Emergency Beacon DF Training

BASIC & URBAN ELT/EPIRB LOCATION COURSE

Credits

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- Adapted from
  - "ELTs: Everything You Wanted to know-and More - Basic Ground ELT Location Course (Classroom)" - Scott E. Lanis of Vermont Wing CAP
  - "Ground ELT / DF Training" - Richard DeCastro of California Wing CAP
  - Copyrighted material from both sources included in this training program

Aircraft, Boat, or Person Lost or In Distress?

- How would we know?
  - Radio distress call
  - Monitored aircraft drops from RADAR
  - Overdue Flight Plan
  - Report from friends/relatives
  - ELT or EPIRB Signal (maybe!)

Contents

- Basic ELT/EPIRB DF Training
- Urban ELT/EPIRB DF Issues
- Classroom and Field Training

Basic ELT/EPIRB DF Training

Classroom Session

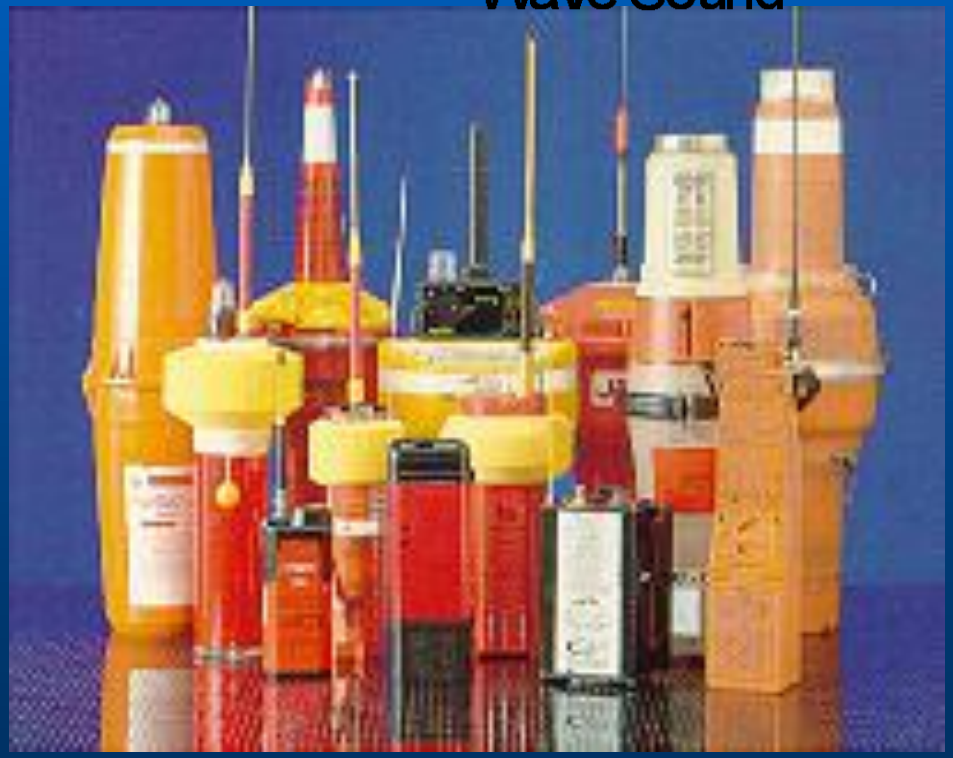
Objectives

- By the end of this course, you should:
  - Know what ELTs and EPIRBs are, and how they can be activated
  - Understand why an ELT/EPIRB signal is an emergency
  - Be familiar with these fundamentals:
    - Basics of the SARSAT system
    - Direction finding - Little L-Per™ Operation
    - Triangulation
- Practice and experience to become expert

What is an ELT?

- Emergency Locator Transmitter
  - It's an automatic radio beacon!
- 3 Frequencies of Operation
  - 121.5 MHz (VHF)
  - 243 MHz (UHF) (Military Guard)
  - 406.025 MHz (new)

Wave Sound



General Types of ELTs

- Aircraft (most General Aviation and all commercial)
- Military (“beepers” or “beacons”)

- NEW:
  - Personal Locator Beacons (PLBs)

COSPAS-SARSAT Rescues

August 15, 2008

Number of Persons Rescued (To Date) in the United States: 191

Rescues at sea: **148** people rescued in **42** incidents

Aviation rescues: **3** people rescued in **3** incidents

PLB rescues: **40** people rescued in **25** incidents

Worldwide – **Over 24,500+** People Rescued *(since 1982)*

United States – **5,949** People Rescued *(since 1982)*

Numbers from 2007

353 people rescued in **130** incidents in the United States

Rescues at sea: **235** people rescued in **73** incidents

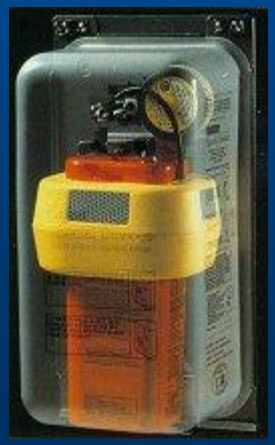
Aviation rescues: **30** people rescued in **19** incidents

PLB rescues: **88** people rescued in **38** incidents

DATA FROM www.sarsat.noaa.gov

What are EPIRBs

- EPIRB - Emergency Position Indicating Radio Beacon
  - For boats and ships
  - Some designed to float, some water activated
  - Sounds JUST LIKE an ELT



Typical Aircraft ELT Operation

- 3 Switch positions (usually)
  - on
  - arm/standby
  - off
- G-switch activated (Generally 9G)
- Activates ELT upon impact when armed
- May be manually operated by placing the switch in in the ‘ON’ position

Inadvertent Activation of an ELT

May Occur From:

- Excessively hard landing
- Ground incident like high winds
- Inadvertent change of switch position
- Removal of the unit
  - activating the manual switch or G-switch
- Malfunction
  - switch short
  - battery leakage

There are MANY causes of false alarms

Who is listening?

- SARSAT/COSPAS
- FAA Facilities - FSS, Centers, Towers
- Airliners - Only if pilot chooses
- Military Aircraft
  - 243 MHz Required
- General Aviation Aircraft
- Some ham radio operators

- Signal report is relayed to AFRCC (Air Force Rescue Coordination Center)

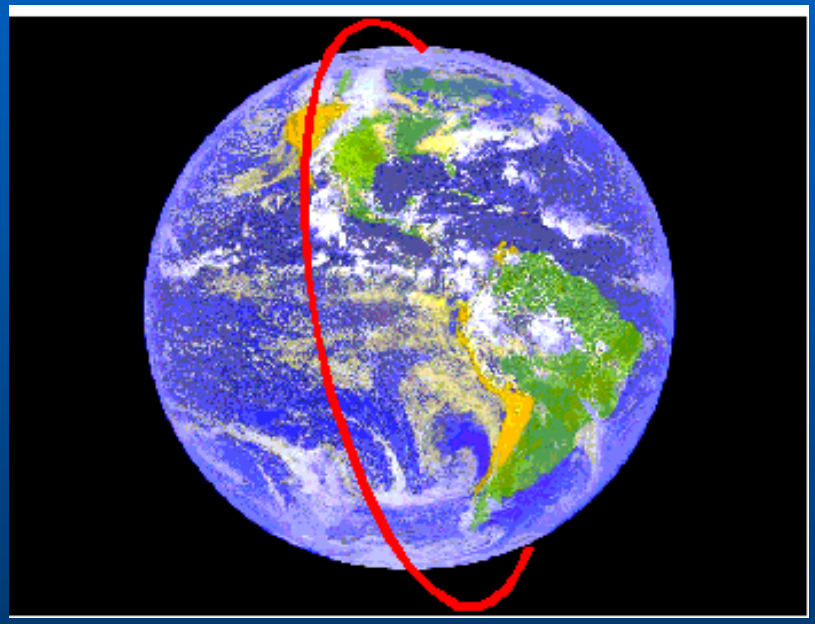
SARSAT/COSPAS

How SARSAT Works

- Receive 121.5, 243, 406 MHz Signals
- Orbiting and Geostationary Satellites
  - Orbiting: SARSAT/COSPAS
    - High Inclination (polar) orbits
  - Geostationary: GOES Weather Satellites
    - SAR payloads for 406 only
- Operated by Canada, France, Russia, USA
- They give us digital lat-long coordinates

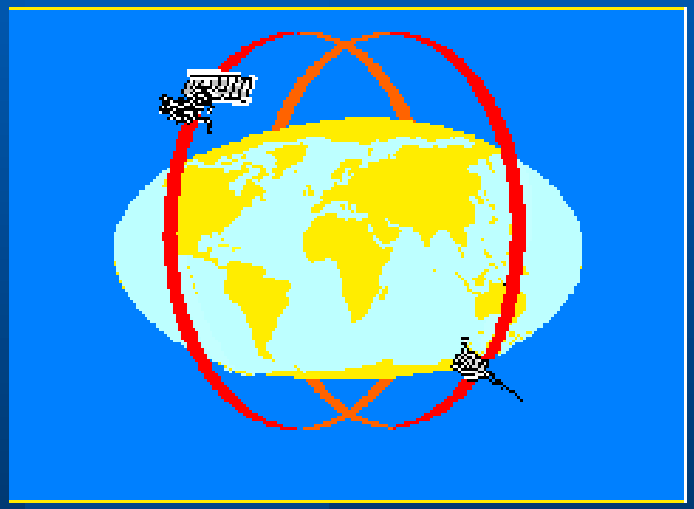
System Operation Details

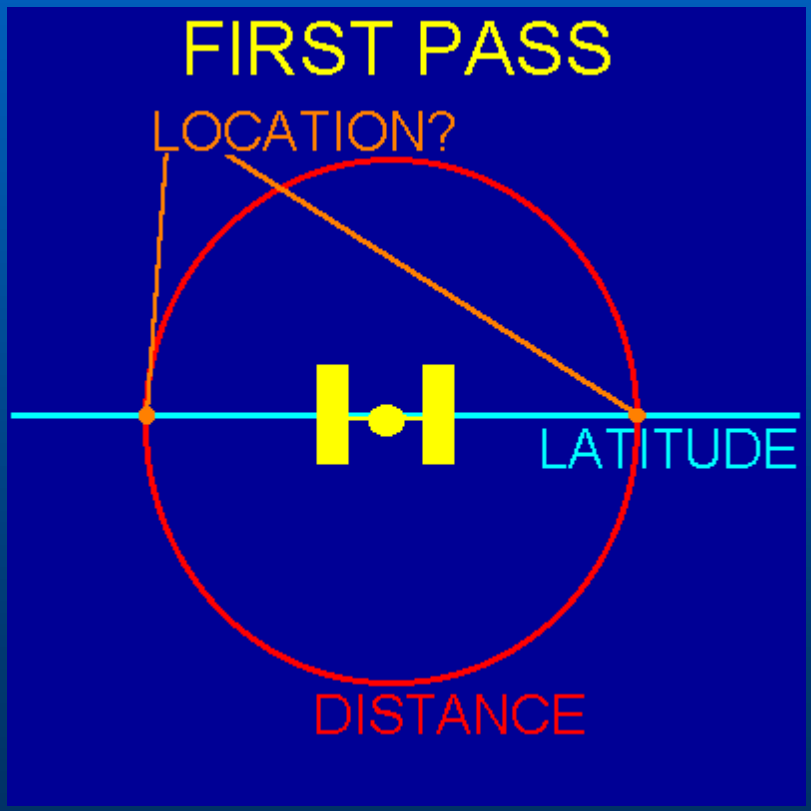
- SARSAT/COSPAS in polar orbit
- Calculates location of signal by measuring Doppler shift
- This yields a latitude and a distance



Narrowing The Search (SARSAT/COSPAS)

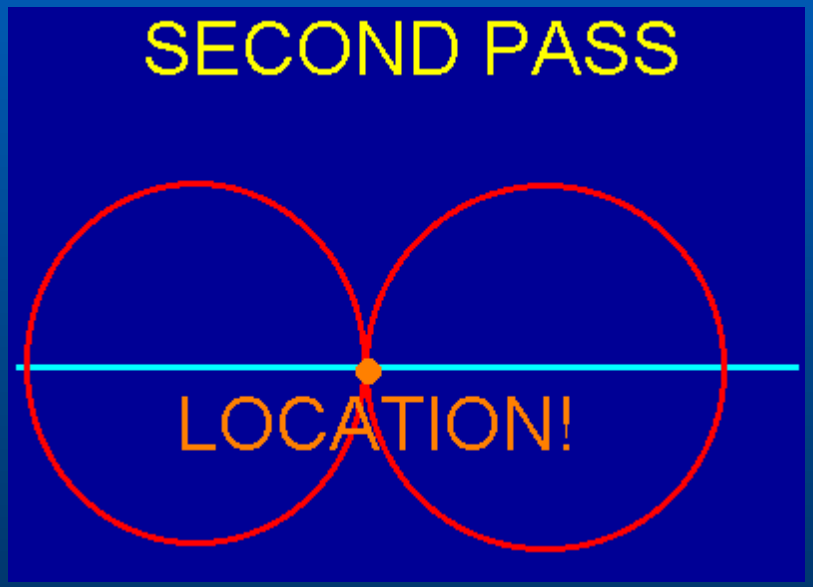
- First pass
  - Ambiguity





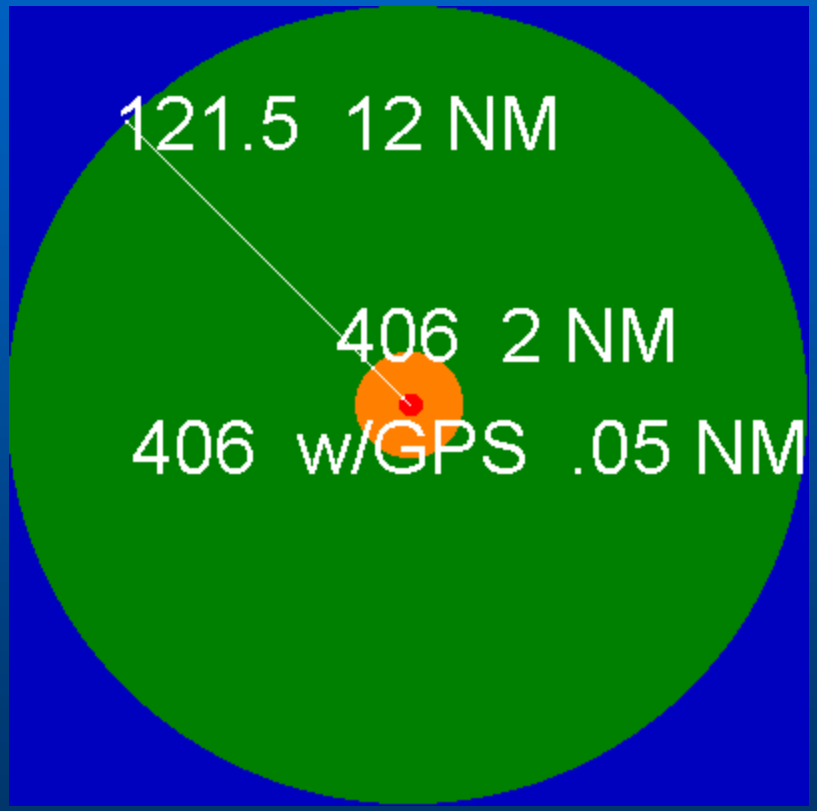
Where Is It?

- Second Pass
  - average 30-45 minute wait
  - Ambiguity resolved
  - 5-12 Nautical Mile Average Error for 121.5 MHz beacons



How Do Different ELTs Stack Up?

- 121.5 MHz ELT
  - 12 NM Radius, 452 Sq Mi (large city)
  - Avg. 6 Hour Notification
  - 60 Milliwatt Transmitter
- 406 MHz ELT
  - 2 NM Radius, 12.5 Sq Mi (large Airport)
  - Avg. 1 Hour Notification
  - 25 Milliwatt 121.5 Beacon
- 406 ELT with GPS
  - .05 NM Radius, .008 Sq Mi (football field)
  - Avg. 5 minute Notification
  - 25 Milliwatt 121.5 Beacon



False Alarms

- 97% of received ELT signals are false alarms
  - 121.5 MHz: 1 in 1000 is an actual emergency
  - 406 MHz: 1 in 8 is an actual emergency (12.5%)
- Why is a False Alarm a big deal?
  - SARSAT can only monitor 10 ELTs at once (within footprint)
  - VERY easy to overload the system
  - Computers “merge” hits and can end up averaging a real emergency with a false alarm
  - Blocks emergency communications
- Blocks a real emergency!

How Should We Treat An ELT?

- As an ***EMERGENCY***!
  - You can't know which ones are distress ELTs
- And even the false ones are good training!

Search is an Emergency

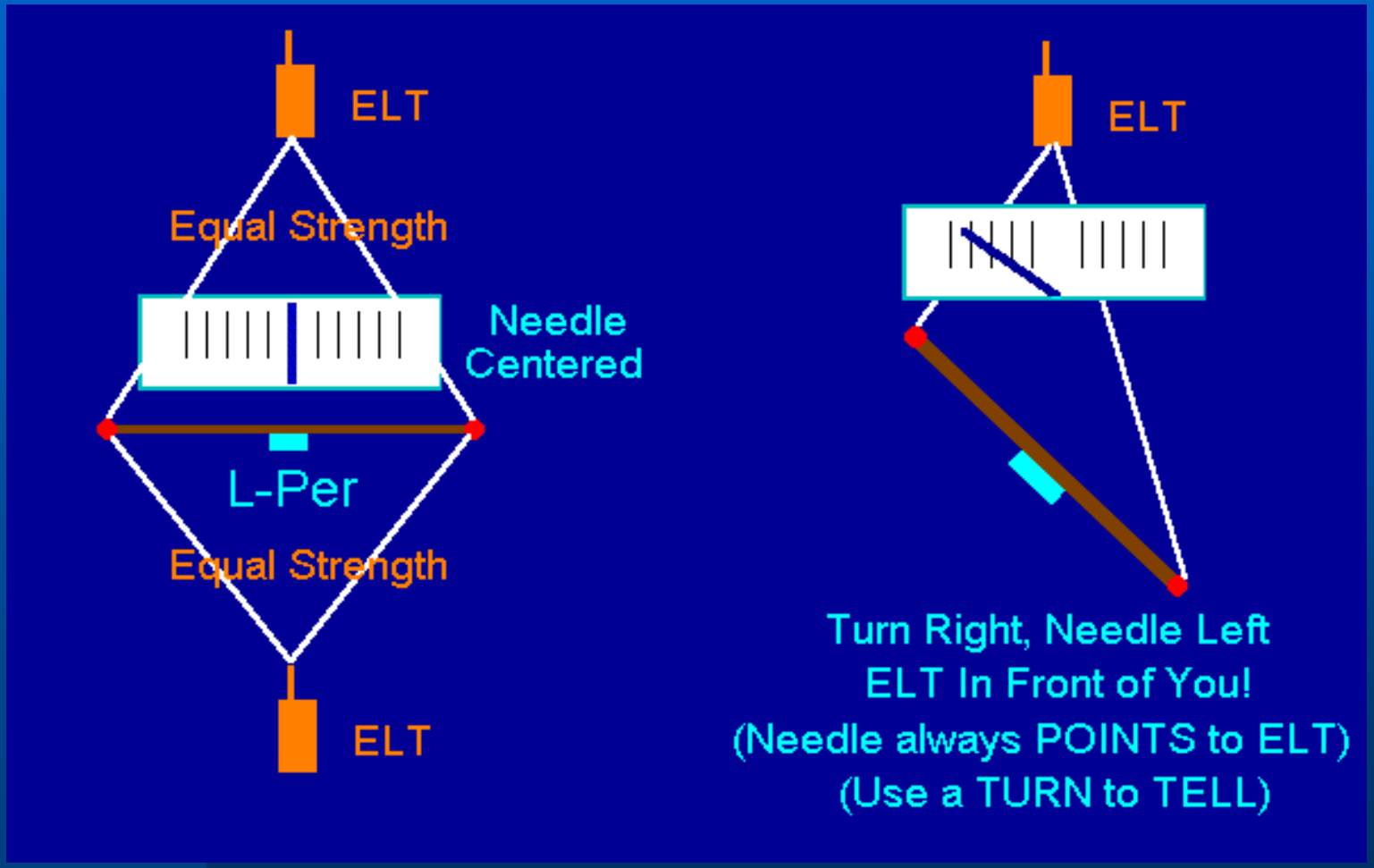
National Association of Search and Rescue

And Some of them ARE Real!

Direction Finding

- DF unit measures relative phase of signal striking each side of the antenna (doppler shift)
  - not wholly accurate, but good enough!
- Therefore, when needle is centered, ELT could be in either direction (directly in front or directly behind)
- When deflected, needle always POINTS to the ELT
- Use a TURN to TELL if the ELT is in front or behind you

Turn to Tell Direction



Little L-Per


LITTLE
L-PER
REC
OFF
DF
121.775 148.15
121.6
243
121.5
ALARM
ON
DIAL LIGHT
ALARM
RESET
MIN
MAX
SENSITIVITY
VOLUME
L-TRONICS SANTA BARBARA
SERIAL 21122

New Little L-Per


Little L-Per
ON
OFF

Screen


FORE
AFT
EXT
PWR
LEFT
RIGHT
533
RECEIVE

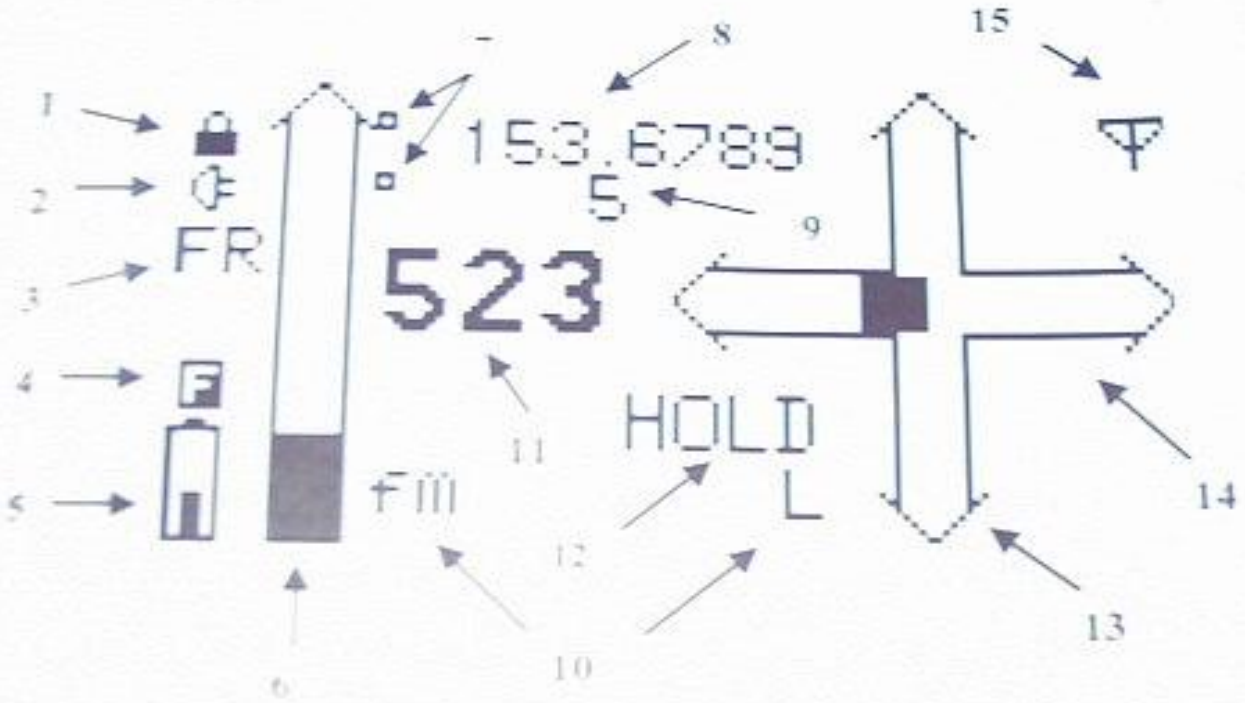


Figure 1 Display Screen Condition Indicators

Figure 1 shows the operating screen in DF mode illustrating the various condition indicators.

1. Lock symbol. Indicates most keys are locked
5. Battery condition bar
6. Signal strength bar
7. Attenuation flags
8. Receiving frequency in MHz
9. Channel name or memory number
10. Secondary settings (am/fm, lights etc.)

Aircraft DF unit

DFing with the Little L-Per™

- 6 Steps: use the *full* procedure every time!
  - Turn the unit to Receive, check proper frequency and volume
  - Turn the Sensitivity Knob to HALF SCALE
    - This will prevent *oversense* and is a good starting point
  - Turn the unit to DF
  - Turn at least one FULL circle
  - Check: Use **T**urn to **T**ell: the needle will point Direct to the target
  - Use your compass, to get a bearing to the ELT

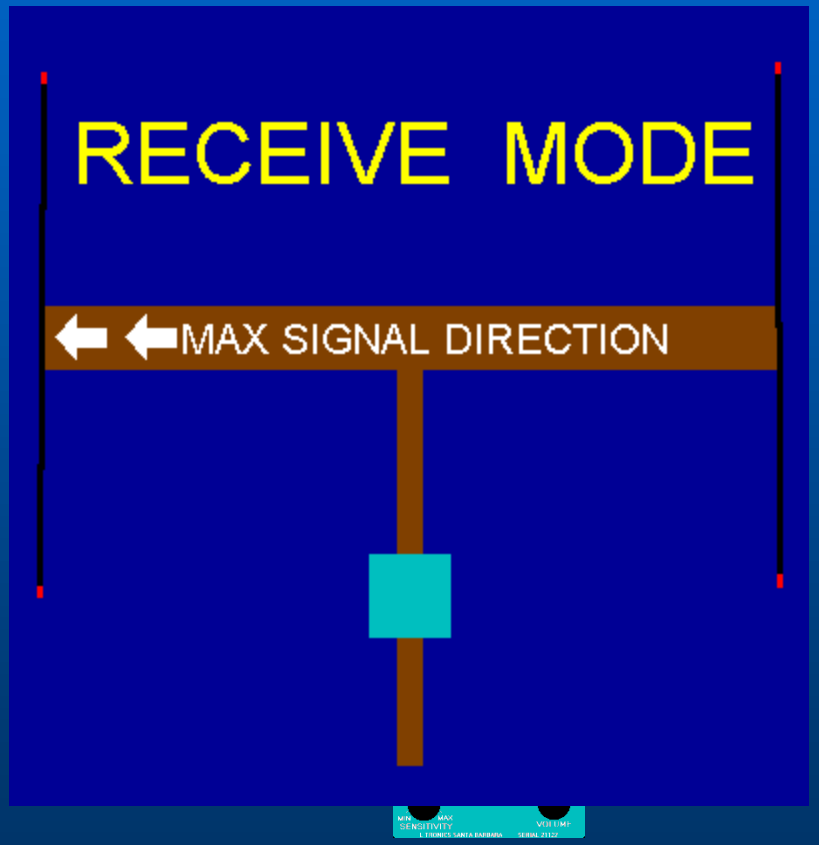
Procedure

- REC
- 1/2
- DF
- Center
- Turn
- Shoot

NOTE: Volume does not affect the needle, only your ears.

Little L-Per™ Receive Mode

- Measures Signal Strength *only*
  - From a direction of the arrows on the antenna (to your left)
- Use it with multiple centers (more than 2) to verify strongest path
  - Usually due to reflections
  - Strongest signal most likely indicates the true direction to the ELT



Reflections

- Caused by flat surfaces
  - Hangars are notorious
  - Rock walls, cliffs, or mountains
- To beat reflections
  - Check sensitivity half scale often
  - Use RECeive mode
  - Rubber ducky antenna
  - Off-frequency tuning
  - Usually strongest DF center is not a reflection

Taking Bearings

- Make sure that nothing magnetic is affecting your compass…like the hood of a car where the chart has been laid out
- Always use MAGNETIC Bearings - but be careful when plotting
- Can be used to plot bearings to triangulate the location

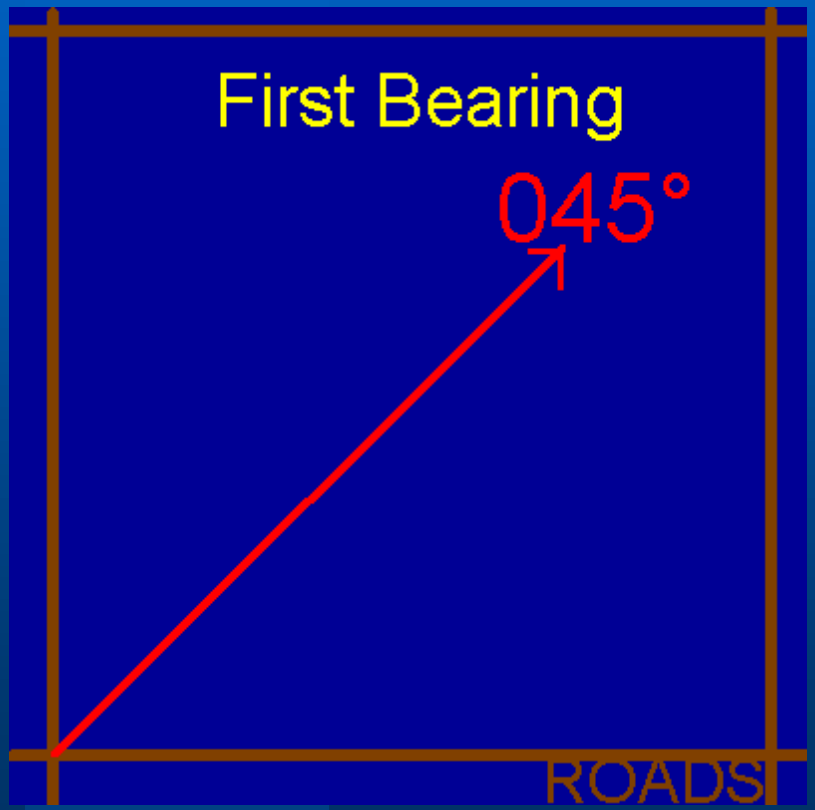
Triangulation

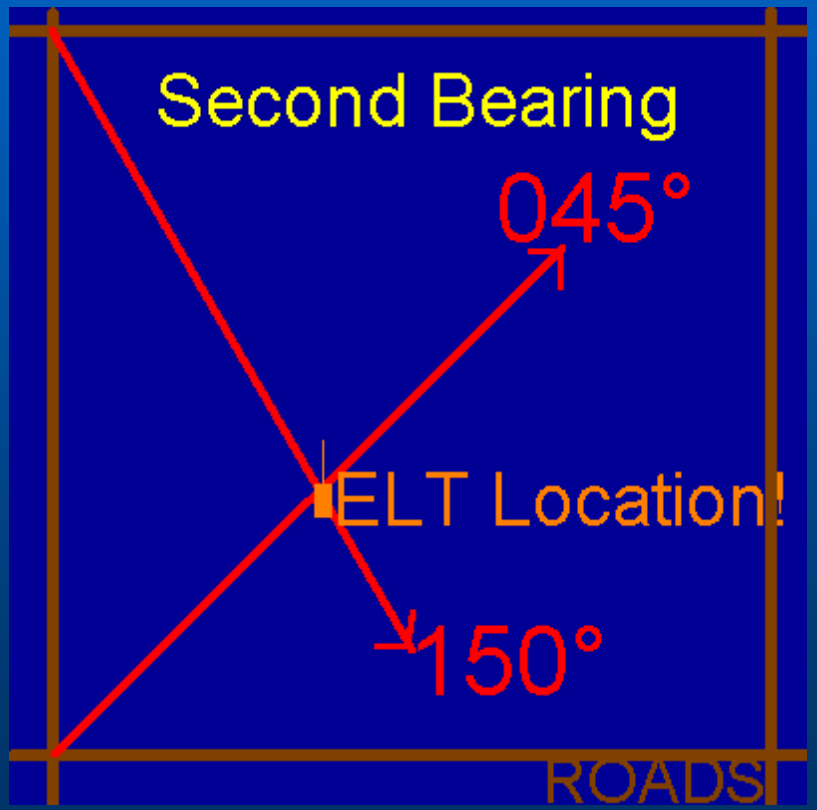
- Best method for ground personnel to get an accurate fix when search aircraft support is unavailable

Triangulation

- You must be able to receive the signal
- Center up DF unit on the signal
- Take the magnetic bearing (shoot an azimuth)
- Correct for magnetic variation
  - East is least, West is best
- Plot your bearings (draw a line) on map
- The ELT should be where the lines cross!

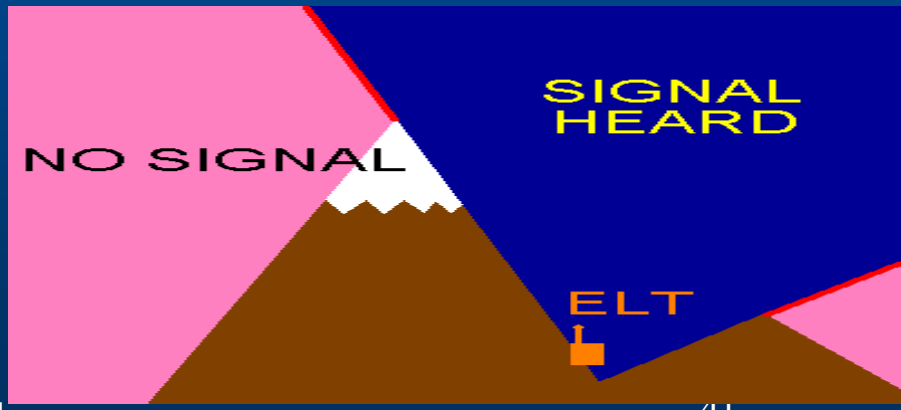
Let's See That





Hey, I Can't Hear the Signal!

- ELTs are limited to *Line of Sight* propagation
- You don't always need to hear the ELT
  - Carrier wave may be broadcasting with no audible sweep
  - Especially true when batteries are low, transmitter is damaged, etc
- You can tell by DEFLECTION
  - Good needle deflection generally indicates a signal that is strong enough to DF

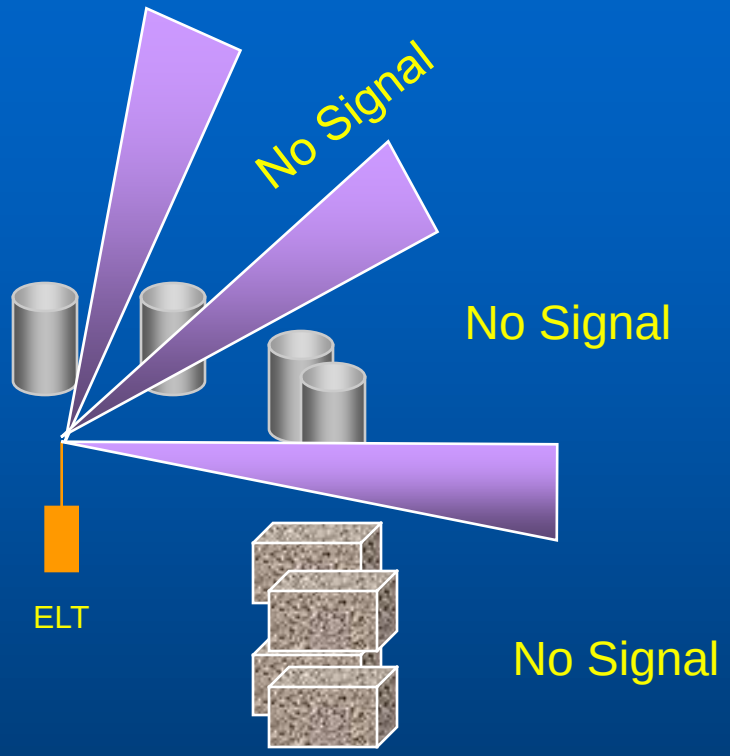


What Else Can Affect An ELT Signal?

- Power lines
  - EM Radiation
  - If you get an actual ELT during a practice search, shut down all practice beacons. The signal on 121.5 may be frequency shifted from your practice beacon! (often due to powerlines)
- Fence Line (signal can follow)
- Coffee Can/Stovepipe effect
- Hangars
- Moving Target

Selective shielding

- Objects near the signal source will selectively shield the signal
- Resulting radiation pattern will be:
  - non-uniform
  - erratic
  - deceptive



Monitoring while Driving

- Drive first
- Take bearings second
- Pull over and park in safe location
  - Park off pavement whenever possible
  - Use reflectors, emergency flashers, etc
  - Wear bright reflective outerwear for high visibility

General Tips and Hints

- Always have communications with the IC
  - Radio or cellphone and phone numbers
- Maps
- Be in some kind of approved uniform
  - Official Golf Shirt, Jump suit, blues - NOT BDU's in urban area
- Appropriate outerwear and footgear for weather

Electronic Searches from the Air

- Aircraft use the same type of methods as used on the ground
  - DF mode (most common)
  - Wing Null Method (body shielding with the wing!)
  - Signal Strength
  - Aural Search (rare)

Search for Missing Aircraft

- Purely Visual Searches
  - Very Difficult: often few clues
    - Air - most effective to cover ground
    - Ground - very limited visual range
- Electronic Searches - “Quick” (24 hrs)
    - Air - best reception and range
    - Ground - autonomous search is slower and more difficult
- Advanced Technology
    - Synthetic Aperture Radar (SAR), Thermal/Infrared Imagery, Other Remote Sensing (satellites/reconnaissance aircraft)

Aircraft Limitations

- Weather
- Ground terrain
  - Trees
  - Shadows
- Can’t pinpoint signal
  - Row of hangers/planes
  - Buildings
  - Marina full of boats

What Will A Crashed Airplane Look Like?

Finding it (Finally)

- Notify IC - note time of first acquiring signal, location and silence
- Determine Location (lat/long) and address
- Access available?
- Law enforcement assistance needed?
  - Residence or business
  - No trespassing
  - No access
- Ensure the aircraft operator is notified you disabled the ELT!

Before Going Home, Silence The Signal!

- Sometimes that's the only goal!
- Methods of disabling an ELT:
  - Switch off (note position!)
  - Remove battery
  - Remove antenna (may damage transmitter!)
  - Foil tent or tube (may damage transmitter!)
  - Grounding wire (may damage transmitter!)

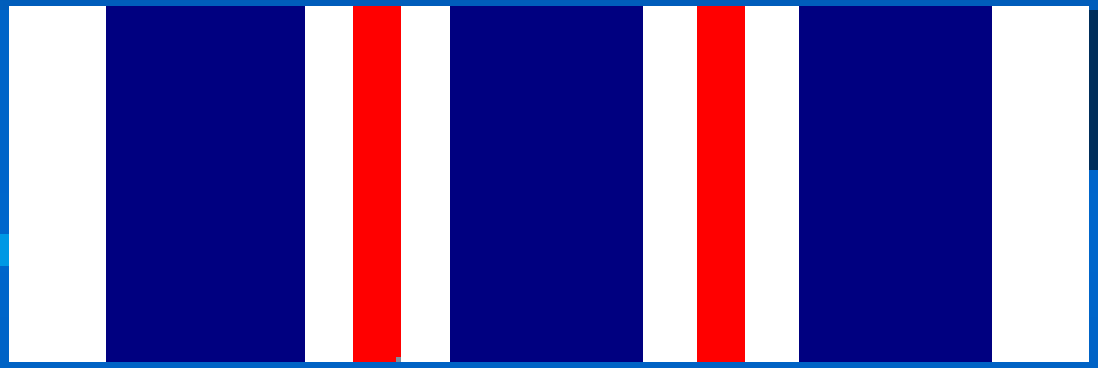
Leave A Note:

- “NOTICE: YOUR ELT (or EPIRB) HAS BEEN Transmitting a distress signal. It has been secured by the Civil Air Patrol. The batteries MUST BE REPLACED!”
- Mission Number and AFRCC phone Number for more information
- Personal information is optional

Data to Record

- Make, model, S/N of ELT
- Date of batteries
- Location
- Make, model and tail number if on an aircraft,
- CF number, name, and any other identifying features if on a boat
- Times - 1st heard signal, located ELT and silenced

QUESTIONS?



Urban ELT/EPIRB DF Training

Classroom Session

OBJECTIVES

- By the end of this session, you should:
  - Understand basic urban ELT/EPIRB DF search issues
  - Be familiar with these fundamentals:
    - Close in DF techniques
    - Body shielding

Why is Urban DF Different

- Usually not a crashed aircraft as signal source
- Massive amounts of interference
  - EMF from computers, microwaves, power lines, lights, etc
- Significant reflections
  - Buildings, boats, steel ...
- Visual clues not available
- Too many target possibilities (flightline, marina)
- Signal range may be limited
- Signal quality may be poor (carrier only)

Where Might the ELT Be?

- Usual suspects - planes, boats, pilot's/boat owner's house
- Marine/Aviation supply stores
- Avionics/radio repair facilities
- Pawn shops
- Junk yards, storage yards
- Trains, trucks and other transport

Location Process

- Process any available data - SARSAT, PIREPS
- Use a high point to DF down over potential area
- Triangulate if possible
- Close in with “spiral pursuit”
- Close-in techniques

Process any available data

- Plot hits on the map
- Plot/interpret data from aircraft
- Solicit additional PIREPS (helicopters (media, PD, etc.))
- Look for potential source locations (marinas, avionics shops, etc.)

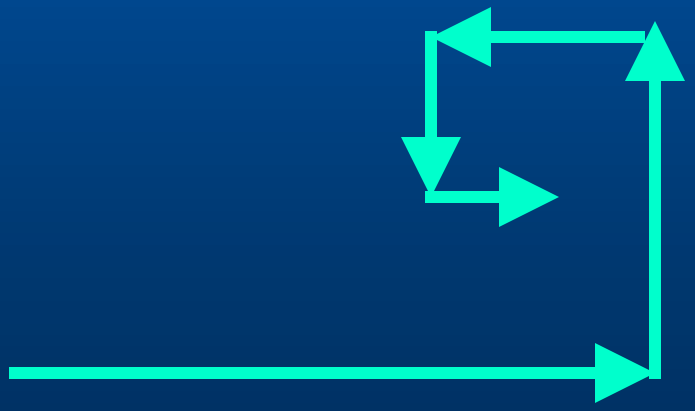
Use High Point to DF Potential Area

- Top of hill, bridge, etc. - try to get an overview position
- Try to acquire signal
- Get a bearing
- Try to triangulate from other locations

Also note if “no signal can be obtained” since this may help direct attention to probable sources (e.g. in the next canyon)

Close in with “spiral pursuit”

- Follow signal into source
- Spiral into source by driving, stopping, DFing
- Do NOT be suckered into very small, never-ending steps toward the suspected source. Take a few bearings from distant points to nail down the search area.



End of the Line - Now What

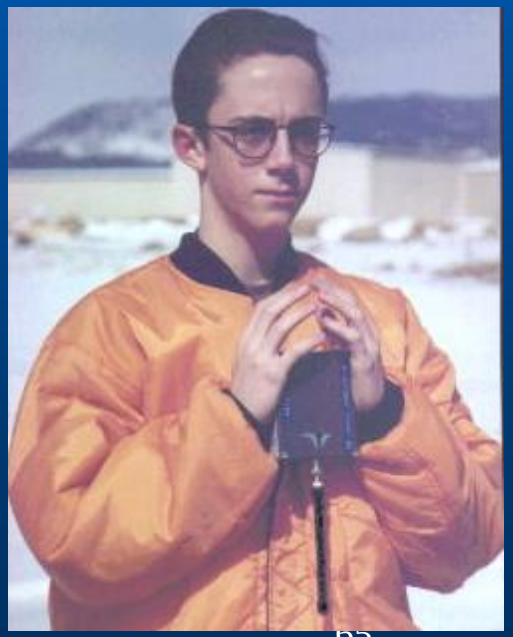
- Unless the source is obvious, close-in techniques will be needed to actually find the source
- Look for clues to help
  - Signs of a pilot or boat owner in the house
  - Light on EPIRB is on
  - Use all your senses - it is not cheating

Close-in Techniques

- Turn down sensitivity (and volume)
- Detune (can you hear it on 121.6?)
- Needle suddenly flickers from left to right
  - Passed ELT
- Use less sensitive antennas (rubber ducky)
  - When really close, signal should be obtainable with no antenna at all!

Body Shielding the BEST method of beating reflections at close range

- Can use L-Per™ or any proper-band receiver/transceiver (note: portable aviation radios are very effective)!
- At extremely close range, a 2m VHF radio unsquelched may work
  - This works OK when trying to figure out a particular aircraft on a flight line
- Hold radio so body blocks out the signal
  - Where signal fades is called a NULL
  - At null, source should be at your BACK



Off-Frequency Tuning

- Tune Off-Frequency when:
  - Sensitivity (L-Per™) is at the minimum and signal is still too strong (full scale on receive)
  - You don’t get a null during body shielding
  - You don’t have a sensitivity knob (radio)
  - Shortening or removing the antenna will also decrease sensitivity
- Off-Frequency tuning may be used any time you have too much signal, but this technique is especially effective during body shielding

Some Situations

Airports

- Access sometimes difficult
- Contact tower, security, or local law enforcement
- Use flashers or rotating beacons
- Monitor ground, CTAF, or Tower freq if possible
- If offender is in a hanger, call the FBO

Do not get complacent! Even though the signal emanates from an airport, there may still be an emergency!

Marinas

- Big problem
  - Masts and rigging of sailboats reflect signals
  - Docks are often locked up
- DF from down low
- Contact harbor patrol or law enforcement for help

Private Homes

- Try to nail down signal to one house so neighbors won't be bothered
- Call IC
- Get law enforcement support
  - ESPECIALLY AFTER HOURS!
  - Let them knock on doors
- DON'T enter
  - Ask occupants to bring the unit to you

Businesses after hours

- Notify IC
- If no emergency contact numbers are apparent at the business - contact law enforcement or fire department to determine if they can gain access
- If no contact can be made, and law enforcement cannot achieve access, send someone the next business day

Government Agencies

- Military - bases, ships, and aircraft
  - These are common sources of false alarms in areas of significant military bases and activity (e.g. Southern California)
  - Have IC make contact prior to attempting entry
- Other (police, fire, airport)

Common Problems

- No Access
- Uncooperative people
  - No law enforcement authority
- Signal leads you out of urban area…do not leave without:
  - Contacting the IC for guidance and permission
  - Verifying jurisdictions
  - Ensuring personnel are properly trained and equipped
- Signal disappears
- Can’t pin down the source
  - Have the right equipment and maps
  - Don’t be afraid to call for help

QUESTIONS?