LL Series Little L-Per®
Portable Direction Finder

OPERATING MANUAL

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OPERATING MANUAL

Attention!!

For those of you who "Don't do manuals," please make an exception and read this one at least once. It's not that long or hard. If you prefer to guess or believe fairy tales from friends and then screw it up, you will get little sympathy from us.

INTRODUCTION

The LL Series portable direction finder is a compact, hand-held, synthesized receiver with tunable, folding antennas capable of receiving AM and FM signals. The sealed case is high-impact plastic and all exposed metal is stainless steel for corrosion resistance. A finger-operated, gasketed plug allows the AA batteries to be quickly replaced. External antenna jacks allow for connection of L-Tronics® magnetic, flexible, and aircraft antennas, as well as other antennas such as beams. A third connector on top of the receiver can be used for external power and earphones.

AN OPERATING INSTRUCTION SUMMARY IS PRINTED ON THE LEFT SIDE OF THE FRONT PANEL. PLEASE REFER TO IT FREQUENTLY UNTIL YOU BECOME FAMILIAR WITH THE EQUIPMENT AND ITS OPERATION.

The DF display shows direction and signal strength simultaneously, along with other information as shown in figure 1. Both the display and the keyboard can be lit for night use.

The receiver is pre-programmed with 121.5 MHz in Channel 1, 243.0 MHz in Channel 2, 121.775 MHz in Channel 3, and Marine calling frequency 156.8 MHz in Channel 4. These frequencies cannot be changed by the customer. Six additional memories can be programmed by user from the keyboard.

Direction finding techniques are the same with this equipment as they are with the older style LH Series Little L-Per®. There are some important differences in the operation of this equipment. With the LL Series:

1. It is not necessary to change antennas when changing frequencies.
2. The display shows left-right homing and signal strength (by number and scale) simultaneously.
3. The receiver is programmable on any frequency from 108 MHz to 162 MHz and 215 MHz to 270 MHz. Later versions will operate from 108 to 174 MHz.
4. The antenna system needs to be calibrated periodically with the CAL key (see instructions).
5. The unit is not field repairable internally; breaking the security seals between the case halves will void the warranty.

DETAILS ON THE OPERATING SCREEN (DISPLAY)

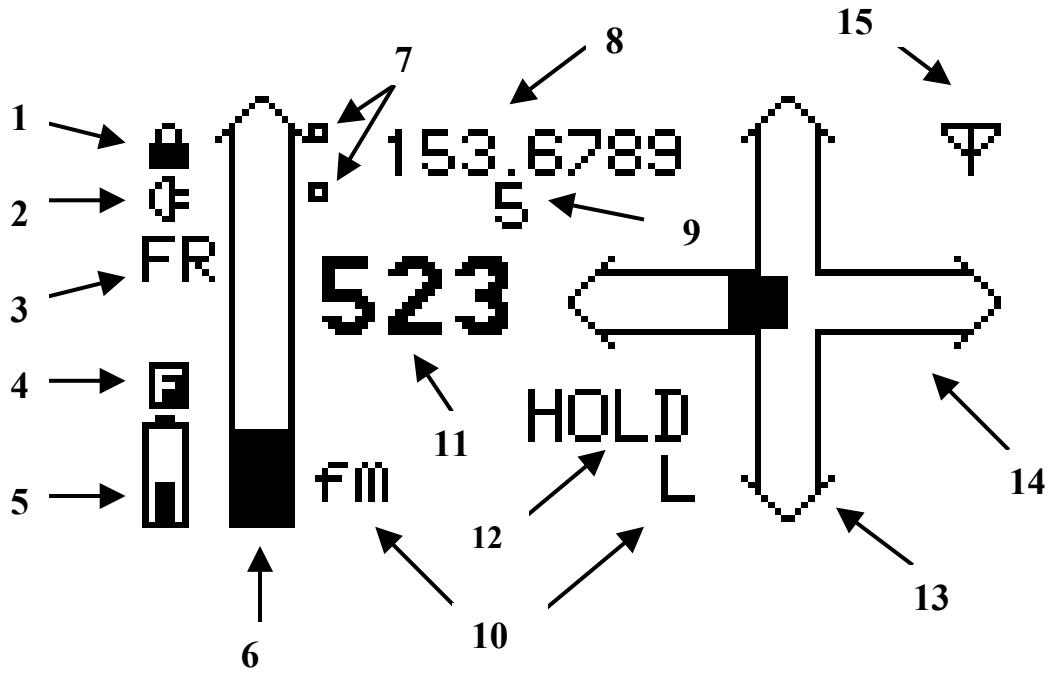

Figure 1. Display Screen Condition Indicators

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

1. Lock symbol. Indicates most keys are locked
2. External Power. Indicates that the DF is running on external power.
3. Entry mode. Shows “FR” when waiting for frequency entry or “ST” when waiting for a memory number for storage.
4. Function indicator for selection of alternate key definitions
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.)
11. Signal strength number, about 3 counts per dB
12. Condition messages
13. Fore/Aft DF bar
14. Left/Right DF bar
15. External antenna indicator

ASSEMBLY FOR OPERATION

The receiver is shipped with a blue protective film covering the display. Carefully peel this film off before use.

The receiver is also shipped with six AA alkaline batteries installed. Details on battery requirements and installation are described in the section "More About Batteries" on page 9.

Unfold the antenna blades and handle by holding the receiver body with one hand while unfolding the four antenna blades and then the handle to their operating positions. Return them to the stored position in reverse order (handle then blades). For optimum DF accuracy when operating on frequencies between 108 and 174 MHz, fan the antennas to the detent at 120º outwards. See Figure 2. For 215 to 270 MHz, set them in the 90º position., as shown in Figure 3. The antennas may be left in the fanned or 120º position when switching between 121.5 and 243 MHz; only a slight decrease in accuracy will result.

Figure 2. Operating Position for VHF Frequencies (108–174 MHz) (antenna elements fanned out to 120° position).

Figure 3. Operating Position for UHF Frequencies (215–270 MHz) (antenna elements in vertical or 90° position).

To turn the receiver on, hold the PWR key down for 2-3 seconds. It will beep and the display will come on. To turn the DF off, hold the PWR key down for one second. It will store the frequency and display settings currently being used, "beep," print "OFF" on the screen, and shut down when the key is released.

The panel light key cycles between three stages: 1) display and keyboard lit; 2) display only lit (brighter), and 3) Off. Using the lights add about 50% to average battery drain. The letter "L" appears in the secondary settings area of the display to indicate the lights are on in daylight (see Figure 1).

Whenever the receiver is operating, the up and down arrow keys raise or lower the speaker volume. While programming, they adjust frequency, contrast, and other functions. Continuous running at maximum volume can cut battery life in half.

To use the DF, antennas are extended and positioned as described above and the receiver is held with the arm extended and the display screen **at or above eye level**. This is **VERY** important for best DF accuracy, as described later. This position is called the "operating position" and shown in Figures 2 and 3.

SUMMARY OF OPERATING MODES

There are three operating modes: 1. Left-right direction finding or homing; 2. Receive or signal strength; and 3. Fore-Aft/Left-Right (FALR) when used with external antennas. The DF and Receive modes are selected by toggling the REC/DF pad on the keyboard. In the Receive mode, the cross disappears and the word RECEIVE replaces it on the screen. The FALR mode is automatically selected when antennas are connected to both jacks on top of the receiver.

In the DF mode, the antenna is rapidly switched, first to the left and then the right. The strength of the signal while pointing left is subtracted from the strength while pointing right and the result is shown by a darkening on the horizontal bar on the display to show the direction of strongest signal. Thus, if the signal source is to the right of the DF, the bar will darken the pointer to the right. Turn in the direction the bar indicates until it nearly disappears or points equally left and right. The operator is now facing the signal source. Any further turn in the same direction (right) and the bar will darken to the opposite side (left). Return to the centered indication to face the signal source. A "buzz" heard in the DF mode is normal.

In DF mode, the larger of left and right signals is selected for signal strength indication. This makes the strength reading nearly independent of antenna angle (omni-directional). DF mode should be used for the signal strength or build and fade method of transmitter location,

Figure 4 shows the operating screen in DF mode with the various condition indicators.

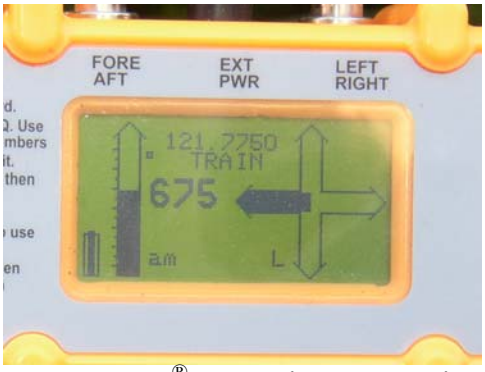

Figure 4. L-Per® Operating Screen in the DF Mode.

In the Receive mode, the antennas act as a directional beam that is most sensitive off the left end of the receiver. In this mode, selected by the REC/DF key, the received signal will have the greatest strength when the left end of the receiver front panel is pointed at the source. This maximum signal is rather broad but may be useful when only a general direction is needed.

The DF will show one or more minimum amplitude points, often called nulls, but these change depending on tuning and should not be used for determining direction. This mode also eliminates the "buzz" present in the DF mode and makes speech easier to understand. A numerical indication supplements the vertical bar to indicate signal strength, with about 400 being the weakest signal and about 850 the strongest.

Figure 5. L-Per® Operating Screen in the Receive Mode.

Details on operating in both the DF and Receive modes are covered in the Direction Finding Techniques section (page 11).

A vehicle is equipped with two sets of L-Tronics® DF antennas, one mounted fore-aft and the second left-right, the coax leads can be connected to the appropriate BNC jacks on top of the receiver. The display on the DF then allows the fore/aft and left/right bars to be displayed simultaneously to give a continuous "all around" indication in the DF mode.

DETAILS ON OPERATION

DF receivers intended for operation in the United States have three standard emergency frequencies and one practice frequency pre-programmed in the memory:

1.	121.500	ELT-1 AM
2.	243.000	ELT-2 AM
3.	121.775	TRAINING AM
4	156.800	MARINE FM

Some receivers built for export and special operations may be programmed differently.

These settings are not changeable from the keyboard. If the DF ever gets into an unknown or unusable state, pressing one of these keys will reset to factory programming. These stored setups are often all that's needed for successful ELT and EPIRB location.

When the DF is turned on, it always starts with the setup it had when it was last shut off. If this is not what is wanted, press any key 0 - 9 to bring up either one of the permanent setups or one that has been stored earlier. If a blank memory is selected, an "EMPTY" message will appear briefly and the setup will not change.

Operation in the DF Mode

To determine direction with best accuracy, select the DF mode with the "REC/DF" key (the cross on the right half of the display screen will appear). Hold the unit by the handle in the operating position: the screen (display) facing the operator and at eye level or higher with the antennas vertical as shown in Figure 2. Turn in the direction of the longer horizontal bar until the bar is short and any remaining length is centered in the cross display (display centered). The operator is now facing the signal source. Any further turn in the same direction will cause the bar to reverse. Always turn in the direction indicated by the horizontal bar until it is centered and any further turn will cause it to go to the opposite side.

Summary:

1. Select DF mode
2. Hold unit with display facing you and at eye level (operating position)
3. Turn in the direction of the longer horizontal bar until the bar is short and centered

Please read the above paragraph and summary again. It is the most important information in this instruction manual. *With a small antenna and short handle, the operator's body is part of the antenna. Poor quality DF readings are guaranteed if the DF is held down by the operator's belt buckle, the antenna blades nearly touch the operator's arm, or curious onlookers gather closeby.*

Operation in the Receive Mode

Direction can also be found using Receive mode. Press the "REC/DF" key. The direction cross on the display will be replaced with the word "RECEIVE." Hold the DF unit in the operating position as described above and turn to where the strength bar is tallest or the strength number is largest. The signal source is now off the left end of the display as noted by the arrows on the panel. This mode is less precise than DF mode but may be less affected by severe reflections. The operator should know how to use both modes.

Calibration.

The DF receiver employs both a tracking pre-selector and tuned active antennas to give good wide-range performance in a small package. These circuits can change with temperature and time and the antennas are sensitive to nearby objects like hands and arms or onlookers crowding about, particularly when operating around 120 MHz. To correct potential errors, the calibration circuitry injects a known signal into the built-in antennas and "peaks up" the various circuits.

Because the antennas are being adjusted for hand held use, they **MUST** be unfolded and the unit **MUST** be held in its operating position during calibration.

To calibrate, first select the desired operating frequency and then press the "CAL" key. The display will show "HOLD" for three seconds while the DF is moved to the operating position. It will show "CAL" while the actual tuning takes place, and then "GOOD" if all is well. It is normal for the speaker to make a noise and for the display to "jump around" during calibration. If "FAIL" appears, see below.

It is **NOT** necessary to calibrate the DF each time it is used. It should **NOT** be calibrated within 100 ft of an ELT or at a busy communications site because this could cause errors or false "FAIL" indication. The most recent calibration values are stored in the corresponding memory.

Calibration should be done any time a new frequency is programmed, if the DF is held in a different way, if the temperature changes by more than 40° F (20° C) or if it has been more than six months since the equipment has been used. Calibration in a quiet radio RF environment will give the best accuracy. Excessive calibration isn't damaging, just unnecessary.

If the DF is being used with external antennas, such as the L-Tronics® LVA series magnetic antennas, only the receiver will be calibrated so the built-in antennas may be left folded. Calibrating while hand-held also calibrates for vehicle use.

If calibration shows "FAIL":

1. Try again. There may have been momentary outside interference.
2. Make sure the antennas are set to "AUTO" (SET1, item 2).
3. Continue use. The old values are put back after a CAL failure.
4. Hold the DF with the body clear of the antennas in the operating position as shown in Figure 2 and try again.
5. Fold and unfold antennas to clean the joints.
6. Check the battery indicator. Replace batteries if no bar is showing.
7. The receiver may not calibrate properly above 162 MHz with this software version.
8. It may be too hot or cold. Limits are -10 to 140°F (-24 to 60°C).
9. The DF may have failed. Factory repair or replace.

Changing Frequency

The receiving frequency may be changed either by direct entry of the desired frequency or up or down in 100 Hz steps.

To change frequency, first, press the "F" key and the press "FREQ." If the "FREQ" key is not pressed within five seconds, the "F" or alternate function condition resets. If this happens, push "F" and then "FREQ" again. While in the frequency setting mode, the letters "FR" appear along the left edge of the display. Press "F" to end frequency entry.

To tune in a signal better, to discriminate against interference, or otherwise change the frequency in small steps, press the up or down arrow key. A short press will move by one step; holding the key down will cause the frequency to move up or down continuously. Any frequency, whether from operator entry or from permanent memory, can be changed this way. The changes will be kept when the DF is

turned off and back on again but they will not affect the values stored in memory. Changing frequency in this way does NOT require a new calibration. For example, 121.5000 MHz loaded from memory 1 could be changed with the arrows to 121.5053 and stay there even if the DF was turned off and on. Pressing 1 again would return to 121.5000.

A new frequency can be entered directly by pressing "F" then "FREQ" and the desired frequency on the number keys. Only the significant digits need be entered and the decimal point is automatic. Any missing digits will be set to 0. Press "F" again to complete the entry. If the new frequency is out of range, "RANGE" will be displayed briefly and the old frequency will remain unchanged. For example: the sequence "F, 1, 3, 6, 2, F" would result in a frequency of 136.2000 MHz. "F, 2, 6, F" would cause a "RANGE" error and retain the old frequency. CAL is required when a new frequency is entered this way.

Note that once an arrow key is pressed, direct entry is disabled and once entry is started, the arrows are disabled. If a mistake is made, just press "F" to quit and then "F" and "FREQ" again to start over.

Storing a frequency

After a new frequency is entered, it will be labeled as "NEW" on the display. There is no provision for custom labels. This new frequency will be retained if the power is turned off and back on but will be lost if any other memory is loaded. To store this frequency for later use, press "F" then "STORE". The letters "ST" will appear on the left edge of the display. Select a memory number for storage of this new frequency and press a number from 5 to 0. The old data, if any, in that memory location will be erased. The "NEW" label will be replaced by the memory number when this entry is later recalled. An attempt to store to a permanent memory location (positions 1 through 4) will be rejected.

USING EXTERNAL ANTENNAS

Two BNC jacks are located on the top of the DF for connecting external antennas. When set for AUTOmatic operation, any antenna with a DC resistance of 500 ohms or less at its connector will be detected by the DF when it is plugged in. The DF will shut off its internal antennas and work from the external one(s). It will return to using its internal antennas when the external antennas are disconnected.

The L-Tronics® magnetic, flexible, aircraft, and LH Series L-Per® handheld antennas will all be detected. Adding a 470 ohm resistor to the L-Tronics® LHBM-1 beam and LVA-1 monitor antennas will allow automatic detection of them, plugged into either jack.

NEVER apply power or more than 10 mW RF or any DC voltage to these jacks. External antennas can also be selected manually (see "Other Adjustable Values" below). The jack that the external antenna is plugged in to sets whether the DF displays the data left and right (left/right jack) or up and down (fore/aft jack). Plugging two antennas at once will switch to the FALR (Fore/Aft-Left/Right) display.

There are two potential hazards associated with external antennas:

1. External antennas usually cover only a narrow frequency range. Beyond their designed frequency, they can be wildly erroneous.
2. The DF will not use its internal antennas unless it is set to AUTO (SET1).

Be careful with external antennas to be sure they are used within their limits. For example, our magnetic and aircraft antennas have a range of only 118 to 126 MHz and 235 to 260 MHz.

OTHER ADJUSTABLE VALUES

Several other settings are selectable beside frequency, DF mode and volume. These are controlled through setup screens

"SET1," "SET2," and "SET3." Currently, "SET2" is an unused reserve for expansion and "SET3" contains only the model number, frequencies and hardware and software revision numbers.

To work with the SET menus, press "F" and then "SET1," "SET2" or "SET3." One or more items on a menu can be changed in a single session by selecting its item number. Except for contrast, these selections are retained in the individual frequency memories. To end the session, press "F" again.

SET1 + KEY PAD ENTRY NUMBERS

1. Pressing this number alternately selects FM or AM audio detection. This selection affects only what is heard on the speaker. It does not affect DF operation. The default is AM below 137 MHz and above 235 MHz and FM elsewhere.

2. Pressing this number selects "AUTO," "F/A," "L/R," and "FALR" antenna switching. The default for permanent memories is "AUTO." The other choices allow for manual selection when using external antennas that do not give sensing for automatic selection. This MUST BE SET to AUTO for the built-in antennas to work.

3. Press 3 and then use the up and down arrows to adjust the display contrast. If the display is too light to read, hold the UP arrow and, if it is all black, hold the DOWN arrow until the display appears. Contrast is stored in a common memory so the last adjustment made applies to all frequency memories.

4. Pressing this number selects "FAST," "MEDIUM," and "SLOW" display filters. "FAST" is the default and is usually best for hand-held operation and catching short, pulsed signals. "MEDIUM" and "SLOW" can reduce the flutter caused by nearby objects while driving or for detecting very weak signals.

5. ELT signals are usually strings of pulses sent at a varying rate to give the warble sound. The transmitter is usually on only 1/3 of the time to give better battery life. Peak detection gives better performance on these signals and is the default for the programmed ELT frequencies. It may give an erroneous left or right indication with no signal on some frequencies. For communication signals, turn peak detection off.

6. Display gain allows reducing the sensitivity of the DF indications when larger external antennas are used. The default is "high." It may be set to the operator's taste.

It is common to use different default settings for mobile and walking. Preferred setups can be stored in some of the user memories to be recalled when needed without having to reprogram each time. It is better to store a setting with the dial lights off so they aren't part of the memory and don't run the batteries down unnoticed during the day.

EXTERNAL POWER AND AUDIO

The 6-pin jack on top of the DF between the BNC jacks provides for external power input and audio output. An optional mating connector with a 4 wire, 6 foot cable is available from L-Tronics® as part number 120014. The mating connector only is available from Digi-Key (www.digikey.com) as p/n HR8560ND (Hirose HR30-6P-6S); soldering small pins is required. Connections are:

Pin	Color	Function
1	Black	Ground
2	Red	+ input power
3	White	Audio out
4	Green	Reserved
5		Reserved
6		Reserved

To connect the cable, align the white arrows on the connector halves and push on the back of the plug. To remove, pull on the ring on the front of the plug, NOT the body. If it comes apart hard, it is being done improperly and it may break.

The input voltage should be between 6 and 28V. Maximum current with lights on and loud audio is about 250mA. The unit will withstand up to +80V and –40V without damage, but will not operate until the voltage returns to the working range. The external power input draws about 10mA with the DF shut off.

The audio output will drive headphones or a small speaker connected between pins 3 and 1 (white and black). **Do not** apply external power to this line. The output level varies with the DF volume control.

ODDS AND ENDS

Pressing "F" and "LOCK" will partly lock the keys. When locked, only the "POWER," "LIGHT," "REC/DF" and "LOCK" keys work. To unlock, press "F" and "LOCK" again.

This DF has a narrow bandwidth logarithmic receiver. This means that older, wide-band FM communications signals and AM signals with full modulation will sound distorted. This is not a receiver fault. It also means that reception of older ELTs, which have wider frequency tolerances, may be improved by tuning the DF receiver frequency by a small amount using the UP and DOWN arrow keys. Careful tuning may also allow separation of two simultaneous ELTs.

One or two attenuators are switched in to extend the strength measurement range for strong signals. They make an audible "ping" when they change and may cause a jump in strength numbers. The attenuator dots show when they are in use (Figure 1).

Occasionally, the LCD display can become confused. If this happens, pressing the DF/REC key twice or the sequence F, SET1, F should clear it. Also, the key pad may not respond properly to rapid key pushing. Slow and deliberate works best.

The low temperature operating limit is set by the LCD display, which responds very slowly when cold. Contrast adjustment helps somewhat. Slow and deliberate works best.

The case of the DF is sealed with the battery plug in place. It is designed to withstand water immersion to 10 ft and altitude to 15,000 ft. With batteries installed, it does float. If it is moved to a different altitude for an extended period and the weather is dry, we suggest opening the battery plug briefly to equalize pressure. The case seal is not hermetic; moisture can accumulate inside as a fog on the display due to "pumping" by daily temperature changes. If this happens, or if water gets inside for any other reason, remove the battery plug and let the case dry out. The process can be speeded by putting it in a warm place, but not over 120°F.

BREAKING THE SECURITY SEALS AND OPENING THE CASE WILL VOID THE WARRANTY.

The folding handle is removable to allow the DF to be mounted another way. The screw has ¼-20 threads, the same as used on most camera equipment and tripods. Take care not to loose the "wavy plates" that are a part of the index mechanism. L-Tronics® also has a simple drop-in bracket, p/n 120013, available to keep the unit in place in a car or airplane.

The screws holding the built-in antennas are sealed with Locktite®. Should one ever work loose, a drop of Locktite, preferably 290 grade (green) should be applied to hold it and to maintain the case seal.

If the battery plug is lost, stuffing crumpled aluminum foil into the open hole may keep the DF running until a new plug is acquired.

MORE ABOUT BATTERIES

First, no matter the type, use fresh, good quality batteries. Customer reports and our own experience over many years suggest far fewer problems with Eveready® and Duracell® than any other manufacturers. Saving a dollar only to have a battery jam in the tube, go dead when needed, or dribble caustic goo in the works is really foolish. If possible, buy

from a store that sells a lot of batteries and check the date codes so you get fresh ones.

The LL Series Direction Finder uses six 1.5V AA size batteries. For normal service, we recommend alkaline batteries, as these give the best combination of service life, cost, and resistance to corrosion. New alkaline batteries will run the DF for about 30 hours. When the bar on the battery indicator symbol on the front panel display disappears, about one hour of operating time remains.

If long storage life or extended operation below –10º is needed, use 1.5V Lithium-iron sulfide batteries (Eveready L91).

NEVER USE 3V LITHIUM BATTERIES. They will damage the receiver.

Use NiCd or NiMh rechargeable cells only if your DF is being used an hour or more per day.

To change batteries, unscrew the battery plug on the right side of the DF until it is loose, then gently pull it out. Insert the batteries with the positive (+) end first into the battery tube. Reseat the plug and push in gently to engage the threads, then screw the cap in until the "O" ring is in contact with the case all the way around.

Alkaline cells have a capacity of about 2600 mAH at 68° F and should give about 30 hours of operation with average volume settings and panel light use. The DF will operate at full accuracy down to 5.4V from the battery or 0.9 volts per cell to extract the full battery energy. Cells lose about 5% of their energy per year at 68°F, more if hotter and about 1% if kept in a refrigerator. Only about 45% of the battery energy is available at -10°F. Battery seals usually last more than 5 years if the cell is not discharged but batteries still should be taken out if the DF will be stored for a long time. If the batteries do corrode, get them out if you can and clean out the mess with a DRY bottle brush. NEVER use any liquid cleaner as it can leak into the circuit boards. Battery tubes are factory replaceable.

Carbon-zinc batteries, strangely often called "heavy duty," have a capacity of about 1500 mAH, have only about 30% of that at -10°F and have a higher self-discharge rate than alkaline. These should be considered only if alkaline batteries are not available.

Oxyride batteries from Panasonic® are relatively new at a small price premium, but are not a good choice for the DF. Their initial voltage of 1.7V per cell is just safe for the DF and they have more available energy than standard alkaline cells for cameras and toys but less at the current drain of typical of DF operation. Further, the low temperature performance is poor.

Nickel-Cadmium and Nickel-Metal hydride batteries are a good choice if the DF is being used often such as for training. NiCd cells up to 1000mAH and NiMh cells to about 2000mAH are available. This is fine as long as they can be readily recharged. The big problem with these batteries is that they self-discharge rapidly, particularly at high temperature, and this leakage usually gets higher with use, particularly if simple chargers are used. The leakage in NiMh batteries can go so high that your DF can be dead after a few hours in a closed car in summer. If you do use these batteries, note that the battery bar on the screen is set for alkaline batteries and will not indicate full scale even with a fully charged battery.

A new type of lithium battery using iron sulfide came to our attention after the DF panels were printed. This one is an exception to the "no lithium" restriction. Currently, the Eveready® L91 is the only one we know to be available and costs $2.50 or more each. These batteries have three advantages: self discharge of 1% per year at 68°F or 15 year shelf life; better than 80% capacity at -10°F; and about 20% greater energy than alkaline batteries when used in the DF. A set of batteries is also about 2 ounces lighter.

DIRECTION FINDING TECHNIQUES

Following is a summary of Direction Finding Techniques. More information can be obtained from our publications LHTM-1, "Air and Ground Direction Finding," LHTM-2, "Locating Non-distress ELTs and EPIRBs," and LHTM-3, "Basic ELT Location Course." All techniques used by the L-Tronics® LH Series Little L-Per® Direction Finders is applicable to the LL Series.

A key to the efficiency of the L-Per® is its ability to evaluate the quality of the bearings obtained. Beware of reflections; it is impossible in a practical sense to obtain bearings from some locations. The L-Per® will tell you quickly when this situation exists so a new site can be selected. Further, bearings of low quality can be identified and taken into account when conflicts occur in a triangulation problem.

We strongly recommend that you do initial practice with the DF in an open, clear area and then around buildings or other obstructions to become familiar with its operation with a known target before trying an unknown. A practice ELT fitted with a dummy load in place of its regular antenna will provide weak signal simulation practice in walking range.

DETERMINING BEARING RELIABILITY

Reliability Circle

In the DF mode, turn in the direction the bar indicates until it nearly disappears or points equally left and right. You are facing the signal source. Now slowly turn in a full circle to the right while holding the DF in the operating position and watching the display. The bar should darken to the left, center at approximately opposite the ELT, darken on the right side, then center when you are again facing the signal source.

If the bar centers twice, about 180 degrees apart, the location is good and the bearing will be accurate. If it centers more than twice, or twice but less than 120 degrees apart, it is not a good location and bearings won't be accurate. Choose a better location for DF.

Walking a Baseline

After performing the reliability check as described above and finding a good location, check for the existence and severity of reflections. You might, by good luck, have chosen a spot that may initially shows good bearing reliability but is really not.

In the DF mode, center the bar and walk a straight line for 10 to 20 feet WHILE CONTINUOUSLY OBSERVING THE INDICATED DIRECTION. If no significant reflections are present, the indicated direction will remain steady to within five degrees.

As reflected signals become prominent, the indicated direction will oscillate back and forth every four or five feet. A good estimate of the true direction of the signal can be made by taking an "eyeball average" of these variations while walking a baseline of up to 50 feet. Fluctuations of more than 60 degrees each direction indicates a very poor DF site.

RADIO SIGNAL PROPAGATION

There are three characteristics of any radio signal that MUST be understood to locate the transmitter. They are:

1. Unimpeded, radio signals travel in a straight line. This principle is responsible for satellites being able to hear an ELT even though objects on the ground prevent it from being heard there.
2. Signals get stronger near the source. The further away from the signal source, the weaker the signal is if it isn't blocked. In addition, the RATE OF CHANGE in signal strength is faster as you get closer. Different conditions can influence *absolute* signal strength but usually don't affect the *rate of change.* This makes rate of change a more reliable indication of how close you are to the transmitter than any given strength reading.
3. Conductive objects reflect and/or block the signal. These include metal structures, stucco buildings (chicken-wire mesh), concrete buildings (steel reinforcing bars), chain link fences, buildings with metalized glass sunscreens, mountains, smooth snowfields, and grasslands. These objects are called "reflectors" because they cause the transmitter's signal to bounce off, much the same way a mirror reflects images.

All DF techniques will come back to one or more of these principles.

REFLECTORS

Reflections cause almost off of the problems in transmitter (ELT and EPIRB) location.

Solid conductive objects, like metal buildings and mountains, both reflect and block the signal. Non-solid objects like fences will reflect some of the signal and allow most of it to pass through. Non-conductive objects act much the same way as the metal fence. The L-Per®'s response depends on the reflector's location. You'll have different results with a reflector near the transmitter, one near the receiver, and one between the ELT and the L-Per®.

Reflectors Near The Transmitter

A reflector near the transmitter can affect your ability to hear the signal, but usually causes no problem in tracking once the signal direct from the transmitter can be heard.

If the ELT is next to a metal building, most of the signal will reflect or "bounce off" the building rather than go through it. The signal will be difficult to hear and track when you are in a location that places the building between you and the ELT. If you can hear the ELT, the L-Per® will give good directional information because both the direct and reflected signal are coming from the same direction.

Reflectors Near The Receiver

A reflector near the receiver can cause severe problems for the L-Per®, but once recognized, can usually be avoided.

A reflector within about 200 feet of the L-Per® will cause it to see both the direct and reflected signal, but each will be from a different direction. However, the signal direct from the ELT will be stronger than a reflected signal and the L-Per® will prefer the stronger, direct one.

Reflected signals always lose power. They will be weaker than the direct signal from the ELT if – and this is the biggest if – nothing is blocking the direct signal.

Blocked Signal, Single Reflector

Reflections are not much of a problem in ELT location UNLESS the direct signal from the ELT is blocked. When blockage occurs, the direction finder will "see" all of the reflections, which will vary in strength and direction.

In some cases where the signal is blocked, the solution to the problem is rather straightforward. If the L-Per® hears a reflected signal from only one direction, it will track the reflection until it can hear the direct signal. Once it does, direction to the ELT will be obvious and it will give you a heading to the stronger, direct signal.

Blocked Signal, Multiple Reflectors

Multiple reflections coming from the same general direction when the direct signal is blocked will cause much the same results as a single reflector. The L-Per® will follow the reflections until it hears the stronger, direct signal then will track the ELT.

As you walk while tracking the reflections, you may notice the apparent direction swings back and forth, but you'll be walking a line that represents an average of the directions to the reflections.

Resolving Multiple Reflections

If your initial bearings on an airport ramp look like you will be working among multiple reflections, such as a group of hangars, you should expect the L-Per® to have difficulty averaging directional information when among the buildings. There are a couple of ways to recognize and deal with this problem.

To evaluate the severity of reflections, make a 360-degree reliability turn while observing the DF display. If you get multiple centerings as you turn, you are in an area of reflectors. Next, walk 15 or 20 feet and keep the bar centered by moving the receiver back and forth. Take a step, swing the receiver to center the display, take another step, center the bar, take another step, center, etc. If you have to swing the receiver in an arc of more than 120 degrees, you have reflections coming from all directions and the DF will not be usable.

If your swings are less than 120 degrees, you can continue walking in a direction that is an average of the headings of the swings. This is not a precise method of DFing, but it will keep you moving in the right direction.

When reflections are coming from many directions or all sides of the L-Per®, the combined directional information will be very confusing to it. The best procedure is to get out of the area. Move 200 feet or more away from the reflectors and walk completely around them if possible. The L-Per® will give good directional information from all sides, even though the direct signal may be blocked from certain angles. This will give you a clearer picture of the area of highest probability before

you have to search among the buildings. You can often isolate a single suspect building from this "standoff" position.

Now you will have a better idea of where to start your close-in search. DF mode may not work in this area; if it doesn't, use the "build and fade" method using the strength indications.

Direction Finding Inside a Building

Direction indications is often not useful inside a building because of so many reflections near the receiver. If there are a number of aircraft inside, it is often faster to rely only on strength readings. *Strength response is not directional in DF mode.* Use DF mode while walking about a hanger or rooms in a building, looking for changes in strength reading. The Model LL L-Per® has enough strength range that offset tuning or external small antennas are unnecessary.

As you walk around the building, watch the strength reading. Continue walking in the direction that causes the strength to increase. Ignore small variations of strength five to 10 feet apart.

While you walk, look around for the ELT or a location where it might be, such as a table, locker, flight bag, etc.

Using the L-Per® in the Fore/Aft Mode

When reflections are a real problem, such as among metal buildings or in harbors, you can use the L-Per® in the Fore/Aft mode, just as you would on a vehicle.

Select the DF mode and then, instead of holding the unit in front of you at eye level, hold it off your right shoulder so you have to turn your head to the right to see the display. The left end of the DF (with the arrows) is facing forward. As you walk holding the receiver in this position, watch the left-right bar and keep the bar pointing to the left side. As long as the bar is on the left side of center, you are walking toward the signal source. If the bar is on the right side of center, you are walking away from the ELT.

Horizontal Polarization

The LL Series Direction Finder works best with transmitters that have vertically polarized antennas. The most accurate bearings are obtained when the antennas on the transmitter and receiver are the same polarization. If the ELT is lying on its side and transmitting a signal that is horizontally polarized, the result can act as a barrier in the direct path and emphasize the reflections.

If holding the L-Per® horizontally overhead shows a strength increase of 20 counts or more, the signal is horizontally polarized. While not convenient, the L-Per® can be held overhead in a horizontal position and worked in the "fore/aft" mode as just described.