Emergency Locator Transmitter – Aircraft Search

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Major contribution from notes by Lauren Schiff (March 25/29 1998)

What do you need to think about in the woods when you're on a field task looking for a plane?

1. Aircraft Fuel – Produces noxious fumes, highly flammable
2. Sharp metal, debris from crash may be hazardous and may be overhead as well as on ground.
3. Trees and power lines may be down where plane crashed
   Look up!

What type of Planes do we search for?

Primarily small single engine planes. These planes mostly fly VFR, but when weather gets bad, and visibility drops, the likelihood of operator failure increases.

What happens when an airplane crashes?

Many planes have an Emergency Locator Transmitter (ELT). This is equipment that puts out a radio distress signal at 121.5 MHz or 406 MHz upon impact. Here is what they look like:

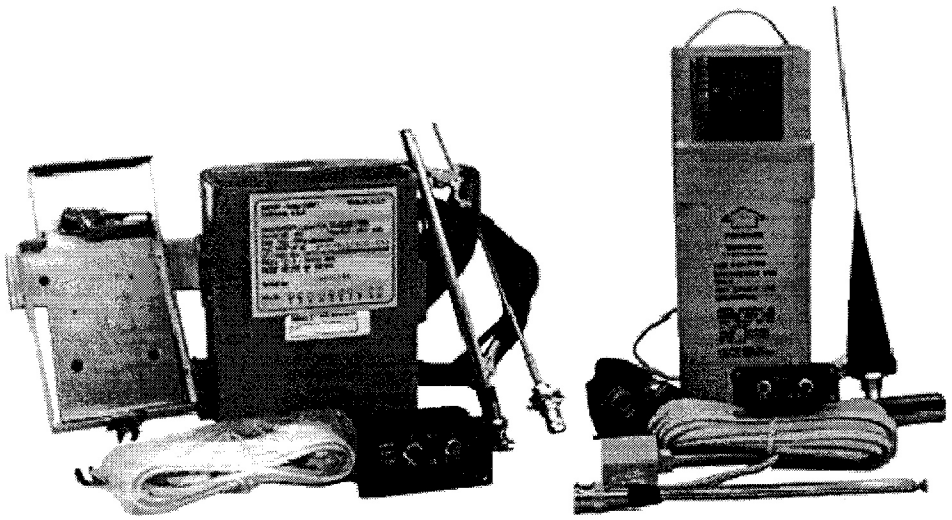


Figure 1: Two ELT models

The Civil Air Patrol (CAP) is most likely to respond to these emergency signals. NASA quotes that "only about 1% of all ELT searches are for actual aircraft crashes. The other 99% are due to inadvertent activation of the ELT." However, if BRMRG is activated, there is good reason to believe that the search is for an actual plane.

What does an ELT sound like?

A training ELT has been provided in the classroom. Digital recordings are also available at various sources online.

How long does the ELT emit a signal?

"Depends on a lot of factors. The design criteria is that they transmit for at least 48 hours at 0-degrees, some will transmit much longer if the weather is warm, the battery fresh, etc. Or they will transmit for less if it's colder, if the battery hasn't been replaced when it was supposed to, etc." --Richard A. De Castro - N6RCX NREMT SAR Tech

How far does the signal propagate?

"The USMCC (the people running the SARSAT program) still claim that the satellite locates ELTs within 11nm 90% of the time and within 2 nm for 406MHz beacons." -- LtCol Mark Fowler ACC/AFRCC

	121.5 MHz	406 MHz
LOCATION ACCURACY	12 miles	2 miles
COVERAGE	Local	Global
SIGNAL POWER	0.1 Watt	5 Watts
SIGNAL TYPE	Analog	Digital
ALERT TIME	2 Hours	Instantaneous
DOPPLER LOCATION	Two Passes	Single Pass
GPS LOCATION	None	100m Accuracy

Figure 2: Straight line propagation for two types of ELT signals. We have equipment to search for 121.5 MHz. Source: NOAA [http://psbsgi1.nesdis.noaa.gov:8080/SARSAT/406-121.html]

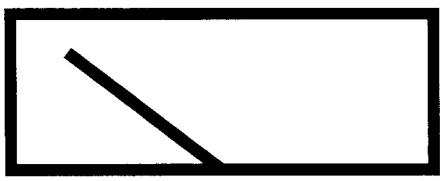
In general, what chance of survival do the subjects have?
"AFRCC statistics" quote that 65% of general aviation crash victims do not survive impact. Of the 35/100 survivors, 21 are injured and last about a day while 14 are uninjured initially and have a "half-life" of about 3 days. – Lt. Col. Mark Fowler ACC/AFRCC
"ELT normally survives only when the victims can and do. If the crash is so bad that the ELT is destroyed then no one can likely live through it." "This is not always true but I have yet to find a lost or downed A/C with a proper maintained ELT that was damaged w/survivors, in 11 years of SAR work." -- Brandon Brown 1Lt. CAP, Dir. of Emergency Services; HQ Group I TX Wing, Chief of Communications; Panhandle Search and Rescue

**The take home message of this is that if an ELT signal is detected, there is a good chance of there being survivors.

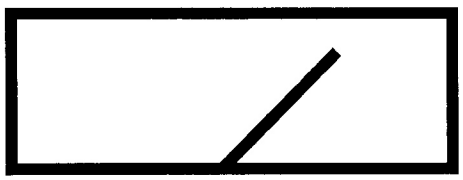
How do we use the ELT to locate the plane?
L-pers are direction finding (DF) equipment used to locate the source of the signal. These receivers give you two types of information: direction and strength of signal.

A. Direction

1. Set frequency, DF mode, SENS minimum, VOL at 12 o'clock.
2. Turn SENS up until meter needle goes left or right and signal is audible.
3. Turn toward needle. You are facing the target.
4. Left to right needle swing is normal when walking, driving, or flying. Follow headings that keep left and right swings about equal.
5. As volume increases and/or needle gets too sensitive, decrease SENS. Slight left-right swing and audible signal is enough.
6. The closer to target the more rapidly volume and sensitivity increase.
7. To evaluate the quality of bearing, turn a full circle. If needle centers more than twice 180 deg apart, move to another location.
8. Shoot a bearing to the source of the signal.



Turn Left



Turn Right

Figure 4: An upright arrow will result in a straight bearing to the ELT. Move the L-per to achieve this.

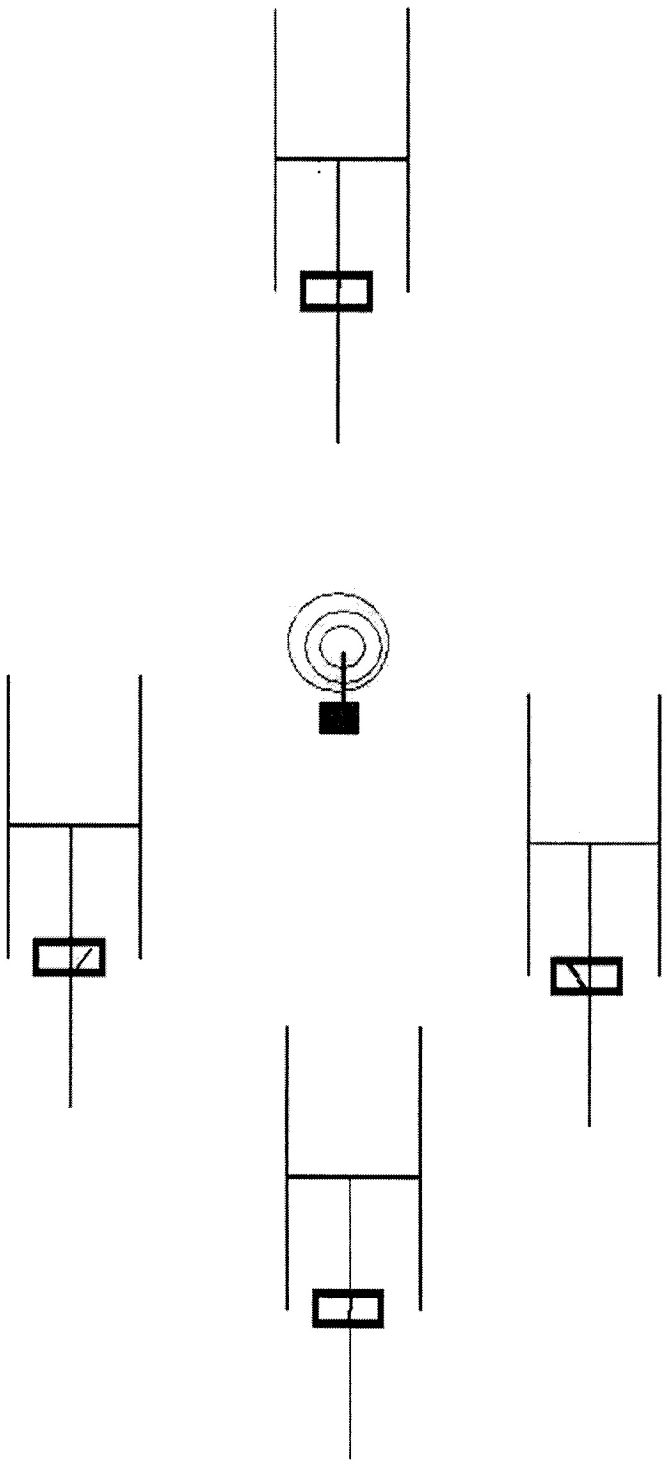


Figure 5: The diagram indicates the needle readings for the L-per relative to the location of the ELT. Note that the needle will be straight up when you are both behind and in front of the ELT! Test the direction by moving your body to the left or right. If you twist to the left and your needle swings back to the right, the ELT is ahead. However, if you twist to the left and the needle follows you, the ELT is likely behind you.

B. Signal Strength
Directions:

1. Set Frequency, REC mode, SENS minimum, VOL at 12 o'clock
2. Turn SENS up until the meter goes up and the signal is audible.
3. Turn in a circle until needle goes furthest upscale. In this position, the arrows on left arm of antenna point to signal source.
4. Without changing controls, turn antenna until horizontal with ground. A noticeable increase in signal strength means transmitter is horizontal.
5. As volume increases and/or needle nears right-hand stop, decrease SENS.
6. The closer to target, the more rapidly volume and sensitivity increase
7. To evaluate quality of bearing, turn in full circle. if multiple readings of about equal upscale movements results, move to another location.
8. The stronger the signal, the further right the dial will swing.

The signal will bounce!
Be careful, because the signal is very likely to reflect off of mountains and other large objects. This may cause you to think that the ELT is in a position that it is not. This may happen multiple times before the signal reaches your receiver. Note that the signal can also be blocked by large objects in your path. Stay away from things like buses and large buildings when shooting bearings.

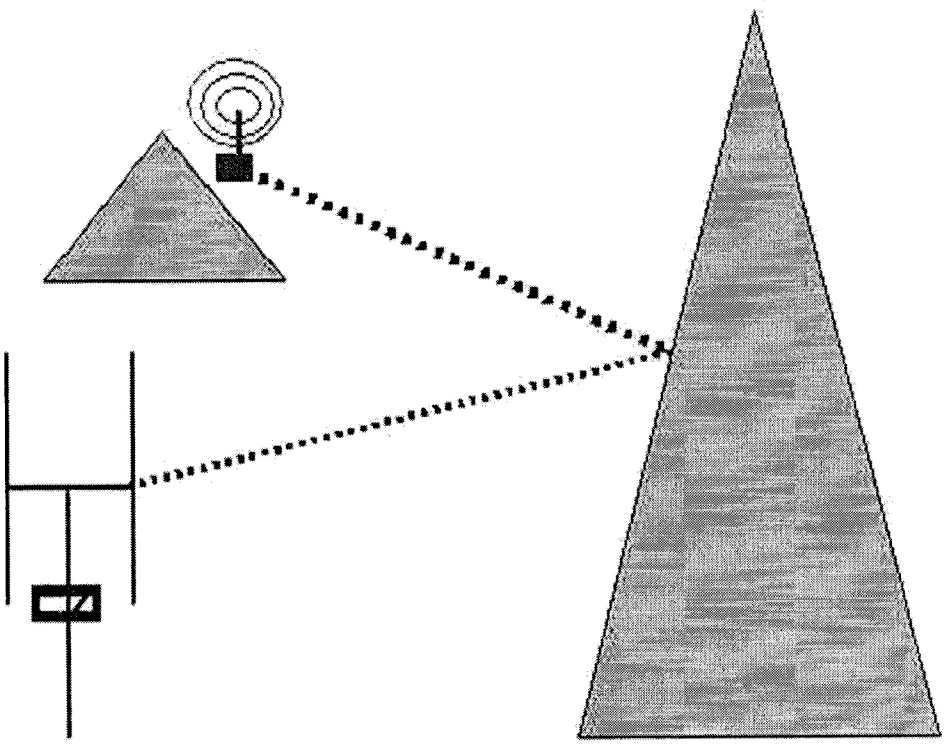


Figure 6: Signal reflected off of a mountain.
Strategy

1. Put your team in a high area, unobstructed by obstacles and above reflecting points (mountains/buildings)
2. Make sure you are on the right frequency.
3. Put L-per in DF mode and shoot a bearing to the source of the signal. (you may want to move within 10 ft and check variability of bearing several times)
4. Draw the bearing on your map and check the strength of the signal in REC mode.
5. Move to another tall position (another ridge or perhaps just several hundred feet away)
6. Repeat process until you are confident with location of signal source.

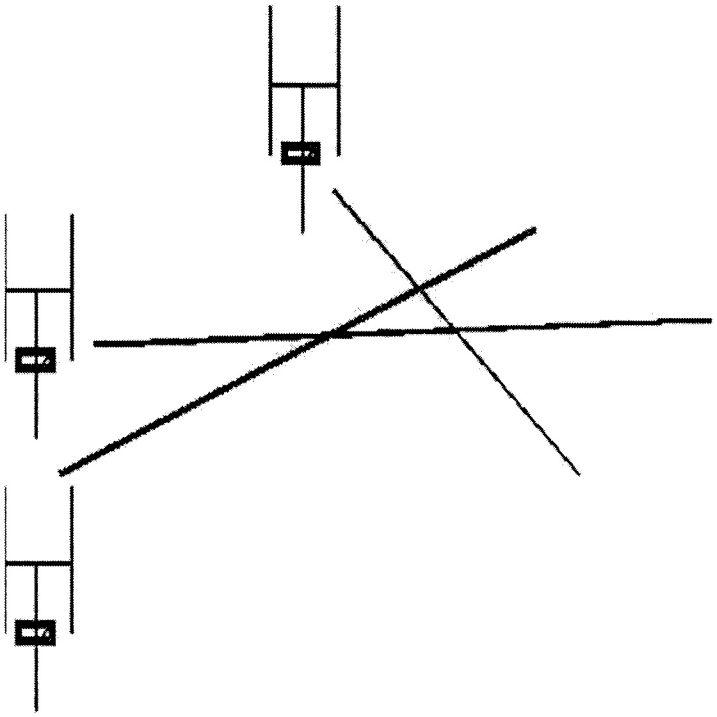


Figure 6: Emitter is likely to be near the triangle of cross-section.

7. Try to leapfrog from last signal point to find downed aircraft

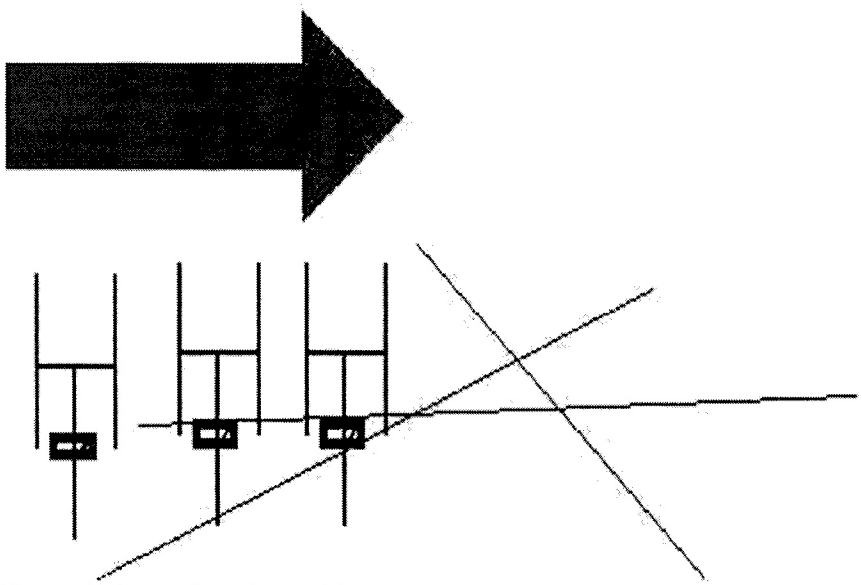


Figure 7: Leap-frog to emitter source

Don't forget basic logic behind plane crashes!
"In mountainous terrain, we (California Wing, Civil Air Patrol, of which I'm the Ground Team Training Officer, but this is NOT an official statement) seem to find them about 500-800 feet below the ridge lines. We think this is because the perception from the pilots seat is that this will allow the aircraft to clear the ridge, and by the time they figure out they won't, it's too late to do anything about it." -Richard A. De Castro -N6RCX NREMT SAR Tech

***The Find Scene**

- Treat it as if it's a crime scene
- First thing: establish a perimeter and keep people out if possible
- You cannot physically keep press/others out, but you can remind them that it's a federal crime to tamper with a crash.
- Determine status of subjects and if the number of bodies matches the number of passengers (survivors have been known to wander off.)
- Disable the ELT. Remove battery, power supply, or cover antenna with aluminum foil. Affix sticker as documentation of ELT disabling.
- DOCUMENT everything: position of wreckage and subjects, movements made of debris, etc. Diagrams are expected.
- Do not endanger yourself or your team in order to perform any of the above tasks.

How to approach the plane

Upwind-because of the danger of noxious fumes.
Uphill, because fuel and precariously perched parts go downhill.

***The Future**

As of February 2009, SARSAT will stop tracking the 121.5 MHz beacons in favor of the more modern 406 MHz. The 406 MHz beacons are detected more rapidly and more accurately, especially the ones which broadcast a GPS signal. Current indications however are that the 406 MHz beacons will continue to also broadcast on 121.5 MHz for final location with a DFer. After all, 2 mile accuracy means a possible search area of roughly 12 square miles – depending on the terrain, that could mean 20-30 ground teams would be needed to cover the area once if no DFer was available.