How and Why to ELT

Despite their controversy, emergency-locator transmitters now make sense for most pilots.

BY KEN ARMSTRONG

Beginning in the early 1970s, the U.S. Congress stepped in where the FAA feared to tread, legislating the installation of emergency-locator transmitters (ELTs) in most U.S. civil aircraft. A few aircraft are exempt, including single-seaters and those engaged in testing (such as a home-built flying off its FAA-mandated test time). But after reading Ken Armstrong's article, owners of the exempted aircraft may decide to join the majority. —Ed.

Buying an ELT is like buying insurance. Everyone knows he should have the coverage, but nobody wants to spend the money. Indeed, having an ELT on flights is like carrying a form of life insurance. Many readers will resent having to install these units in their aircraft, and others know that the regulating agencies have crammed imperfect models down our throats in the past. Exploding lithium batteries, poorly set (and poorly met) specifications have given low-level entertainment to many would-be users. The fact that ELTs have had serious teething problems has not endeared them to aviation consumers.

These bugaboos have been of two natures: two-thirds of the production ELTs have failed to operate after a crash and only 3% of the activations have been valid. Thirty-three false alarms for every real emergency have cost taxpayers millions of dollars annually to track down the culprits. Unfortunately, the transmission of a false alarm can also cover the often weaker return of a crash-site victim. However, these deficiencies are slowly being corrected and the merits of these transmitters are becoming obvious.

Personally, my feelings have switched from doubt to a strong belief in these devices. Having flown as a military search-and-rescue pilot gives me a vantage point from which to see clearly the various points of view. When flying in mountainous or forested areas, it is possible to take off, fly a few minutes, crash and be hidden in impenetrable bush.

Without a functioning ELT, the likelihood of survivors being rescued is remote. For those who dislike carrying one of these two- or three-pound deadweights, let me ask you a question. How much is your life worth? The question made me realize that the $500 investment was infinitesimal compared to any human life!

OK, now that we have established the fact that these items can be, and are, lifesavers, let's look at the technicalities.

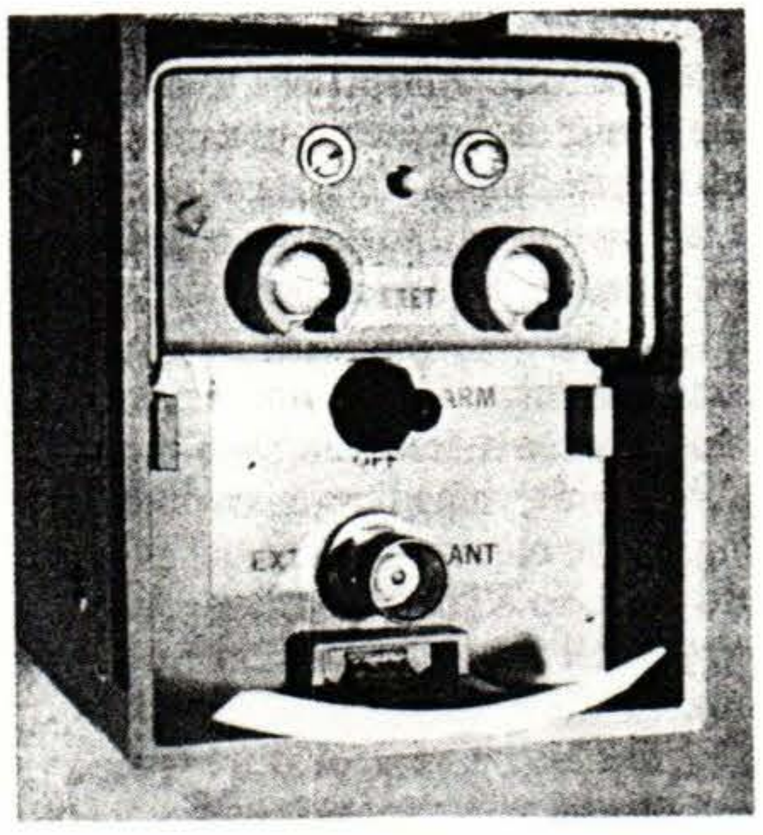
A few years ago, Canada, France, Russia and the USA produced satellite-borne equipment capable of receiving the emergency signal and retransmitting data to the ground-based Local User Terminal. The LUT equipment measures the doppler-shift and, through the magic of electronics, calculates the location of the downed aircraft. Now that the Search and Rescue Satellite-Aided Tracing system (SARSAT) is orbiting the earth on a 24-hour basis, and given the fact that they cover the entire surface of the globe, it is unlikely that an ELT signal will not be detected. While this leads to even more "cries of wolf," it has also saved many more lives. This constant coverage results in signals being detected much more quickly and with greater accuracy. The combination ensures that rescue occurs as soon as possible, thereby reducing injuries and loss of life. To date, SARSAT has saved about 700 lives.

Essentially, the chain of events that would occur in an actual event are as follows. During the preflight inspection, the pilot inspects the ELT's general condition and ensures that the three-way switch is in the armed position. The other positions are *on* (this turns the transmitter on, thus sending out an emergency signal), and *off* (this disarms the unit so that it will not transmit even after a crash). By resetting the g switch and selecting the *arm* mode, the circuit to the g switch is activated. During the deceleration forces of an impact (usually 5 g or more), the transmitter will be triggered on. It will then transmit an attention-getting warbling (undulating) tone on VHF frequency 121.5 and the double of this, namely 243.0, on the UHF hidden in impenetrable brush. SARSAT frequency of 406 MHz also will be used to transmit the aircraft's registration during activation—so it pays to develop good habits to avoid future embarrassment.

The emergency signal is received by the SARSAT satellite retransmitted to the LUT, and a message is passed on to the USAF Aerospace Rescue and Recovery Service (AARS) in mainland USA, or in Canada to the CAF Search and Rescue center.

Most high-flying aircraft also monitor the emergency frequencies with the result that your plea for help

Here's the business end of a typical emergency locator transmitter (ELT). Note the antenna connector and arm/reset switch.



might be received and relayed immediately. In the worst case, if one of the four orbiting stations has just flown over the horizon, you will have to wait up to 90 minutes before the signal is picked up by another satellite. Flight Service Stations also will conduct a radio search on various frequencies when an aircraft is overdue or if the FSS receives an ELT signal.

If these attempts at radio communications are unable to determine the cause of the signal, and if an aircraft is overdue on a flight plan by 30 minutes or more, the search-and-rescue aircraft are alerted. If you are not on a flight plan and therefore are not deemed to be overdue, the search won't be started until much, much later. . . .

Obviously, it pays to flight-plan! With the high SARSAT accuracy available, it is only a matter of listening for and visually signalling the arriving rescue team when they fly over. If you are physically able, this can include laying out signal panels, using a signal mirror, use of a transmitter on 121.5 or 243.0 MHz (if safe and available). Also, you might use a signal flare or build a smudge/smoke fire. However, be aware of a possible forest fire hazard. It makes no sense to survive a prang, only to perish in a raging fire.

Recently, the American Radio Technical Commission for Aeronautics formulated a new set of specifications, C91a, that will improve reliability in crashes and also reduce the number of false alarms. This is achieved with improved g switches that would be tuned to more realistic impact forces, and a cockpit monitor that would indicate visually and aurally that the ELT is transmitting. Additionally, the units are being beefed-up to withstand impact forces and environmental considerations.

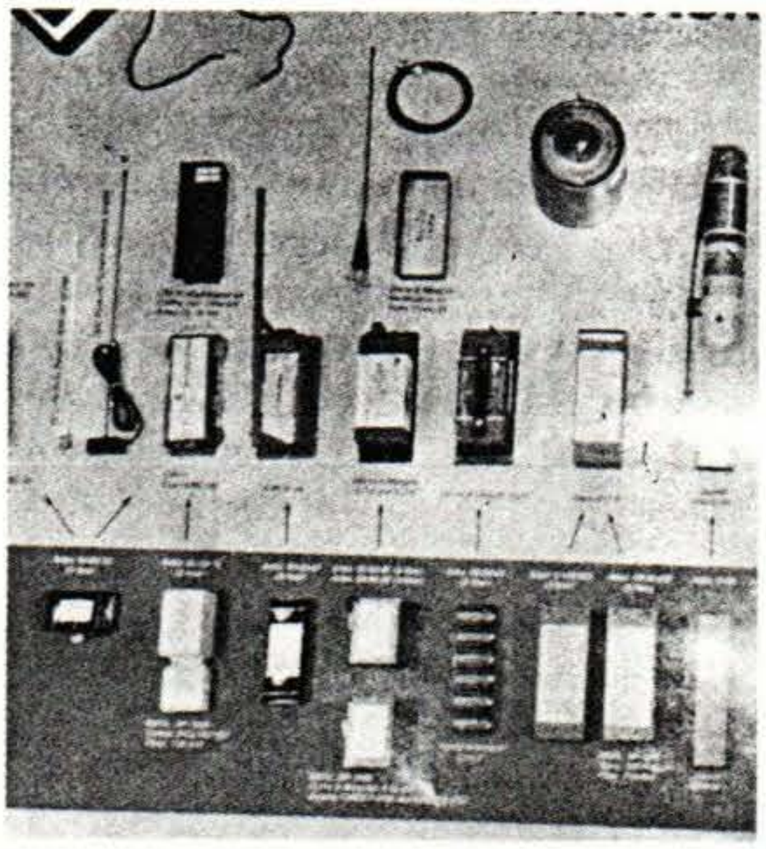
One of the major changes that could occur in the future would be the use of the 406 Mhz frequency. Due to the higher stability of the signal, crash-location accuracy could be improved more than 500%. This would result in the orbiting satellite giving an area of probability of one to three miles in radius. It is necessary to point out that this frequency does have limitations and may therefore not be used in future plans. Also, keep in mind that these new TSO specs are not yet mandatory. It is hoped that the bugs will be worked out of the system this time before the equipment becomes mandatory. Officials are also looking at lower-cost crash position indicators that would be ejected automatically from the aircraft on impact. Unfortunately, these units currently cost tens of thousands of dollars.

Optimizing Your Emergency Transmissions

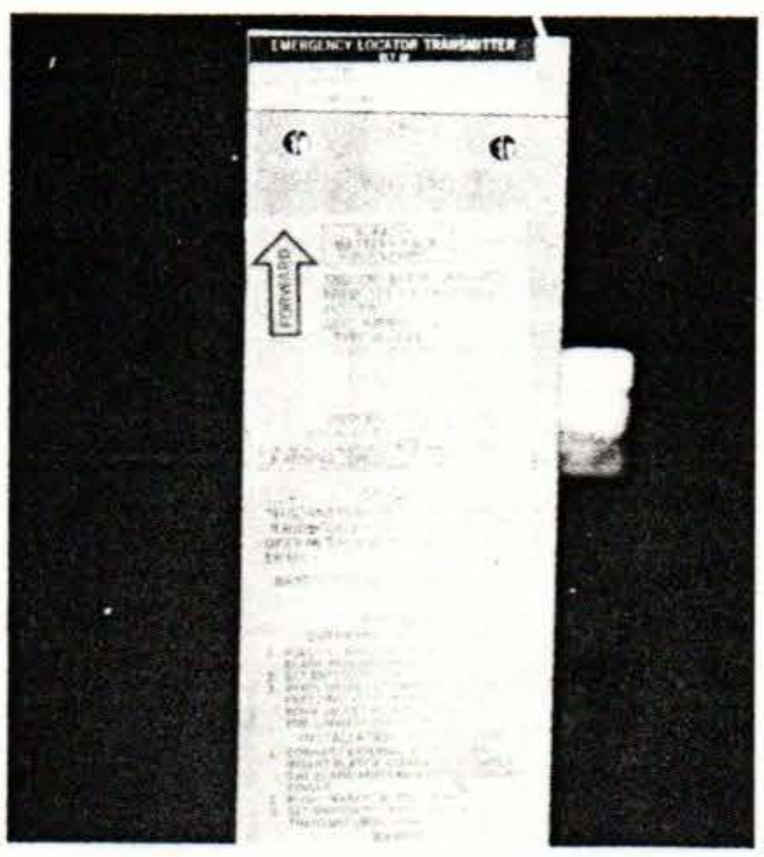
While this article lacks the scope to cover all survival considerations, we will look at how to use your ELT most effectively. As a post-accident fire could destroy the aircraft, it is generally wise to remove the ELT and portable antenna from the wreckage. To do so, turn the master switch to *off* and disconnect the antenna cable that goes to the fuselage mounted antenna. Then connect the telescopic antenna that should be attached to the unit, extending it to full length, and turn the master switch to *on*.

If the aircraft fuel cells are not ruptured, and you have no cause to suspect fire, you could perhaps turn on the navcom and listen to 121.5 to confirm that the transmitter is working. Don't be alarmed if you hear the signal on other frequencies as well. The power of the ELT and its proximity to the VHF results in the communications receiver being saturated on all channels. As VHF and UHF frequencies have line-of-sight transmission capability (they will be blocked or weakened by overhanging forest or hill features), it would be wise to find an unobstructed elevation to locate the transmitter. However, don't wander far from the aircraft as it will make finding you more difficult for the rescue crew.

Battery replacement has been a big problem for ELT owners; lack of industry standardization has resulted in too many types.



Units like this Narco ELT 10 contain instructions for removal from a downed aircraft to improve signals or for portable use.



A physical property of transmitting antennae is that they like to have a *ground plane* below the whip to reflect the maximum signal. As a result, you could set the unit on the ground on a two-foot-square (or larger) piece of metal from the wreckage or on a flat rock to enhance range. The swept-tone signal can be received by rescue aircraft up to 100 miles away. However, if the transmitter is left in the wreckage, tied to a tree or held aloft by a crew member, the range will be reduced significantly.

To transmit in all directions equally, ensure the unit is kept upright and do not turn the unit off at night or during inclement weather. Battery life may be 80 hours at 50°F but only 10 hours at minus 40°F. As a result, during cold weather, keep the ELT at or near body temperature by placing it next to the body or another heat source.

Do not turn the unit off until you have been rescued. The search aircraft may have to fly over your location a number of times to fix your exact position electronically and a few more times to actually locate you for the rescue team they will drop. If you have one of the old models that have voice modulation, giving you the capability to talk to an overhead aircraft, now is the time to talk. However, do not use the voice capability at any other time as battery life is shortened considerably (to perhaps as little as one hour with voice modulation). Of course, if you are able, signal the overflying aircraft with whatever means is possible. Signal mirrors, controlled smokey fires or colorful panels laid in a clearing are very easily spotted. Do not fire pyrotechnic devices at or in front of the rescuing aircraft. Many of us have nearly been shot down on a number of occasions by errant phosphorus flares—or was it the panicky aim?

Before You Buy

While purchase prices vary from $300 U.S. to more than $3000, you must also consider the maintenance and "power-plant" costs. By law, the battery must be replaced every three years. However, it is not uncommon for alkaline units to last only 18 to 24 months. Also, annual inspections will add approximately $25 to your expenses.

Readers should also be aware that many of your local avionics shops are not qualified to conduct all of the specified tests. (Because of this, Pointer insists that its units be returned to its authorized centers for recertification at a nominal charge.) Annual checks should include: frequency accuracy, g-switch parameters, modulation, output power and current drain. An ELT service technician told me that 50% to 60% of the units that came in for the annual inspection failed to meet at least one of the test parameters—usually due to attempted, unauthorized "field repairs" or component failures.

Additional problems occur when service personnel in local shops replace factory batteries with other companies' batteries. This is *verboten* in DOT's paper on the topic. For this reason DOT has stated in its NAMEO No. 12/86 that the antenna, cable and batteries must be approved by the manufacturer. Batteries must also be replaced if they are used in an emergency, activated for more than one hour or a period of unknown duration. Be sure your ELT batteries are in excellent condition. Otherwise it would be similar to having an insurance policy that isn't paid up—no coverage!

Appendix A
ELT Manufacturers

Pointer Inc.
USA: 1453 Alameda Drive, Tempe, AZ 85282; (602) 966-1674.
Canada: 1235 Shawson Drive, Unit 11B, Mississauga, Ontario, L4W 1C4; (416) 678-1600.

Narco Avionics Inc.
270 Commerce Drive, Fort Washington, PA 19034; (215) 643-2900.

Dorne & Margolin
2950 Veterans Memorial Highway, Bohemia, NY 11716; (516) 585-4000.

Emergency Beacon Corp.
15 River Street, New Rochelle, NY 10801; (914) 235-9400.

ARNAV Systems Inc.
16100 S.W. 72nd Ave., Portland, OR 97223; (503) 684-1600.

Leigh Instruments Ltd.
2680 Queensview Drive, Ottawa, Ontario, Canada K2B 8J9; (613) 820-9720.

Dayton-Granger
3299 S.W. Ninth Ave., Fort Lauderdale, FL 33315; (305) 463-3451.

Garrett
Canada: 255 Attwell Dr., Rexdale, Ontario, Canada M9W 5B8; (416) 675-1411.

Technisonic
Canada: (416) 276-8313

My Recommendation

Among the lowest price and highest standards, the Pointer Models 3000 and now 4000 are a best buy. I'm joined by Bell, MBB and de Havilland Aircraft, to name a few who outfit their aircraft with these units. The use of magnesium cells results in a three-year battery life and a lifetime warranty on the transmitter. Now that's standing behind your product. Also, the signal output is very crisp and free of distortion—very important when your life may hang in the balance. The unit includes the Rolamite inertia g switch pioneered by Pointer, a remote/portable antenna and a quick-release mounting bracket. A second choice would be Narco's ELT 10: a very good signal at moderate cost.

Since all units meet at least the minimum standard, Appendix A is included as a list of approved units. Researching this topic and studying the statistics has convinced me to carry an ELT. How about you? This is insurance that could prevent you from being late for lunch some day and/or save your family considerable grief. □

MH	DEV	CH	MH	DEV	CH	MH	DEV	CH
030	+1	031	150	−5	145	270	−4	266
060	0	060	180	−6	174	300	−2	298
090	−2	088	210	−5	205	330	−1	329
120	−3	117	240	−5	235	360	+3	363

Figure 1.

flaps for best trim at top speed, may have a wide variance in the error, partly due to pitot-tube angle of attack.

Some of the error may be corrected. In fact, all error may be eliminated in some cases by changing the angle of attack of the pitot tube after the calibration run and recalibrating ... if one wanted to go to all that trouble. From your pilot training you may remember the terms IAS, CAS and TAS. IAS (indicated air speed) is what the instrument says, CAS (calibrated airspeed) is IAS corrected for instrument/pitot error and of course TAS (true airspeed) is CAS corrected for altitude and temperature.

Compass Swing

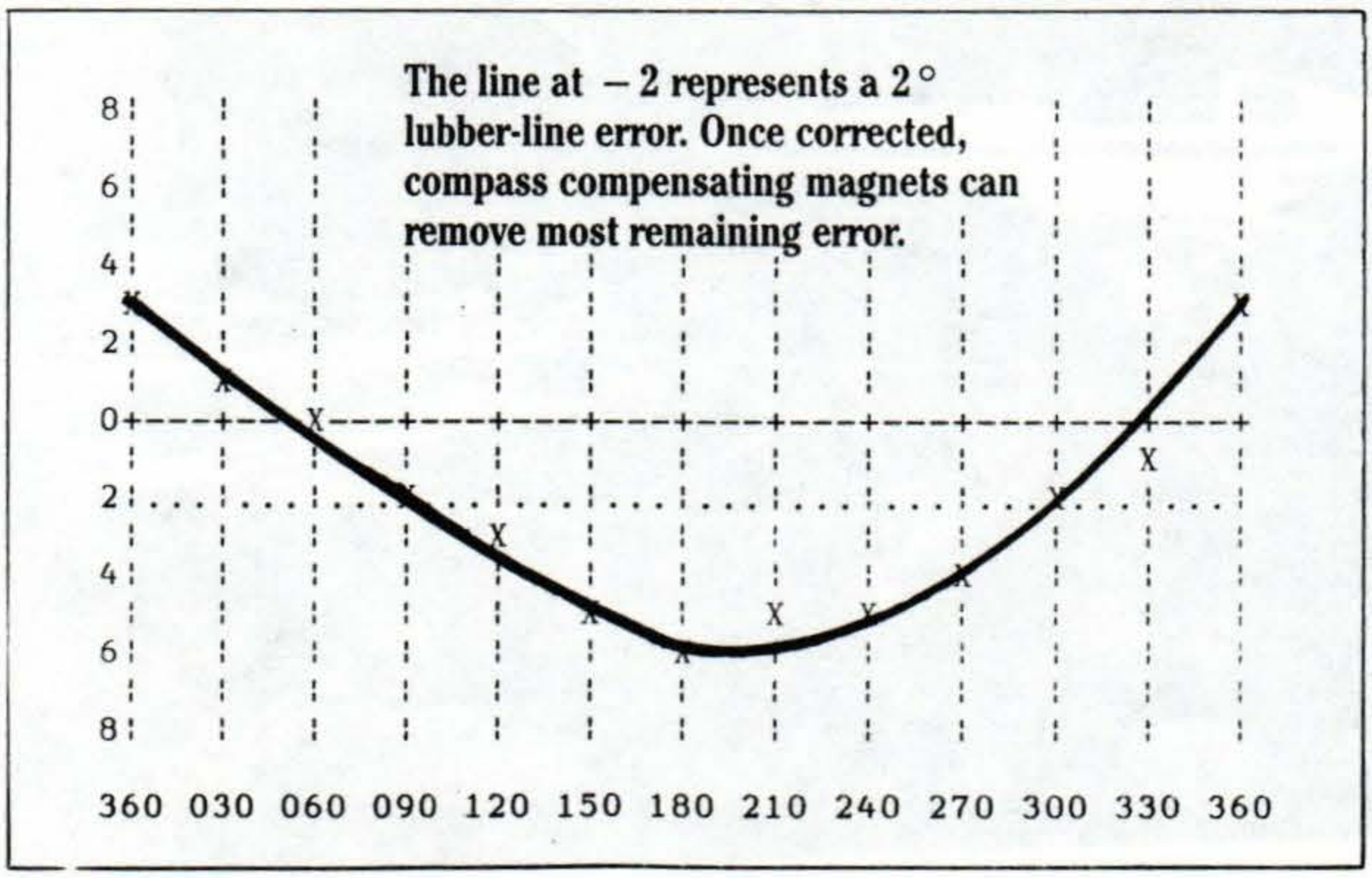
To swing the compass, the airfield must have a compass rose. These vary somewhat from airport to airport, but most of the bigger airports have one. I once swung the compass on my Long-EZ at Van Nuys, California. That's the fanciest one I ever saw. It had a turntable in the center for one maingear so you could change heading easily. Wouldn't you know my Long-EZ would fall on its tail with the nosegear extended. No one was in the front seat and I was alone.

Most pilots are happy with measuring deviation every 30°, but as an ex-Air Force navigator, I want it every 15°. Your choice!

The compass should not be mounted with steel screws, nuts or washers. New units are usually furnished with beryllium copper brass or stainless steel hardware. Unless you were very careful about mounting your compass, you may have a lubber line error (fore and aft line of compass not parallel to centerline of aircraft). Any lubber line error will become known after the compass swing is completed.

To swing the compass, proceed as follows. With the aircraft parked facing north or south, read the compass. Turn the master switch and, one by one, all your electric-powered goodies. Note any change in readings. If there are any changes, most likely with instrument lights or with alternator switched on and engine running, try to eliminate the cause. Deviation caused by instrument lights can be removed by twisting the two wires to the light(s). Repeat this step with the aircraft facing east or west. Correct as much electrical-or magnetic material-induced deviation as you can.

Figure 2. Plot of compass errors.



Pick a calm day, or at least one with light wind. Place the airplane on the compass rose with the centerline of the plane parallel to the north-south line on the rose. Tap on the compass to overcome the tendency of the compass bearings to stick (usually required on vertical card compasses) and read the compass. For the greatest accuracy, a plumb bob may be used to ensure that the airplane is parallel to the compass rose.

Make a table with the headings as shown in Figure 1 and record the compass headings. Repeat for every 30° through 330°. Subtract the magnetic headings from the compass headings to find deviation. Record the deviation as plus or minus on the deviation chart as shown in Figure 2. Connect the points with a smooth line missing points as necessry to smooth the line. Read the smoothed-out deviations and add all the deviations algebraically. If the answer is not zero, there is a lubber-line error. The lubber-line error is equal to the sum of the errors divided by number of headings.

If a lubber-line error exists, correct the mounting and repeat the swing. With no lubber-line error, two courses are open: 1. Plot the results on a graph, smooth the curve and fill out your compass correction card. 2. Correct the errors and discard your deviation card.

Sometimes the second choice cannot be completely accomplished but more often than not, the deviation on all headings can be made to be less than the pilot's steering error. With the airplane on a north heading, turn the north/south adjusting screw with a non-magnetic screwdriver (brass or stainless steel) to remove half of the north deviation, or if the north deviation is different in amplitude from the south deviation, remove half of the average amount of the two. Repeat this with the airplane on an east heading, averaging the amount of the deviations on the east and west headings and using the east/west adjusting screw and non-magnetic screwdriver. A repeat of the original compass swing should now result in little or no deviation, depending on the amount of uncompensated magnetic influences.

To me, instruments that don't read right are like folks who don't tell the truth. I have no use for either. I hope this will help you make truth-tellers out of your instruments. □