

Air and Ground Direction Finding

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Characteristics Of The ELT And Its Signal

Most civilian aircraft are equipped with a battery-powered transmitter that is activated on impact or a crash. The power output is very small (1/16 to 1/4 watt), which makes the range over which it can be heard usually under a hundred miles (we will go into conditions later that will show you it sometimes has a range of less than a mile). These transmitters are officially called Emergency Locator Transmitters, or ELTs, and sometimes called rescue beacons, crash locators, or beepers. The ELT is designed to transmit simultaneously on two radio frequencies, VHF (121.5 MHz) and UHF (243.0 MHz), but sometimes are damaged and only transmit on one frequency. ELTs used by the military normally operate on UHF only. Some boats are also carrying these transmitters; they have the same characteristics as those used by civil aircraft and are called Emergency Position Indicating Radio Beacons (EPIRBs). All beacons have a distinctive swept tone (usually sweeping downward in tone) with two or four sweeps per second.

Radio waves are invisible, and this sometimes makes it hard to visualize how they can be reflected, blocked, scattered and polarized. In many ways, they behave like light, and this analogy should make it easier to make sense of an otherwise confusing set of DF indications.

The ELT Location Problem

There are three parts to this problem:

1. Get to a point where the signal can be heard.
2. Establish a direction to the target or a target location.
3. Get to the target.

Execution of these steps will vary radically from incident to incident. On an airport, it may be as simple as walking out of a door, taking a single DF bearing and walking to the offending plane.

The vast majority of beacon searches so far have been non-distress or accidental. Most of these are undamaged and located in clear areas like airports. Finding them, particularly from high flying aircraft, is like "shooting fish in a barrel" and has led to exaggerated

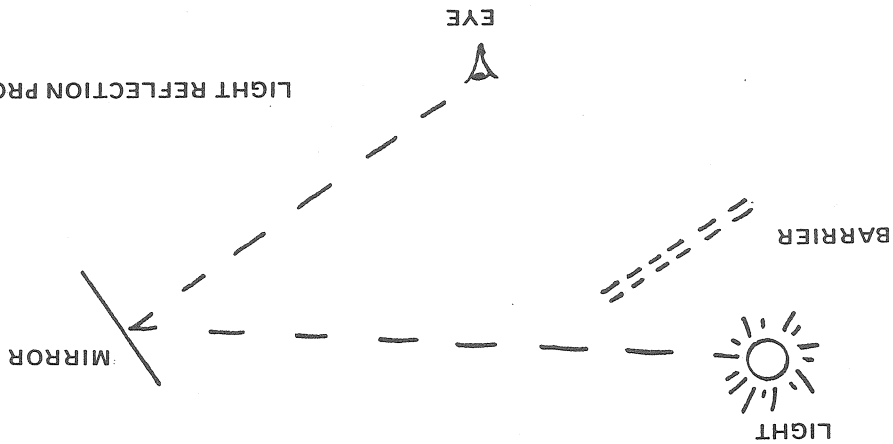
claims both for equipment and techniques. Unfortunately, the cases of real distress are also the ones likely to involve damaged beacons in awkward positions, rough terrain, wet or snowy weather, night operations, and difficult access, any or all of which will tax the best of our skills and equipment. While directed toward the ELT, the principles described apply to all types of VHF radio location and underlie the specific procedures outlined in later sections.

Under IDEAL conditions, the signal from an ELT (1) radiates equally in all directions, and (2) takes a path directly from the transmitter to the receiver. The first characteristic means that the signal strength gets stronger as the ELT is approached, regardless of the direction of approach. Signal strength or "build-fade" location patterns use this principle and work in many cases. Unfortunately, the condition of equal radiation in all directions is the one most radically violated in distress situations and this location procedure is slow at best and should never be depended upon as a primary search technique.

The second condition says that the direction to the transmitter is the same as the direction of arrival of the signal at the receiver. All direction finders use this principle.

You use this second effect constantly with light with a darkened room, you could easily "measure" its direction from you with your eyes and could easily "track" your way to it if required. There are two drastic differences between "optical DF" and radio DF. First, you have been practicing optical DF and becoming aware of its illusions and reflections all your life. Second, the eye has MUCH more resolution, or ability to distinguish between objects, than the radio DF antenna. A radio antenna equal to the eye's resolution would be miles in diameter and hardly portable. The small, portable or aircraft DF antenna "sees" the world in about the same way you would if your eyes were covered with 16 sheets of waxed paper. The larger portable or fixed antennas are better — like 6 or 8 sheets of waxed paper — but a long way from 20-20 vision. Even with all that waxed paper in front of your eyes, you would be able to track toward a single light in a room, though not with the precision as with no waxed paper goggles.

A word here about sensitivity. Sensitivity refers to the ability of a receiver to pick up a weak signal (to see a dim light). Both a good receiver and a "high gain" antenna are required for a sensitive DF. The ELT signal is weak, like a very dim light. Using a receiver with poor sensitivity would be like putting on sunglasses under the goggles or spraying them with black paint. They might still work, but you could do a lot of stumbling in the dark before first catching sight of the light. There seems to be no such thing as too much sensitivity.



to the observer. The directions perceived might even be due to "wrinkles in the waxed paper" (small defects of the DF receiver). The effect is rather like trying to find the sun on a very foggy morning; you know it's there because it is light, but you had better have a compass to find east! The solution to this problem is often the same as for the ELT — change position to get your head (antenna) out of the fog.

For ELT search, "getting out of the fog" usually means going higher for either ground or air search. This will both get away from nearby reflectors and improve the chance of getting a clear view of the source over the obstructions. Exceptions occur in air operations where the signal is blocked from going upward or is too weak to be heard 10,000 feet away. If climbing isn't possible or doesn't work, a methodical search will probably be required to find a place where the source can be seen clearly. In most cases, clear view is distinguished by a positive direction that does not change much as the observer moves. Before we leave our room with light and mirrors, imagine trying to find the light by plodding back and forth with an opal glass bowl over your head so that only changes of brightness could be sensed. This is essentially the build-fade location method.

If the mirror, which is a very good reflector, were re-placed in turn with a wrinkled sheet of metal foil, a white wall, a dark wall and a strip of black velvet, the reflection would grow progressively weaker, and at some point, our "antenna" would again "see" and point to the light from the side of the flashlight or sneaking around the barrier. Natural terrain also varies in its efficiency as a reflector. Metal is obviously a good reflector but smooth, wet snow or smooth, wet grassy hills are almost as good. Rough, dry rock is closer to the dark painted wall, white heavy tree or brush cover approaches the "velvet" class. The reflective situation can thus change with the season or even time of day. This is why some easy summer exercises have turned into winter muddles in the same place.

So far we have dealt with one source and one mirror. With our waxed paper goggles in place, it should not be too hard to appreciate that if several mirrors were placed at various angles all around the observer's position while keeping the direct source obscured, any direction would be very hard to determine and directions that were found would change substantially with small changes in the observer's position. The changes in direction with observer motion would be particularly large and rapid if the reflectors were very close