BMG ENGINEERING, INC.
RADIO DIRECTION FINDING

Tutorial:

LOCATING AN ELT ON THE GROUND

This talk is divided into two parts;

1. At an airport .
2. In the field.

LOCATING AN ELT ON THE GROUND AT AN AIRPORT

If air-born, get permission to crisscross the field at low altitude to localize the area for a ground search. You should be able to resolve the ELT location to a 50 by 50 foot area

Once on the ground hunting is more difficult than in the air. You are often confronted with shadowing and multipath that can be mind boggling if you are not prepared for it.

Basically, ground RDF consists of a long series of collecting data and formulating hypotheses. The initial data is taken, and a hypothesis (or guess) is made. More data is taken, and an attempt made to fit it into the present hypothesis. If it fits nicely, we keep that hypothesis (at least for now). If it doesn't fit nicely, we try to formulate a better hypothesis which all the data taken so far fits better. This is the area where most mistakes are made; there is a STRONG tendency to stick with the original hypothesis, and "force" new data into it, or to ignore contradictory data altogether. As the process continues, the area of uncertainty (of where the ELT is) gets smaller. Ultimately, it will appear that the ELT (or the vehicle or object which contains it) has been found. If it is a plane, car, or other container, you should use different techniques from different distances and directions to try to verify the find. If you get the wrong guy out of bed, he will be angry!

Once on the ground, the L-Per can be used handheld, with its folding antenna, if available. This should work well if the ELT is relatively in the open, such as in the plane parking area. Even so, certain precautions should be taken.

1. Carefully choose the area from which you will take bearings. Get in the clear, away from any objects, such as cars, planes, poles, tanks, and buildings, and away from the airport's radio transmitters.
2. Do not rely on a single bearing to tell direction. Move over a few feet and take another. Do this several times in the same general area. Note how well they agree. If agreement is poor take the average, and use it as a general direction indication only.
3. KEEP CAREFUL TRACK OF SIGNAL STRENGTH (the sensitivity control of the L-Per). This information will be very helpful, especially when you are getting close to the ELT. If you have to reduce the sensitivity after moving just a few feet, the ELT is close (or you have just come out of a shadowed area, look around you).
   4 Try to triangulate. If bearings are not accurate (see 2, above), do not rely on the triangulation.

If you have an L-Per receiver but no handheld antenna you can still hunt on the ground. There are two techniques that work reasonably well.

The first is called body shielding. The procedure is to use a short wire stuck into the antenna input. Its a good idea to have a short antenna (6 inches) stored with the L-Per. If you are close enough you may be able to get a signal with no antenna at all. Hold the L-Per in close to your body, with the antenna also close to you. Your body will affect the signal in the same way that wing shadowing does in the air. Set the L-Per for "signal strength" mode and the sensitivity to a convenient position. Slowly, rotate your self and the L-Per as a unit through 360 degrees. At some point you should note a minimum reading on the meter. You are then facing directly away from the transmitter. Turn around and walk in that direction some distance, and then repeat the procedure.

The second technique makes use of signal strength only. The procedure is to divide and conquer. Hold the L-Per, with a short wire for an antenna, out in front of you, away from your body. Walk length wise to the airport noting whether the signal is consistently getting stronger or weaker. If there is a fast fluctuation of the meter, pay attention only to the peaks of the readings. If getting weaker, turn around and go in the other direction. If stronger, keep going until you have passed the strongest point. Go back to where it was strongest. At that, point walk in a direction which is perpendicular to the previous walk, repeating the whole procedure. You should be able to continue in this fashion until the ELT is located. Reduce receiver sensitivity as needed.

These two techniques will probably work better than conventional direction finding on an ELT which is inside a building; especially something like a metal hanger. The internal reflections can be very confusing, but dividing the area will probably still work.

Additional Hints

No matter what method is used, continually monitor the signal strength using the sensitivity control. Pay attention to only the peak readings as

you walk along. Ignore the fast fluctuations, if any. Wide swinging fluctuations indicate severe multipath, while narrower swings indicate less multipath. If the strength suddenly changes, try to figure out why. Look around you for the reason, and try to fit them into your present hypothesis. Some explanations might be:

1. You have just walked out of a shadowed location into one which is fully illuminated by the ELT or vice-versa. Look for nearby fences, buildings, or other large objects.
2. You have just walked into a depression in the terrain, or up onto a rise in the terrain.
3. You have walked into the path of the signal emerging from an opening in a building.

HUNTING AN ELT IN THE FIELD

This type of hunting usually requires more preparation, training, and experience than most people are willing to commit to. It can be broken down into two types; mobile, and on-foot. On foot requires specialized training and equipment (other than RDF) just to stay alive, let alone be effective. Mobile is less demanding, and is the area where I have most of my experience.

Many mobile hunters use the L-Per with one or two sets of fixed antennas mounted on the roof. Two sets are better, in that they can be used alternately to tell which quadrant (relative to the vehicle) the transmitter is in without rotating the car or the antenna. They are set up to indicate Left/Right, and Front/Rear. The relative meter readings taken can be interpreted to further refine the bearing somewhat. Accurate bearings can only be taken by rotating the car or antenna.

I use a system of my own design, the SuperDF. SuperDF behaves rather like the L-Per, but uses different electronics and different laws of physics. The indicators are either two lights, a zero-center meter, or a two tone system giving Left/Right information. A zero-center meter can be added to units not having them. It connects to any unmodified scanner or other NBFM receiver. It will work anywhere between 100 and 1300 MHz and therefore can be used to locate communications radios. A long time constant in the circuit causes the unit to average about 1000 individual bearings taken while moving along the road, thereby tending to average out reflections which otherwise could be confusing. The faster the car is moving, the more accurate the bearing becomes.

I prefer to use a single antenna which I can rotate manually. It allows me greater accuracy without stopping the car, and ease in interpretation.

The comments made earlier on locating an ELT at an airport still hold for mobile hunting, such as using signal strength, average bearings, and so forth. One difference is you are working on a much larger scale. Another is that you are more restricted to where you can travel.

There is usually more data that you have to deal with. When hunting l am collecting and evaluating data all the time, usually while in motion. I'm looking at direction. At how fast the direction is changing. At signal Strength. At how fast the strength is changing. At the terrain I can see, and that which l can't see, but have knowledge of. At the relative elevation of terrain features to each other, and to me. This data has to be put into a meaningful hypothesis which l hopefully can refine with more data. All the while this is going on, l must stay on the road, and not get lost. Usually the only time I stop is to check my map so I'm sure of where I am, or to figure out how to get to where I think I need to be. This is the area where a copilot is very handy!

In general, a good site from which to take triangulation bearings should be high and unobstructed all the way around. It should not have any reflective objects on top, like towers, tanks, buildings, power poles, power lines, or fences. If trying to obtain bearings looking into a mountainous area the site should be several miles from the mountains; the farther the better, while still being able to hear the signal. This tends to prevent peaks and ridges at the edge of the range from blocking signals coming from behind them.

Even the fact that you are not able to get a good, consistent bearing at a particular site is useful information. It tells you that there is multipath there, and that probably means the direct path is shadowed to you. The ELT is on other side of something, and you are hearing reflections.

Sometimes a rapid loss of signal as you move alone can provide directional information just as useful as a good clean bearing. Look to see if there is a peak that might be acting as a shield. Draw a line from where you are to the top of the peak and beyond. If it fits with other data taken, use it just like a bearing.

If as you travel towards a signal and it gets weaker as you approach a hill or mountain, it is a good bet the ELT is beyond the edge of the hill as you presently see it. It may be on top but back from the edge, or beyond the hill. Also the bearing may become less consistent (due to the greater impact of reflections, now that the main signal is weaker). Once sure of this analysis, look for a way to the top and / or around the hill. Note that these observations are opposite of what you would see from the air.

The use of topological maps is recommended. They can help greatly in understanding the lay of the land, and therefore in the creation and modification of hypotheses.

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(31 Jan 1996)

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