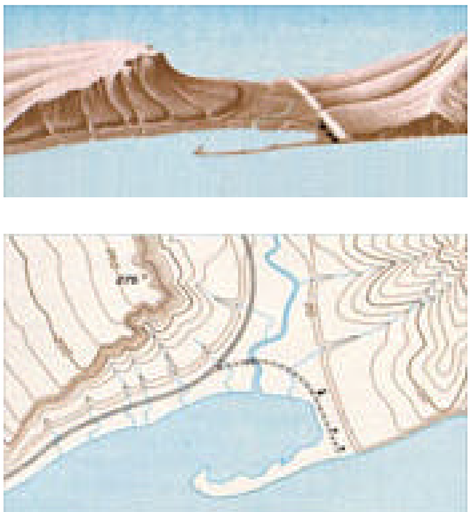

Figure 2 - Graphical and topographic depiction of terrain

Topographic contours are shown in brown by lines of different widths. Each contour is a line of equal elevation; therefore, contours never cross. They show the general shape of the terrain. To help the user determine elevations, index contours (usually every fourth or fifth contour) are wider. The narrower intermediate and supplementary contours found between the index contours help to show more details of the land surface shape. Contours that are very close together represent steep slopes. Widely spaced contours, or an absence of contours, means that the ground slope is relatively level. The elevation difference between adjacent contour lines, called the contour interval, is selected to best show the general shape of the terrain. A map of a relatively flat area may have a contour interval of 10 feet or less. Maps in mountainous areas may have contour intervals of 100 feet or more.

Elevation values are shown at frequent intervals on the index contour lines to facilitate their identification, as well as to enable the user to interpolate the values of adjacent contours.

Bathymetric contours are generally offshore since they show the shape and slope of the ocean bottom. They are shown in blue or black. Bathymetric contours are shown in meters at intervals appropriate to map scale and coastal profile, and should not be confused with depth curves.

Depth curves are shown along coastlines and on inland bodies of water where the data are available from hydrographic charts or other reliable sources. Depth figures, shown in blue along the curves, are in feet on older USGS maps and in meters on newer maps. Soundings, individual depth values, may also be shown.

Compasses. UDF team members need an orienteering style compass. Orienteering compasses have a more or less rectangular base plate, and a rotating dial that houses the magnetic needle. Other styles of compasses are either unsuitable (electronic, round, wristwatch, survival knife) or require additional equipment and different techniques (such as military, "lensatic" compasses). Compasses show the direction of magnetic north, there are a couple of other north references but we will only concern ourselves with magnetic and true north.

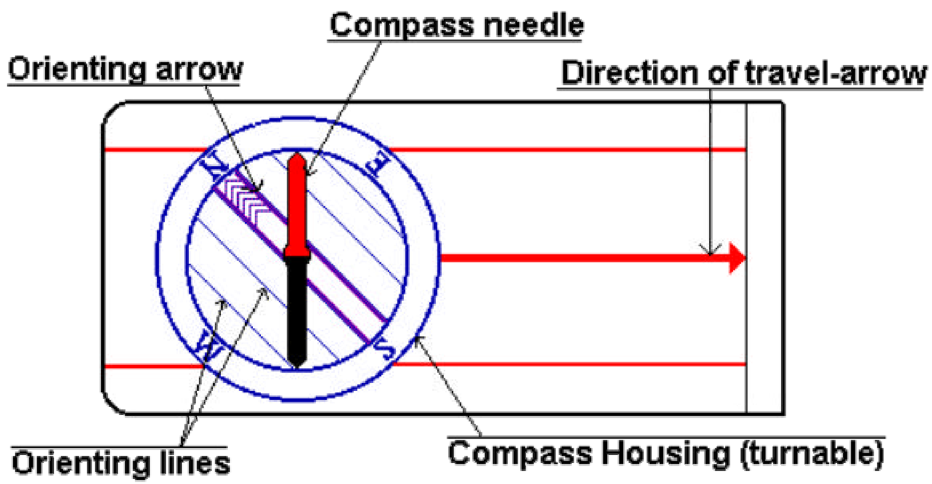

Figure 3 - Typical Orienteering Style Compass

Magnetic north is the direction to the magnetic north pole, which is located almost 1000 miles from the true north pole. The true north pole is the axis of the earth, the magnetic north pole is where the lines of magnetic force converge. Since maps typically show true north at the top, and compasses show magnetic north, a conversion must be made when switching from magnetic (compass) bearings to true (map) bearings. This is the angle difference from your location between the true and magnetic poles. In California, the conversion varies from about 13 degrees in extreme southern California to 17 degrees in extreme northern California. When converting from true to magnetic subtract the appropriate amount (called variation or declination) from the true (map) bearing to get the magnetic bearing. To convert from magnetic (compass) to true (map) bearings add the variation. It is very easy to mix up the bearings, for this reason it's usually better for field teams to all use magnetic bearings, and let the IC or mission base staff do the conversions. So, always specify the bearing and if it's true or magnetic.

Following a known bearing using a compass

To follow a known bearing using an orienteering compass, first set the bearing by turning the compass housing until the bearing is lined up with the direction of travel arrow. Then, holding the compass level at about waist height, with the direction of travel arrow pointing in FRONT of you, rotate your entire body until the red end of the compass needle is lined up OVER the marked end of the orienting arrow in the compass housing. Look up and find a distinctive landmark that is in line with the direction of travel arrow, and then you can walk to that landmark, and repeat the process.

Taking a bearing using a compass

Taking a bearing using a compass is very similar to following a bearing. Holding the compass at about waist height, with the direction of travel arrow pointing away from you, rotate your entire body until you're pointing at the object you're taking a bearing too, or in the direction you're taking a bearing. Then, rotate the compass housing until the marked end of the orienteering arrow in the compass housing is lined up UNDER the red end of the compass needle. Read the bearing on the dial.

Converting a bearing from the field (compass / magnetic bearing) to a map (true) bearing

As mentioned earlier, compasses measure magnetic north while maps are based on true north – to plot a magnetic bearing taken in the field onto a map, it must be converted to true north. Based on your location in California, you will ADD the local magnetic variation (sometimes called declination) to the magnetic bearing taken with a compass. For instance, if you're in Davis, California, the magnetic variation is about 16 degrees EAST. If the bearing you took is 187 degrees magnetic, you would add the variation to the bearing, resulting in 203 degrees TRUE. Always remember to specify if the bearing is magnetic or true. You can find the local variation on aeronautical sectional charts (look for curving, heavy dashed blue lines with the variation on them) or at the bottom of topographic maps:

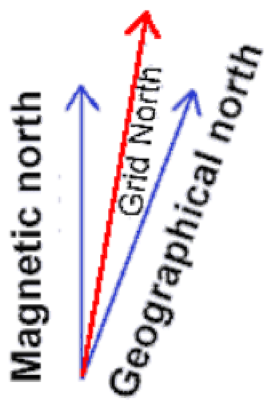

Figure 4 - Direction arrows on a topographic map

The North arrows at the bottom of topographic maps will specify the correct variation for that map, round off to the nearest degree. Geographic and True North are the same, disregard the Grid North arrow.

Converting a map bearing (true) to a magnetic bearing for use with a compass

A similar procedure is used to convert a bearing measured on a map for use in the field. Take the True bearing, and SUBTRACT the variation from it. In our example above, if you have measured a bearing on a map of 322 degrees TRUE, you would SUBTRACT the 16 degree variation from it for a MAGNETIC bearing of 306 degrees.

Measuring a bearing on a map

To measure a bearing between two points on a map, lay the edge of the compass on the map so that it touches both points (if necessary, draw a line connecting the two points and line the edge of the compass with it). The direction of travel arrow on the compass should be pointing in the direction you're measuring TO. Rotate the compass housing until the orienteering arrow is lined up parallel to a true north-south line on the map. Many maps have these lines as lines of longitude, the edges are also true north or south. Then read the bearing at the direction of travel arrow on the compass housing. When measuring a bearing on a map, the magnetic needle isn't used.

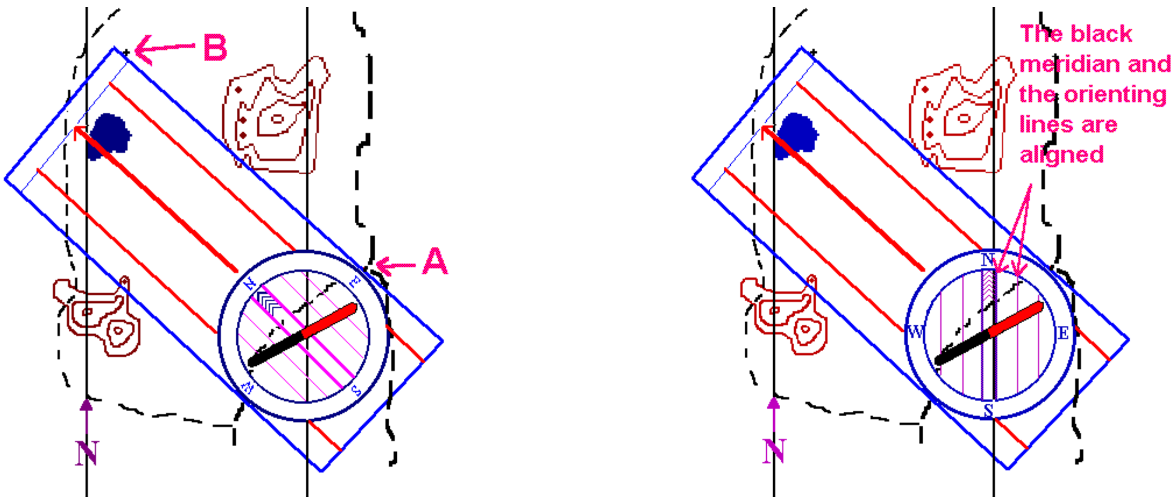

Figure 5 – Measuring Bearings on a Map

A. Line Edge on both points

B. Rotate compass housing to line up with True North Line

Scale and Distance

In addition to measuring directions, measuring distances on a map is important too. Since maps are smaller than life representations of the earth, the size of an object, or distances between objects, is smaller too. The ratio of the difference between life size and the map is called the scale.

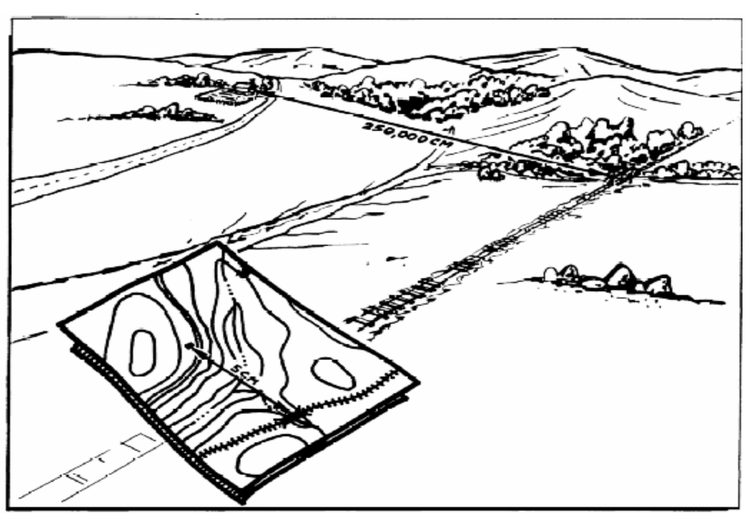

Figure 6 - Life size distance (250,000 cm) and scale distance (5 cm) (Scale = 1:50,000)

Different maps and charts have different scales. The scale is usually mentioned on the map in the margin notes, but some maps (especially road maps) may have only a scale bar.

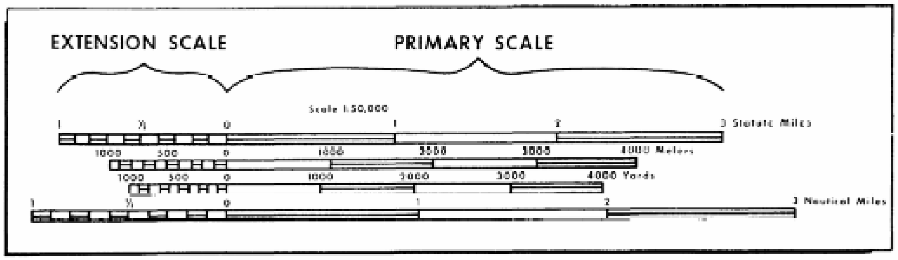

Figure 7 - Scale Bar

Certain types of maps always have the same scale. Sectional Aeronautical charts scale is 1:500,000, which is equal to 1 inch on the chart equaling 8 statute miles (7 nautical miles), a typical topographic map is 1:24,000 scale, or one inch equals about 2000 feet. Check other maps for other scales. Some scale bars have an extension scale as on the left of the example above, this divides the distance into smaller sections. If you're using a scale bar with an extension, be sure to measure to the ZERO line, not the end of the extension scale.

<u>Measuring distances on a map</u>

To measure distances on a map you might be able to use a scaled edge on the edge of your compass, or another scale device. There are many such devices, used like a ruler they will directly indicate the distance for a given scale.

If you don't have a handy scale to measure directly, you can measure distances using the edge of a piece of paper.

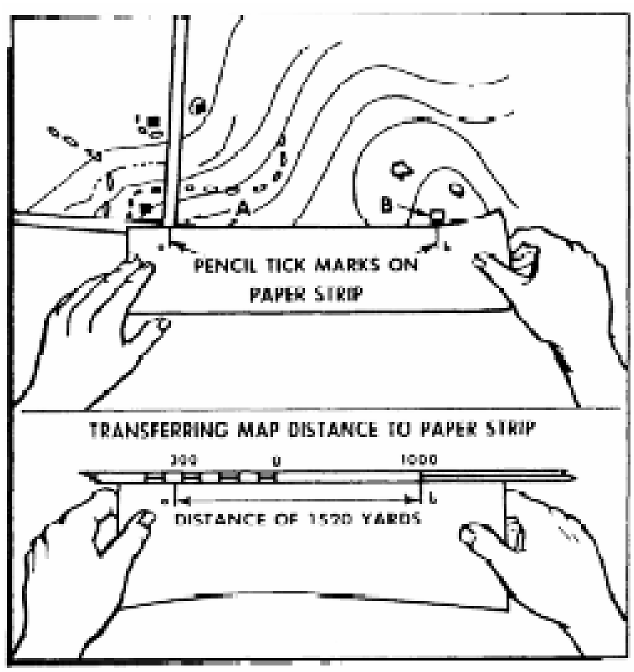

Figure 8 - Measuring straight distances

You can also use this technique to measure distances that are curved, along a road, for instance: Just lay the paper along short, straight segments making tick marks on it, turning the paper as the road turns, then measure the entire distance on the scale bar

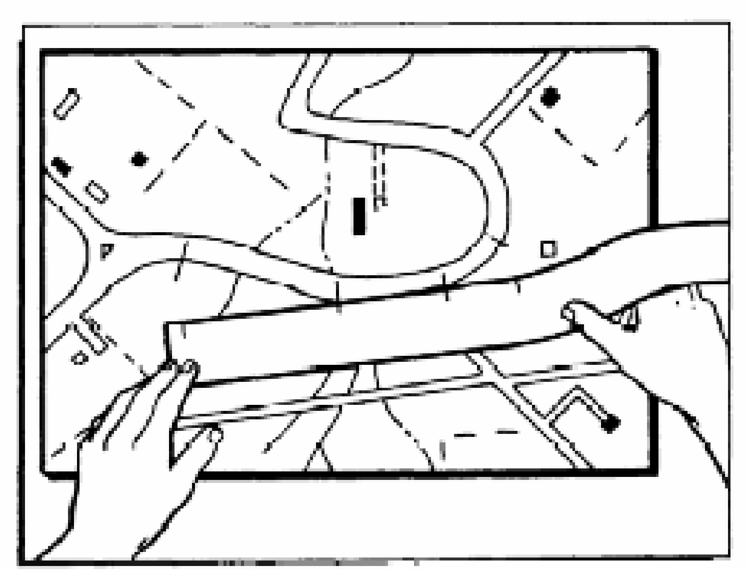

Figure 9 - Measuring curved distances

Triangulating Bearings

Oftentimes in urban Direction finding, the actual location of an ELT signal may not be clear – especially if it's in a residential or industrial area. Being able to take several bearings from high points around the suspected target area will allow searchers to zero-in on the actual location more quickly than driving around and taking bearings, or listening for a signal.

In triangulating bearings, a bearing to the signal (taken with the DF unit, see below) is made, and plotted on a suitable map. Ideally, several teams can participate, each taking one of the bearings. With three or more bearings plotted, the actual location of the signal is readily seen. One person should be responsible for plotting the bearings, to minimize the chances of errors.

In the example map, three bearings on an ELT signal were taken from three different points. Each bearing was plotted on a topographic map of the area, showing the point the bearing was taken at and the bearing direction. If the bearings taken are perfect, they should intersect at a single point, however this is rarely seen. Intersecting in a small triangle is sufficient for a UDF team to get into the area, and detect the signal, then locate it.

Taking bearings for triangulation can also show you that the target is moving (in a car, truck, etc). If a team takes a bearing, and a few minutes later another bearing shot from the same location shows that the bearing has changed significantly (more than 5-10 degrees) then it's very likely the target is moving.

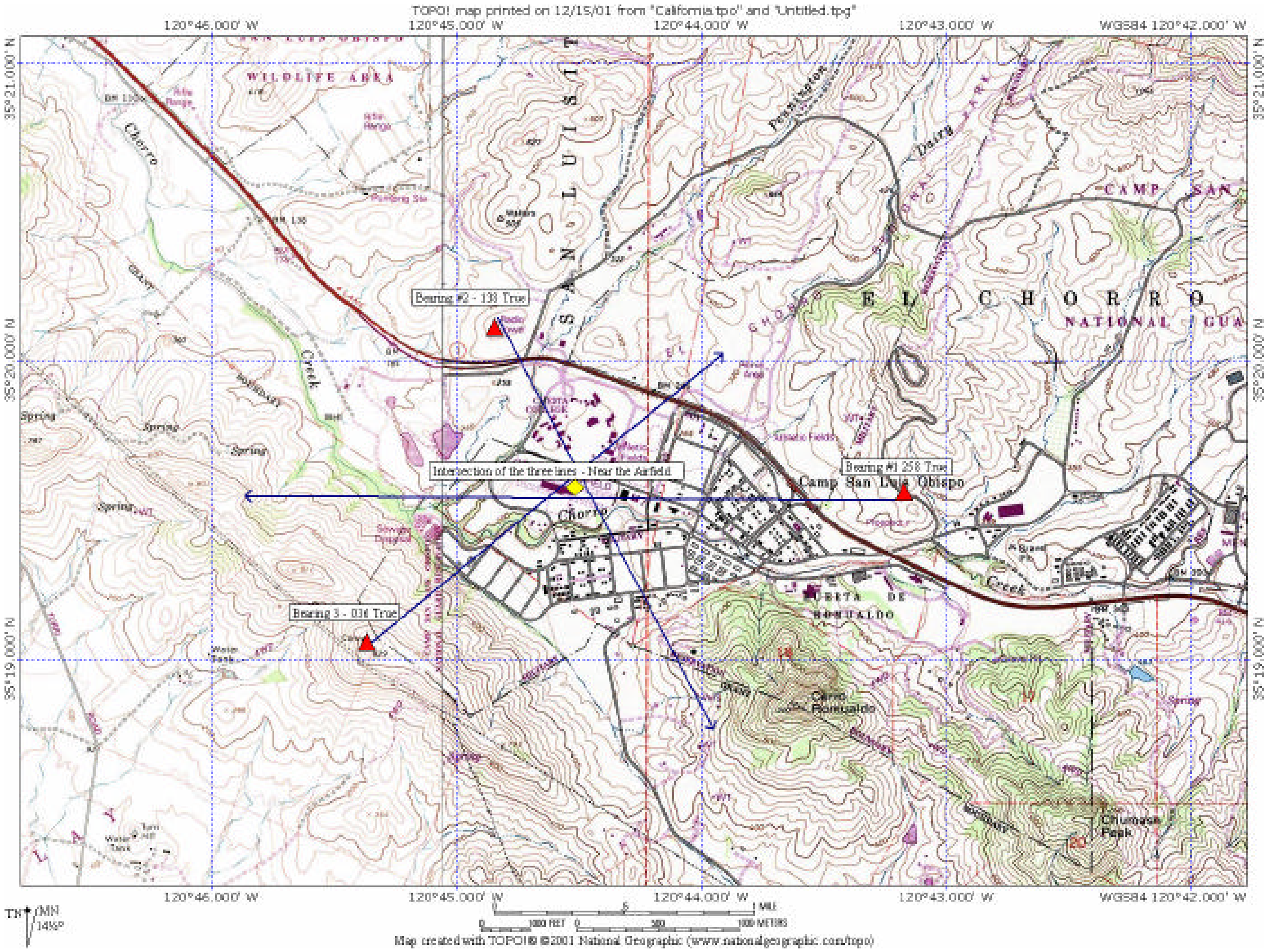

Figure 10 - Intersecting triangulated bearings on a 1:24,000 Topographic Map

10. Direction Finding. Locating and securing emergency radio beacons is CAP's main ES mission, and nobody does it better. Every year, California Wing secures over 350 ELT/EPIRB's all over the state. Proficiency in locating these is important for all CAP UDF and ground team members.

Emergency Locator Transmitter (ELT's) are self-contained radio transmitters that may be automatically or manually activated in the event of an aircraft crash. They have a switch that is activated by a force that simulates a crash, and transmit a signal on one or more frequencies that alert rescue forces. EPIRB's (Emergency Position Indicating Radio Beacons) are generally similar except they don't have g-switches, and are turned on either by a position switch that activates the unit when turned right-side up, or manually activated, and are used on boats rather than aircraft. See Figures 1 and 2 for typical ELT's and EPIRB's.

Figure 11 – Typical ELT's and EPIRB's

Figure 12 – Typical EPIRB's

ELT's are required on many, but not all, general aviation aircraft. ELT's are not required on jet-powered aircraft (including airliners), agricultural aircraft, and a few others, although most non-jet powered aircraft have them installed. ELT's typically are installed in the rearward most 25% of the aircraft, but may have an additional ELT located elsewhere. EPIRB's are generally designed to be mounted on the outside of boats, upside down in a bracket that allows them to float free, turn right side up and begin transmitting.

ELT's and EPIRB's sound exactly alike, with a downward swept tone. Elt2.wav Click here for an example of an ELT audible tone. While military aircraft are not required to have ELT's some do, these will typically transmit on only the military distress frequency of 243.0 MHz. They can be mounted in the aft end of the aircraft, or in fighter aircraft in ejection seat survival kits, as well as survival radios carried in survival vests. Also, packed life rafts might have EPIRB's installed.

ELT's may be either standard, or new technology. Standard ELT's typically will operate on one of three frequencies. Civil ELT's will transmit on 121.5 MHz, one of the international distress frequencies, while as mentioned military ELT's and beacons will transmit on 243.0 MHz, another distress frequency. Since 121.5 MHz is one-half of 243.0 MHz, the military can track civil ELT's without special equipment, but standard 121.5 MHz equipment can't track military beacons. New technology ELT's and EPIRB's work differently, transmitting a data signal on 406.025 MHz for 50 seconds per minute, and then transmitting a very weak 121.5 MHz signal. The new technology devices are still in their early stages of deployment, and there are relatively few new technology ELT's but we find a few. There are more 406 MHz EPIRB's.

The advantage with the 406 MHz ELT/EPIRB's is that they are much better designed (resulting in far fewer accidental activations), have much higher power (5 watts vs. .5 watts), and are detected by satellites much more quickly. The 406 devices are registered to a particular individual, so when the report is first received the owner can be contacted, and report which aircraft or boat is being looked for, some also have the ability to interface with a GPS unit and then transmit the GPS coordinates, which helps locate the device. The low power 121.5 beacon is used for final homing once the search team is in the immediate area. The 406 MHz devices are also detected by higher-flying satellites than the 121.5 / 243 devices, which results in much more thorough coverage, and more rapid detection and location of the transmitter.

The disadvantage of standard ELT's is that they have a very high accidental activation rate – in excess of 94% worldwide, and more than 98% in California. Because of the design of the g-switch, accidental activations are common, yet when an aircraft crashes the ELT is often destroyed.

The SARSAT / COSPAS system. Search and Rescue Satellite Aided Tracking (SARSAT) (COSPAS is the Russian acronym for the same system) is a multi-national system of satellites that have the ability to locate and repeat the signal from 121.5 / 243.0 MHz ELT's, but because of the design of the system at least two satellite passes are needed to isolate the location of the ELT, and the satellites are on orbits that result in gaps in coverage that can be several hours long. In order for a signal to be reported, the satellite must be "visible" to both the ELT/EPIRB and the earth station, which locates and reports the signal. The US earth station is located in Maryland, and is operated by NOAA. Earth stations are also located in Canada, France, and Russia, among other countries. The position reported by the satellite is actually one of two possible locations, in order to resolve the location a second satellite pass is necessary (see figures 4 through 7). The need to be visible to both ELT and earth station results in coverage of 1800 nm radius from the earth station, with coverage of only about 1/3 of the world.

Because of the design of the 406 system which utilizes different, geostationary satellites, the position reported by the satellite is much quicker (no need to wait for an additional satellite pass), and more accurate (within three miles or so radius typically) the 406 MHz system is much more accurate than the 121.5 system, which typically results in a 15-20 mile error on location. If the 406 ELT has GPS capability the location reported is accurate within 1 mile, at which point the low power homing beacon is used.

Figure 13 – SARSAT System

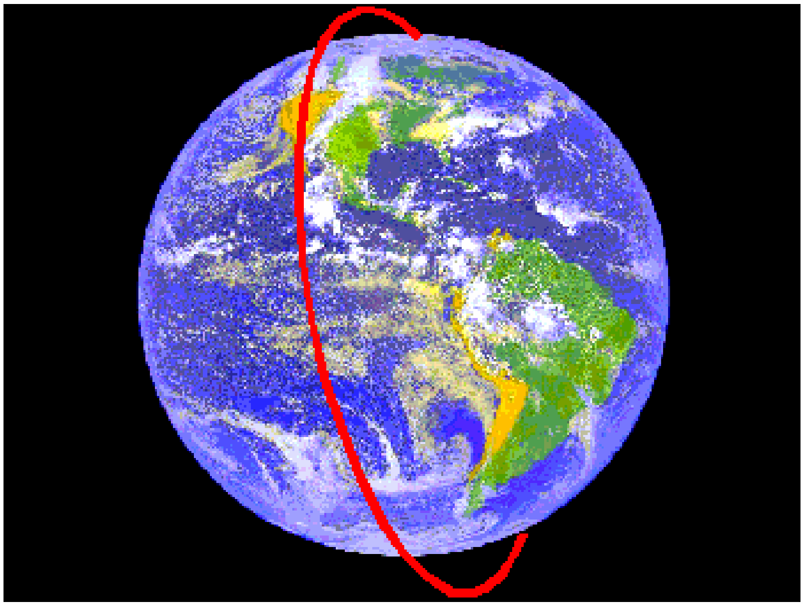

Figure 14 - Satellite Pass (Single)

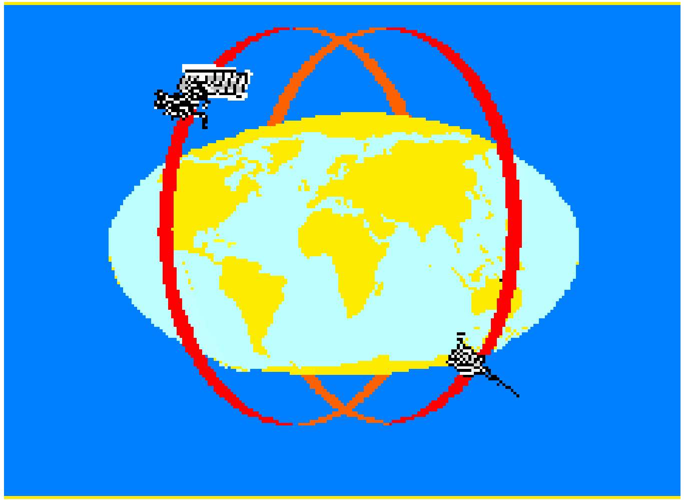

Figure 15 Satellite Pass – Second

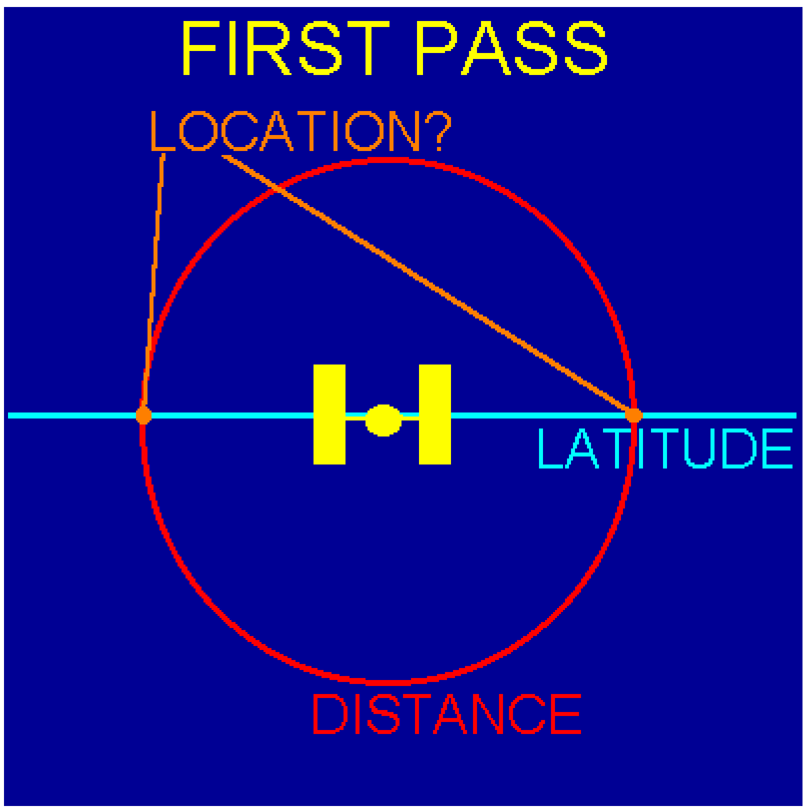

Figure 16 Resolving location discrepancies – one pass

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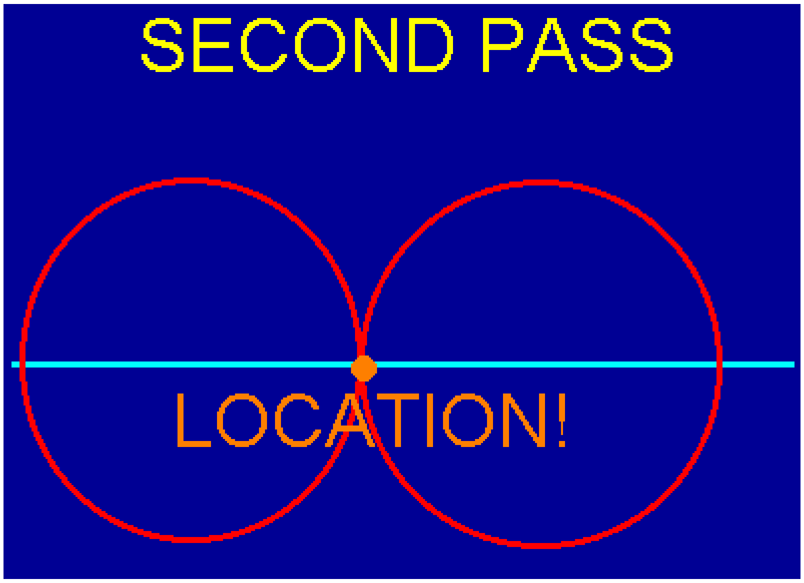

Figure 17 Resolving location – second pass

Direction Finding (DF) Equipment. The typical DF unit used by CAP ground teams or UDF teams is the L-Tronics L-Per (see figure 8). This unit is handheld, powered by two 9-volt batteries, and can be factory configured for a variety of frequencies – most are set up for receiving on 121.5, 121.775 (the practice ELT frequency), and perhaps 243.0 MHz as well. It isn't able to receive the 406 MHz signal, but can track the 121.5 homing beacon.

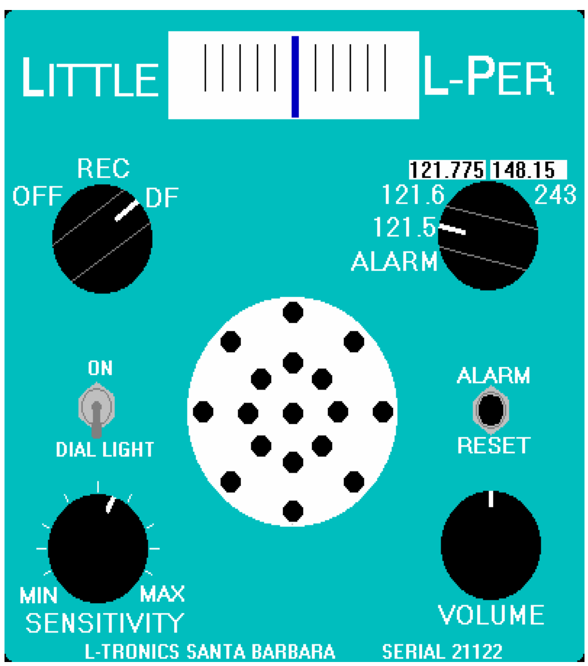

Figure 18 – L-Per DF unit front panel

Operation of the L-Per. As stated, the L-Per is operated by two 9 volt batteries which are installed under the rear cover. Once the batteries are installed, the unit is turned on using the OFF-REC-DF switch on the upper left corner of the panel. Place the switch in the DF or REC position, then adjust the sensitivity control (lower left panel) to the fully clockwise position and adjust the volume control (lower right corner) to a comfortable level. Select the desired frequency using the upper right control. The battery level can be checked by turning the light switch on, if the light turns on there is at least 5 hours of battery life left. Some units will have a battery test switch, pressing it will show a needle scale deflection showing the battery level.

The L-Per is attached to a mast and antenna by clipping the DF unit to the screws on the mast, and connecting the coaxial cable to the connector on the DF unit. The antenna crossbar is extended with the aluminum antenna elements extended and held vertically (see figure 19).

Figure 19 – L-Per DF unit mounted on antenna mast

Once the antenna is extended with the DF unit in the "DF" position hold the mast vertically, in front of you (figure 19) and with the L-per front visible and rotate it by turning yourself around until the meter needle centers (it may be necessary to turn the sensitivity control down to get the meter to move). Once the meter is centered, the ELT/EPIRB will be either directly in front of or behind you, to resolve this discrepancy switch the control to the REC (Receive) mode, and rotate until the meter shows a maximum right-scale deflection (it may be necessary to adjust the sensitivity control again). The arrow on the antenna crossbar will point to the transmitter (see figure 20).

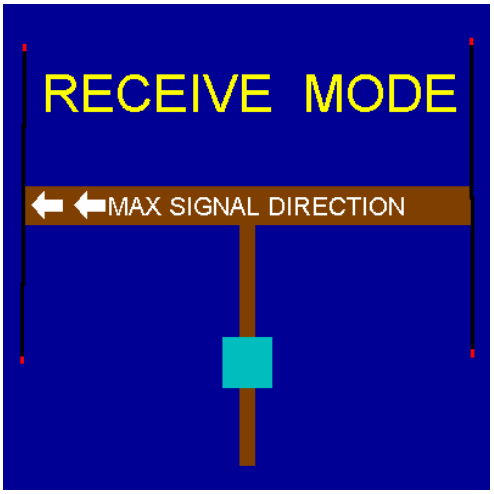

Figure 20 – Max Signal Arrow on L-Per Mast

Monitoring the DF unit while moving. It's essential that UDF teams monitor the DF unit while traveling to and from the suspected search area. Attaching the DF to an external antenna and keeping the volume sufficiently high to be able to hear a signal will prevent driving right past the signal, as often happens. The antenna used doesn't have to be big or sophisticated, any sort of a temporary antenna such as a magnetic mount antenna used as a backup for other radios is fine – you just need to be able to listen.

Dedicated, external mount (permanent or magnetic) antennas are available for the L-Per. These antennas, when set up correctly, will show left/right sensing on the L-per from inside the vehicle. An additional set of antennas that will show front/rear and left/right sensing is available, if desired.

Triangulating a bearing.

Once you have DF'd the ELT, you can use a compass and take a bearing in the direction of the signal. With your known position and a map you can extend a line, and with another bearing from another location get an intersection where the bearings cross (see Figure 21). This triangulation technique is helpful when the signal can only be heard from certain areas.

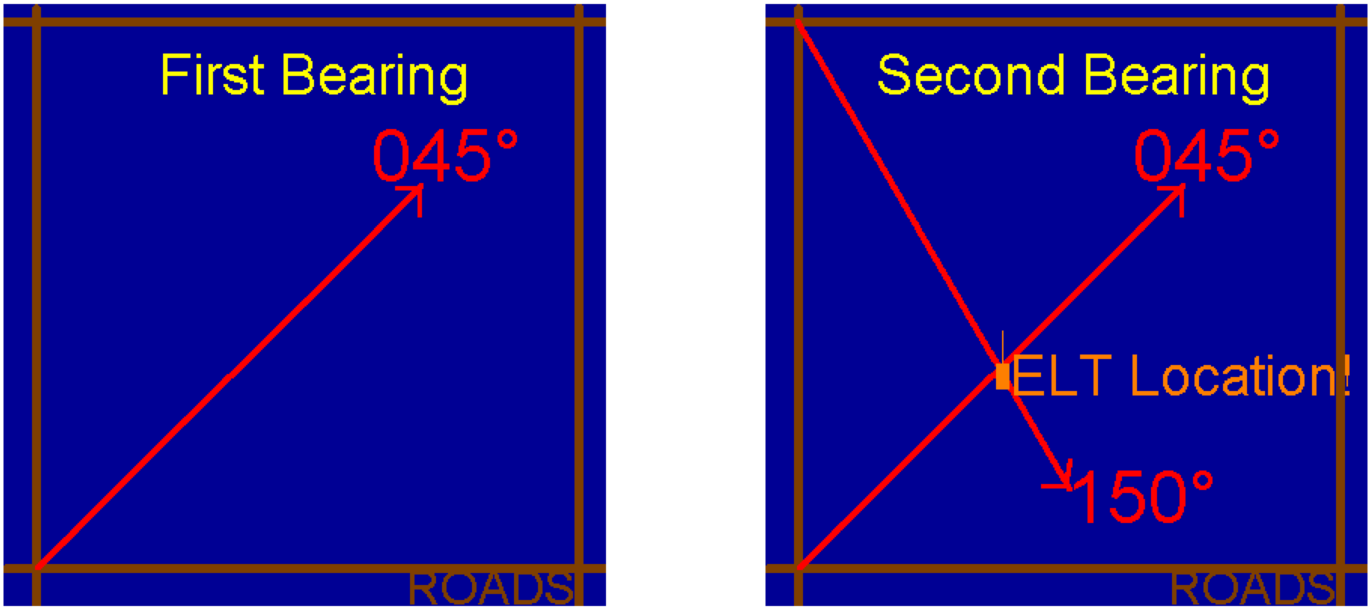

Figure 21 – ELT Bearing Triangulation

Sometimes you can get a needle deflection without hearing a sweep tone – this may be caused by a carrier only transmission, or a defective ELT (damaged, weak batteries, etc.). You can still DF on these, using the deflection received.

ELT's are line of sight transmissions – they can be blocked by buildings or mountains, the signals can also be reflected by them. If you're receiving a non-uniform or erratic signal you might be receiving several reflected signals. ELT signals can also be reflected by power lines, fence lines, or boat rigging and masts.

Sometimes it's difficult to locate the ELT when you're close to it. Turning the sensitivity down helps, if that still doesn't work you can tune the DF unit to a different frequency (such as 121.6 or 121.775) and get closer. You can also attach a standard "rubber duck" antenna to the DF unit and hold it behind you, using your body to shield the signal. This body shielding technique can also be used with other radios like aircraft band or ham handhelds, while it isn't good for long-distance DF'ing it works close-in.

Once you're at the airport or marina, notify security or the harbor patrol – they can be helpful in getting access, and will want to know who's wandering around the area. If you think the ELT may be in a private residence, notify the IC and request they call the appropriate law enforcement agency to assist you – especially at night. Never approach someone's home unannounced, they may have stolen the ELT or EPIRB. Wait in the area for law enforcement assistance, but try to have it narrowed down to the correct house. When you've discovered the hangar or airplane the ELT is in, notify the IC and the airport security, when you have found the boat in a marina, notify the IC and harbor patrol.

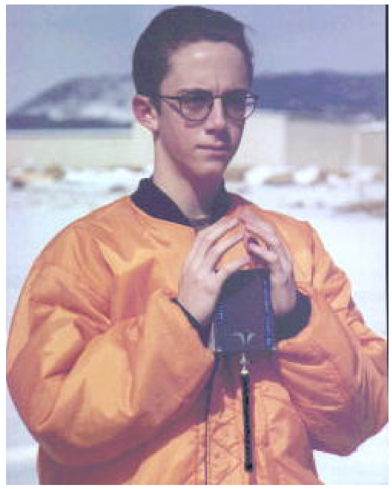

Figure 21 – Body Shielding

Once you've found the ELT, notify the IC and note the time. We try to turn them off if we can, either by notifying the owner or operator of the boat or airplane. Remember, CAP members have no authority to break into any boat, airplane, home or hangar to secure an ELT. If in doubt, discuss with the IC. Techniques used in the past to secure ELT's (such as removing antennas, grounding antennas, placing an aluminum foil tent over the antenna, etc) should NOT be used, they may damage the ELT or aircraft. Never tape anything to the aircraft, when the tape is removed the paint may come with it, and we don't want to pay for a paint job.

If you can get access to the ELT or EPIRB (legally), shut it off (and verify you've secured the right one). If placing the switch in the OFF position doesn't turn it off, it might be necessary to remove the battery pack. This often requires a screwdriver. Once the battery is disconnected again verify the signal has stopped, and leave the ELT with the owner or operator. If the owner or operator has given us permission to enter the boat or aircraft and secure it, leave the ELT visible in the aircraft, with a note stating the time and date it was secured, the mission number and the phone number for the RCC (800-851-3051) so the owner can get additional information if necessary.

If access to the ELT isn't available, try to leave a note on the aircraft where the pilot will get it (near the door lock is a good choice, but never tape it down!), with the same information. You shouldn't leave personal information about yourself (such as name, home phone, etc), if the owner wants to get in touch with someone the RCC has the IC's number.

The IC and the RCC will want some information as well – the make and model of the aircraft or boat, the registration number (N-number, CF number, etc), the time it was secured, the location (the GPS is handy for the location), and if possible the make and model of the ELT, the serial number, the battery expiration date (which should be on the ELT case), and the switch position. Write this all down in your notebook, you can tell the IC later.

Conclusion

Now it is time to take the written test which can be found at https://ntc.cap.af.mil/ops/tests/default.cfm?Message=Ok&grp=PCR&CFID=83322&CFTOKEN=47437621

Passing the on-line test will give you credit for the following UDF tasks:

O-0201 Use a compass
O-0204 Locate a point on a map using map and compass
O-0207 Locate a point on a map using a polar plot from a terrain feature
O-0211 Determine elevation on a map
O-0212 Measure distance on a map
O-0214 Determine and plot an azimuth on a map
O-0215 Determine azimuths on a map using two points
O-0304 Triangulate on a distress beacon signal
O-0412 Conduct individual actions on a find
P-0201 Sign in team on a mission

After passing the test present the certificate to your unit commander and he/she can enter these qualifications into the WMU, and issue a 101-T card that allows you to participate as a trainee, under the direct supervision of a qualified trainer, a TTT qualified Ground Team Leader or CAWG designated senior member UDF team member.

GROUND TEAM	Mission Number	Mission Base	Team Leader's Name (Last, First) ,	
CLEARANCE	Date	Tm Ldr Radio Call	Destination	Sortie Number

VEHICLE						
Make	Type	License	Radio	Start Mileage	Ending	Freq. Available

Wing Assigned Veh. ID No.	Other Equipment

TEAM MEMBERS		
PRINT Last Name, First Initial	ES Qualification	Personal Equipment

BRIEFING	
Primary Assignment (describe in detail) Time Team Reached Area	Grid Numbers/Area
	BRIEFING CHECKLIST
	Base Radio Capability,
	UHF Freq.
	Base Call
	Base Phone Numbers(s)
	Restricted Areas
	Search Aircraft/Grid
	Radio Call Sign
	Target Sighting Actions
In Field Reassignment Instructions	Other Agencies
	Weather Current
	Expected 24 hrs
	Other

Code words			
ETD	ATD	ETA	ATA

Signature of Briefing Officer	Signature of Team Leader

DEBRIEFING					
Clouds	Clear	Scattered	Broken	Overcast	Debriefing Checklist
Precipitation	None	Rain	Scattered	Snow	ELT Signals Landmarks Old Wreckage Possible
Light Conditions	Bright	Dull	Near Dark	Night (%moon)	Ground Activity Search Hazards Aircraft
Visibility	> 10 mile	> 5 mile	> 1 mile	< 1 mile	Other Ground Teams Recommendations for Further
Terrain	Flat	Rolling Hills	Rugged Hills	Mtns	Probability that Target was in Area
Ground Cover	Open	Moderate	Heavy	Other	
Wind Speed	Calm	$\leq$ 10 mph	$\leq$ 20 mph	$\leq$ 30 mph	

REMARKS AND SKETCH OF AREA COVERED. Show location of significant findings.

Debriefing Officer	Team Leader Signature

Attachment 2. ICS Form 214 (two pages) (Sample, actual form may be slightly different)

<table>
<tr><td>UNIT LOG</td><td>UNIT NAME:</td><td>TASK #</td><td>DATE PREPARED:
TIME PREPARED:</td></tr>
<tr><td colspan="2">TASK NAME:</td><td>FOR OPERATIONAL PERIOD #</td><td>PREPARED BY (PLANNING):</td></tr>
<tr><td colspan="2">UNIT LEADER NAME:</td><td colspan="2">POSITION:</td></tr>
<tr><td colspan="4">PERSONNEL ROSTER ASSIGNED</td></tr>
<tr><td colspan="2">NAME</td><td colspan="2">ICS POSITION</td></tr>
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<tr><td colspan="4">ACTIVITY LOG (CONTINUE ON REVERSE)</td></tr>
<tr><td>TIME</td><td colspan="3">MAJOR EVENTS</td></tr>
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<tr><td></td><td colspan="3"></td></tr>
<tr><td colspan="3">A UNIT IS ANY SINGLE FUNCTIONAL ENTITY (DISPLAYED AS A BOX) WITHIN THE ICS ORGANIZATION CHART</td><td>ICS 214</td></tr>
</table>