AC 91-44A

DATE 12/12/80

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

Subject: OPERATIONAL AND MAINTENANCE PRACTICES FOR EMERGENCY LOCATOR TRANSMITTERS AND RECEIVERS

1. PURPOSE. This advisory circular (AC) combines and updates the material in several AC's on the subject of emergency locator transmitters (ELT) and receivers for airborne service.

2. CANCELLATIONS.

a. AC 20-81, Accidental or Unauthorized Activation of Emergency Locator Transmitters (ELT), dated October 10, 1972, is canceled.

b. AC 20-85, Emergency Locator Transmitters and Receivers, dated March 16, 1973, is canceled.

c. AC 20-87, Airborne Homing and Alerting Equipment for Use With Emergency Locator Transmitters, dated May 7, 1973, is canceled.

d. AC 20-91, Lithium Batteries Used in Emergency Locator Transmitters, dated April 11, 1975, is canceled.

e. AC 91-44, Emergency Locator Transmitters Operational and Maintenance Practices, dated February 20, 1976, is canceled.

3. RELATED FEDERAL AVIATION REGULATIONS. Sections 91.52 ,121.339 and 43.13 of the FAR.

4. RELATED READING MATERIAL. Technical Standard Order TSO-C91; Radio Technical Commission for Aeronautics (RTCA) Document No. DO-168, Minimum Performance Standards--Emergency Locator Transmitters, and DO-154, Recommended Basic Characteristics for Airborne Homing and Alerting Equipment for use with ELTs. All RTCA documents may be obtained from: RTCA Secretariat, Suite 665, 1717 H Street NW., Washington, DC 20006.

Initiated by: AWS-130

5. BACKGROUND.

a. On December 29, 1970, Congress amended the Federal Aviation Act of 1958 to require the installation of an ELT on most civil airplanes of U.S. registry. The Federal Aviation Administration (FAA) implemented the new statute by adopting two new Federal Aviation Regulations (FAR), Sections 91.52 and 37.200 (TSO-C91). Section 91.52 prohibits, with certain exceptions, the operation of a U.S. registered civil airplane unless it is equipped with an ELT meeting the performance standards specified in TSO-C91.

b. Any accidental or unauthorized activation of an ELT will generate an emergency signal that cannot be distinguished from that of an actual emergency and could lead to expensive and frustrating searches. Moreover, the unwarranted ELT signal could tie up the emergency frequencies such that a genuine emergency signal would not be picked up. If this ELT signal is transmitted on or near an airport, it may, in addition, render some radio communications channels useless.

c. The Federal Communications Commission (FCC) regulations specify authorized ELT operations, and it should be noted that portable ELTs approved for aircraft service are not for use when "backpacking," i.e., recreational or wilderness exploration on foot.

6. DEFINITIONS AND GENERAL OPERATIONAL CHARACTERISTICS OF ELTS. Two general types of ELTs are currently in use. Those aircraft operating primarily over land areas will most likely be equipped with an ELT radiating, when activated manually or by impact, a peak effective power of at least 75 milliwatts. This ELT may be attached to the aircraft structure or it may be portable. For operations over water, the ELT is required to be type S which must have 225 milliwatts of power output since its antenna would be only a few inches above the water and may often be below the crest of waves. There is no requirement for an inertial impact switch in these ELTs since they are usually activated manually or by water penetration into the ELT battery.

a. Inertial Activation. To meet the "g" force requirements of TSO-C91, automatic fixed-type inertially activated ELT's (except overwater type) must activate at any inertial force, parallel to the longitudinal axis of the aircraft when installed in accordance with the manufacturer's instructions, of 5(+2, -0)g and greater for a time duration of 11(+5, -0) milliseconds or longer. However, many inadvertent activations have been caused by inertial switches actuating in other directions. Experience has shown that automatic fixed type ELTs should be attached to the airframe or other solid structure free and clear of cables, pulleys, etc. Attachments to thin

partitions or to panels, such as the sides of baggage compartments, are susceptible to natural vibrations which may undesirably exceed the inertial force of the impact switch lower limits. Attachment solely by means of Velcro strips and other flexible materials is not considered satisfactory since the "g" switches may fail to operate or the equipment may come out of its mounting resulting in damage to the ELT and possibly causing damage to the antenna or antenna coaxial cable. Permanently mounted ELTs should have their antenna cables attached to the airframe in such a manner as to preclude inadvertent damage by passengers or by baggage, and be as far aft as practicable. For portable type ELTs, the manufacturer's installation instructions should be followed since placement and orientation of the ELT may be critical in order to avoid inadvertent activation. The manufacturer must clearly indicate how the ELT is to be mounted in order to prevent such activations. Except for automatic deployable types, the mounting should be of such design that the ELT cannot be ejected. The manufacturer should also provide cautionary information relative to smaller radiated signal levels when antennas are improperly mounted, especially when inside the aircraft. The antenna should be fully extended and in a vertical position when the airplane is in the normal flight attitude and as close to a window as possible without touching the metal window casing or other metal airplane parts. If the antenna is not enclosed in an insulating sleeve, one may be slipped over the antenna in those areas where the antenna is likely to touch metal if the cockpit area is deformed in a crash. The antenna should be located in the approximate center of the window so that at least 12 inches of the antenna length is exposed to the window. The window should be at least 12 inches high and 12 inches wide to accommodate the antenna. Radio Technical Commission for Aeronautics (RTCA) has published Document No. DO-168, which contains suitable installation precautions to be taken when using alternate means of transmitter activation such as frangible switches and others.

b. Activation Due to Radio Frequency (RF) Susceptibility. A cause of inadvertent activation of ELTs has been attributed to poor RF susceptibility characteristics of the ELT; however, this problem may be limited to only certain designs. TSO-C91 does not require tests for RF susceptibility. Accordingly, it would be advisable for ELT manufacturers to test their products to determine that their ELTs when "Armed" cannot be damaged or activated by a test signal of +23dBm (0.2 watts) directly coupled to the antenna terminals, while the frequency of the test signal is swept over a range of 118 megahertz (MHz) to 1,000 MHz several times. A suitable test procedure appears in RTCA Document DO-168. After installation in an aircraft, the ELT should again be "Armed" and then be tested

to determine that it would not be activated by the RF generated by the switching transients associated with the aircraft communications transmitter. One method is to transmit on all selectable frequencies over the entire transmitter frequency range to determine that there will be no inadvertent activations by these transmissions. ELTs have also been known to activate as a result of other RF interference inherent to certain aircraft, but again it is primarily the result of the design characteristics of the ELT. For this reason, the ELT should be "Armed" and the remainder of the aircraft electronic equipment operated collectively to determine susceptibility. It is recommended that the ELT antenna be as far aft as practicable, but at least 30 inches from other very high frequency (VHF) antennas since the close proximity of the ELT antenna to the other VHF antennas can disrupt normal communication and navigation capabilities aboard the aircraft. All inadvertent activations pose a serious safety hazard and each such incident should be reported to the FAA for its service difficulty program to provide a factual base for corrective action. Any General Aviation District Office will supply a Malfunction or Defect Report Form to report such incidents. The FAA maintains computer records of inflight and other accidental ELT activations and, if the readout shows a developing trend, action will be taken to reverse this trend.

c. Responsibility for Activations. It is important that all aircraft operators and maintenance personnel assume their share of the responsibility for inadvertent activations. The pilot in command of an aircraft equipped with an ELT is responsible for its operation and, prior to engine shutdown at the end of each flight, should tune the VHF receiver to 121.5 MHz and listen for ELT activations. Such activations have been known to occur after hard landings and sometimes as a result of acrobatics in flight. If the ELT has been activated, it should be immediately shut off and the nearest FAA tower or flight service facility should be notified of the action. Maintenance may be required before the ELT is returned to the "Armed" condition. Maintenance personnel are responsible for accidental activation only during the actual period of their work.

7. MAINTENANCE TESTING OF ELTS. Maintenance of ELTs are subject to Part 43 (Maintenance, Preventive Maintenance, Rebuilding, and Alteration) of the FAR and should be included in the required inspections. Since the ELT is a passive device, the status of which is unknown until called upon to perform, it is essential that at least the impact switch operation and the transmitter output be checked during these inspections. Manufacturers instructions should be followed. Testing of an ELT prior to installation or for reasons due to maintenance should be conducted in a screen room or metal enclosure in order to avoid outside radiation by the transmitter. If

conducted outside of a screen room, the transmitter should be connected to a dummy load to limit radiation. This may not always be possible, in which instance it is advisable to conduct the tests only within the first 5 minutes after any hour. The tests should permit only three sweeps of the audio modulation of the transmitter. A VHF receiver tuned to 121.5 MHz should be used to monitor the tests. If the tests are conducted other than during the first 5 minutes of the hour, they should be coordinated with the nearest FAA tower or Flight Service Station. Subsequent to installation and maintenance, a functional test should be performed in concurrence with the method stated above. Ground crews which move aircraft should subsequently monitor 121.5 MHz and immediately shut off any ELT which has been inadvertently activated.

8. BATTERIES.

a. Battery Replacement. Manufacturers of ELTs are required to mark the expiration date of the battery, based on 50 percent of the useful life (or for rechargeable batteries at 50 percent of their useful life of charge) on the outside of the transmitter. Batteries are required to be changed on that date or when the transmitter has been in use for more than 1 cumulative hour. The date stamped on the replacement battery must also serve as the new expiration date marked on the outside of the ELT. Batteries subjected to long periods of high temperatures, such as ramp areas in the arid Southwest, may require replacement sooner than indicated by the date marked on the battery case. During battery replacement, attention should be directed to conditions which may affect the functional operation of the ELT (i.e., corrosion, moisture) which may prevent the ELT from meeting minimal standards. The replacement can be done by the pilot if the preventive maintenance limitations of Part 43.3(h) of the FAR, are complied with. For example, a portable type ELT that is readily accessible and can be removed and reinstalled in the aircraft by a simple operation should be considered preventive maintenance. Fixed type ELT installations are often permanently mounted in a remote area of the aircraft near flight control cables, vital aircraft components and critical attachments to the aircraft structure. Installations of this nature require an external antenna and often a remote on/off transmitter control switch that is usually located near the pilot's flight position. This type installation is complex and battery replacement should be accomplished by a certificated mechanic or certificated repair station. Replacement batteries should be approved (normally under TSO-C91) for the specific model of ELT and the installation performed in accordance with Section 43.13 of the FAR. When replacing a lithium battery with another battery type appropriate precautions associated with difference in voltage characteristics may apply. For

example, one maufacturer's ELT, if not retuned, may transmit excessively on frequencies not assigned to it and thereby could interfere with the aircraft's voice communications or navigation equipment. Any replacement of the battery requires that an entry be made in the maintenance record. It would be helpful to also enter the battery expiration date since there may be a loss of the date due to corrosion. If maintenance personnel find that the battery date is about to expire during routine maintenance, an annual, or 100-hour inspection, they should notify the owner or operator of this condition. Water activated batteries, which furnish power for stowable or survival type ELTs used on overwater flights, have virtually unlimited shelf life. They are not usually marked with an expiration date. They must be replaced after activation regardless of how long they were in service. Discarded lithium batteries in quantities in excess of approximately 1 kilogram, may leak toxic chemicals into the soil in hazardous amounts. The batteries are also flammable when crushed, and they have been known to cause fires in garbage trucks and at landfill sites.

b. Lithium Battery Problems. Lithium sulphur dioxide batteries have been known to vent violently and occasionally explode. This has resulted in an FAA/industry effort during 1979 to develop performance standards for safer batteries. During that time, several successive airworthiness directives required removal of such batteries pending the manufacture of a sufficient supply of batteries meeting the standards of the new Technical Standard Order. Some ELT manufacturers are now using other types of batteries such as magnesium and alkaline. In some instances, the aircraft owner may be unable to obtain a suitable battery, particularly if the ELT manufacturer is no longer in business. This may necessitate the purchase of a new ELT for which the newer types of batteries are available. The flight crew should be aware that the newer TSO approved batteries (TSO-C97) may emit undesired gases and odors (sulfurous compounds, SO_2) although the venting is controlled to preclude explosions. At the first indication of battery venting, the cabin area should be ventilated to the maximum extent possible. The SO_2 gas emitted by any Lithium battery can combine with various polymers or residual soldering resins of the ELT and form a sulfurous compound which is believed to be a relatively clear liquid and is non-corrosive. However, upon combination with humidity in the ambient air, these sulfurous compounds form highly corrosive sulfurous acid (H_2SO_3), which can cause corrosion in the ELT. ELT corrosion has been confirmed in ELT's to be the cause of inadvertent activations, battery shorting, and inertia switch malfunctions. SO_2 corrosion is a recurrent problem, and may surface weeks or even months after battery replacement. Owners of lithium powered, or what were lithium powered ELT's, in which the electronic components share the same compartment as the

battery are, therefore, advised 1) against lithium battery retrofit unless non-emission of SO_2 can be guaranteed and 2) against any type of battery replacement until an inspection for corrosion has been conducted.

9. OPERATION OF ELTS DURING MANUFACTURING, DEMONSTRATION, AND TRAINING. Emergency locator transmitters used in connection with design, manufacture, demonstration, or testing should not be operated on 121.5 or 243 MHz. These units should be used with offset crystals and operated at frequencies of 121.6, 121.65, 121.7, 121.75, 121.8, 121.85, and 121.9 MHz as provided by Part 87 of the Federal Communications Commission (FCC) rules. The FCC rules also require that all ELT users obtain station and operator licenses. (Reference to the FCC should be made to keep updated with any FCC rule changes). Prior to each operational test period, the test transmission on the selected frequency should be coordinated with the appropriate FAA Regional Frequency Management Office, see Appendix 2 of this advisory circular, to avoid interference with normal communications on these frequencies.

10. AIRBORNE HOMING AND ALERTING EQUIPMENT FOR USE WITH ELTS. Three categories of homing and alerting equipment discussed in RTCA Document DO-154, Recommended Basic Characteristics for Airborne Homing and Alerting Equipment for Use With ELTs, are as follows:

a. Category A. This category is comprised of a homing adaptor for use with an airborne communications receiver to provide steering information for the search aircraft.

b. Category B. This category is comprised of a self-contained airborne receiver operating at the fixed emergency frequencies, which provides alerting signals upon detection of an emergency signal. It also provides steering information.

c. Category C. This category is identical to Category B except that it also provides signal strength indications for "build and fade" search procedures.

11. SEARCH AND RESCUE RESPONSIBILITY. The primary search and rescue responsibility for downed aircraft lies with the U.S. Coast Guard and the U.S. Air Force through the Civil Air Patrol. The FAA has equipped its aircraft, which flight check its ground facilities, with ELT monitor receivers and alerting indicators. The FAA recommends that the pilots of all aircraft monitor the emergency frequencies with any available additional receiver. There is no additional cockpit workload, and monitoring

provides a vital service to the entire aviation community as well as making certain that the aircraft's own ELT has not inadvertently been activated.

12. ALERT AND SEARCH PROCEDURES. The following are suggested actions in the event an ELT signal is heard.

a. Notification. Notify the nearest FAA ground facility stating your position when the signal was first heard and also your position if and when it was lost. You need do nothing more unless requested by the ground facility and then only at your discretion. If you have actually discovered the site of a crash, you may want to circle it to guide rescue teams or you may wish to extend whatever aid is requested. You also may be requested to activate your transponder for a more accurate location or to gain altitude and transmit to assist other ground facilities to obtain a fix on your position.

b. Search Procedures. If your airplane is equipped with a VHF homing system, flying to the source of an ELT signal is simple and the procedures are generally well-known. If not, one of the following methods will assist in locating an ELT.

(1) Build and Fade Using Signal Strength Meter. Not so well-known, but equally effective, are the "build and fade" methods of locating the source of an ELT signal. One method requires a radio receiver equipped with a signal strength meter and the courses to be flown are outlined in Appendix 1, Figure 1 of this advisory circular.

(i) Once the ELT signal is heard, continue your flight on the same course and note how the signal strength meter readings change.

(ii) If the signal strength is increasing, continue on course; if dropping, make a 180° turn and fly back along the same track.

(iii) At some point along the return track, the signal will maximize and then start to drop. Again, make a 180 turn and return to the point of maximum signal strength at which point the ELT is either 90 degrees to the right or to the left of that position.

(iv) Make either a 90° right or left turn and observe the signal strength. If the signal strength diminishes, you have made the wrong choice and must make a 180° turn in order to fly toward the ELT signal source.

(v) Passage over the ELT will be indicated by either a sharp rise immediately followed by a sharp drop or by a complete momentary loss of signal. In some instances, the signal strength may rapidly fluctuate several times before steadying again as the ELT site is passed. These variations depend on the orientation of the ELT antenna after the crash, and any unusual signal strength gyrations usually indicate passage over the ELT. To assist in pinpointing the ELT location, try switching the homing receiver to an adjacent channel if it appears to be overloading because of high sensitivity.

(2) Wing Shadow Method. The wing shadow method is another search method that may be used to locate the general area of an ELT which is useful when the antenna is approximately centered on the top of the wing or located directly opposite on the bottom of the fuselage. This method works best if the aircraft has metal wings, and the use of this method is illustrated in Appendix 1, Figure 2. The pilot must be familiar with the location of his antennas, particularly in dual radio installations, if he is to avoid ambiguity, i.e., which antenna is in the signal shadow cast by the metal wings or fuselage.

(i) On hearing an ELT signal, start a 360° turn to the left at a steep bank angle. At some point in the turn, the receiving antenna will be in the radio shadow of the wings and the ELT signal will be lost. If the receiving antenna is top mounted, the right wing will point in the general direction of the ELT when the signal is lost. If the antenna is bottom mounted, the left wing will point in the general direction of the ELT when the signal is lost.

(ii) By repeating this procedure at locations about 20 miles apart, the general location of the ELT can be determined close enough to justify a concentrated search of the area.

(3) Build and Fade Using Squelch. There is another build and fade method using receiver squelch if the receiver is not equipped with a signal strength meter. This method is illustrated in Appendix 1, Figure 3, and is performed as follows:

(i) When the ELT signal is first heard, adjust the receiver volume control for normal listening. Adjust the squelch control to the point where the squelch cuts off the audio and then back the squelch off to where the audio just cuts back in. Note your position over the ground.

(ii) Continue on course. If the signal from the ELT immediately cuts out, you are flying away from the ELT signal source; in which instance make a 180° turn and fly back along the same track, at which time the signal should return. Continue along the reverse track, sometimes as much as 10 miles, until the signal again cuts out and note your position over the ground.

(iii) Again make a reverse turn and fly back about half way. At that point, the ELT is approximately 90° right or left of your position.

(iv) Make a 90° right or left turn and if the signal again cuts off, you are flying away from the ELT, thereby requiring another 180° turn back toward the transmitter. Again, it may be required that you detune your search receiver if it is sensitive and appears to overload as you approach the ELT.

M. C. Beard
Director of Airworthiness

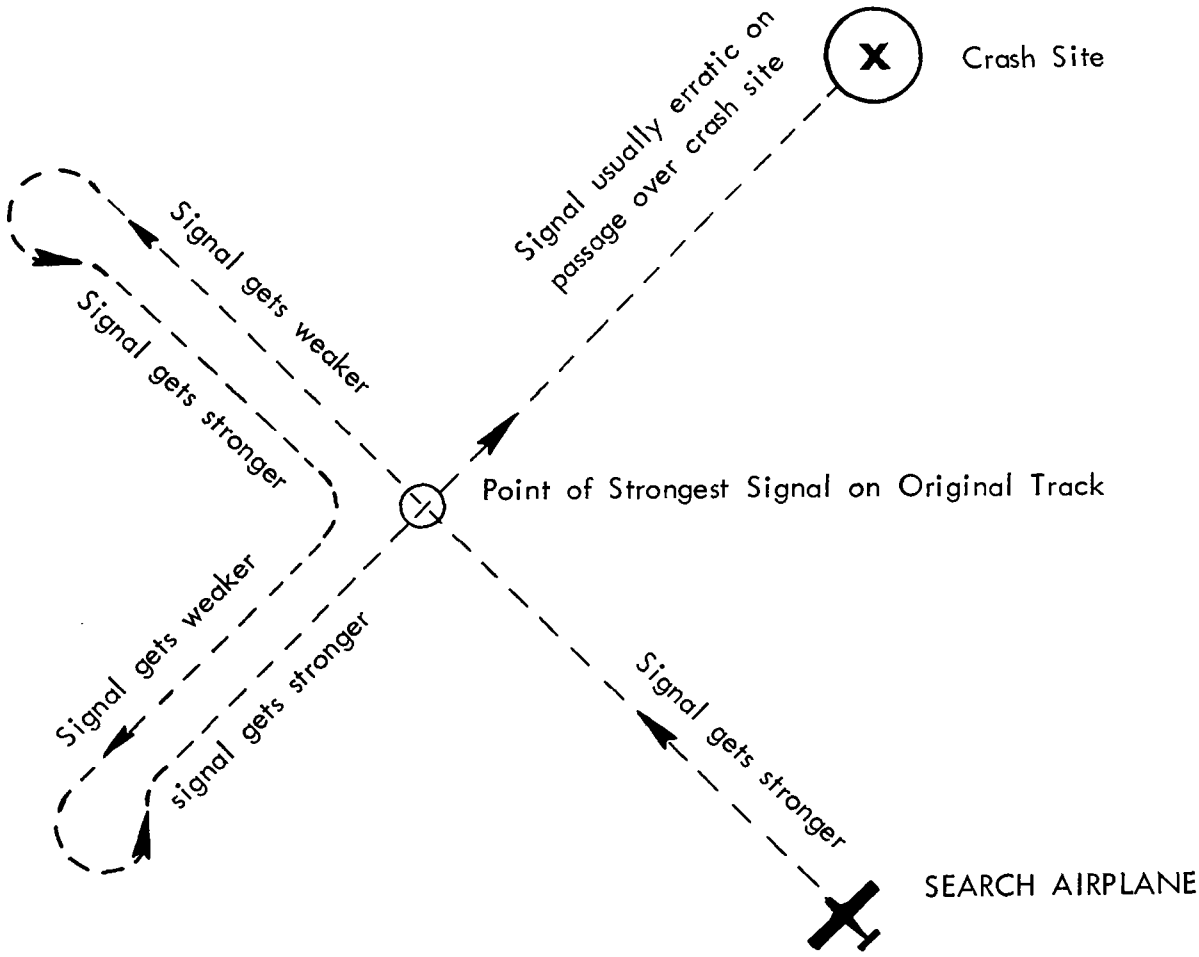

FIGURE 1

FLIGHT PROCEDURE FOR LOCATING ELT USING A
SIGNAL STRENGTH METER, BUILD AND FADE METHOD

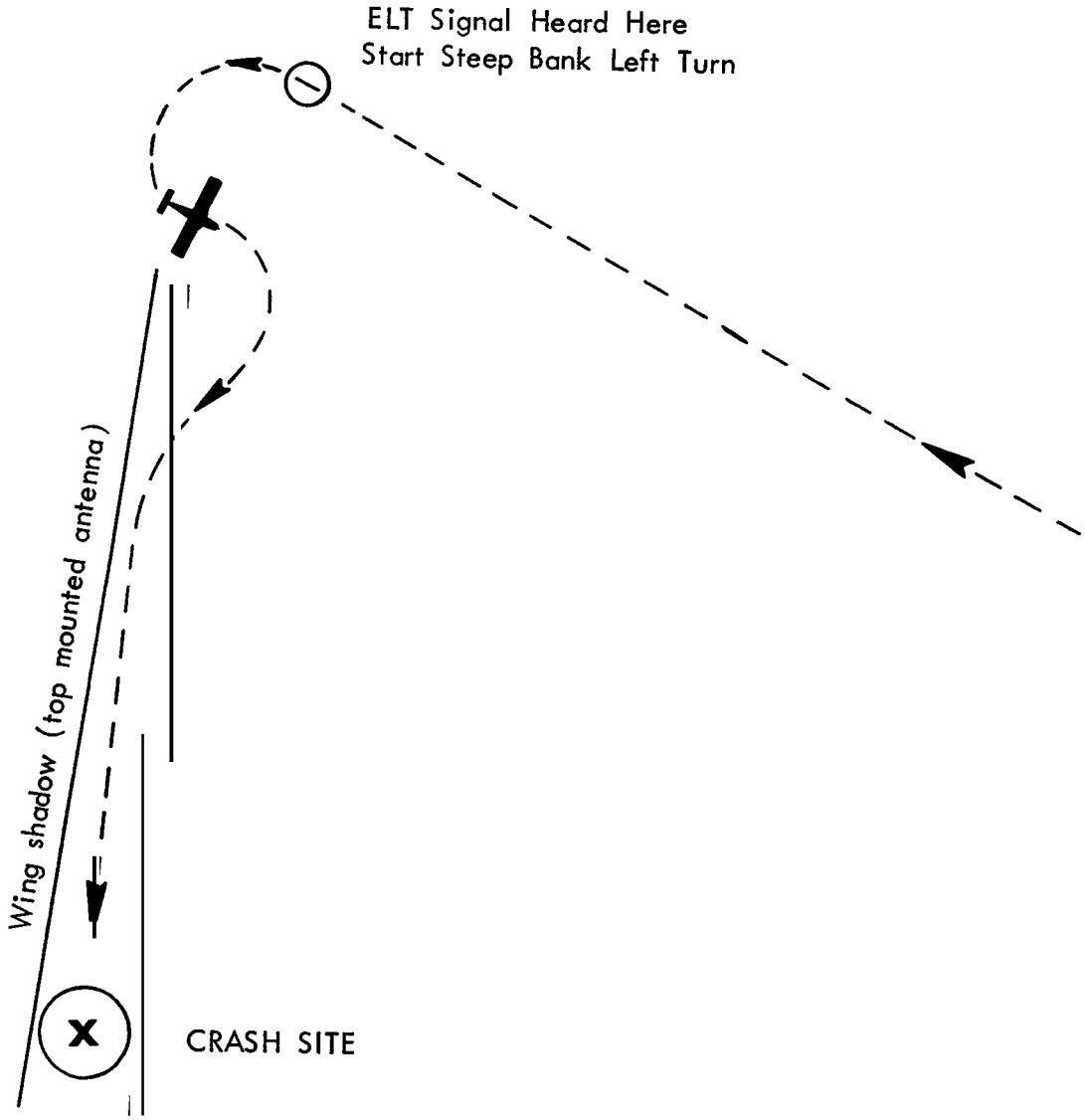

FIGURE 2

WING SHADOW METHOD OF LOCATING AN ELT

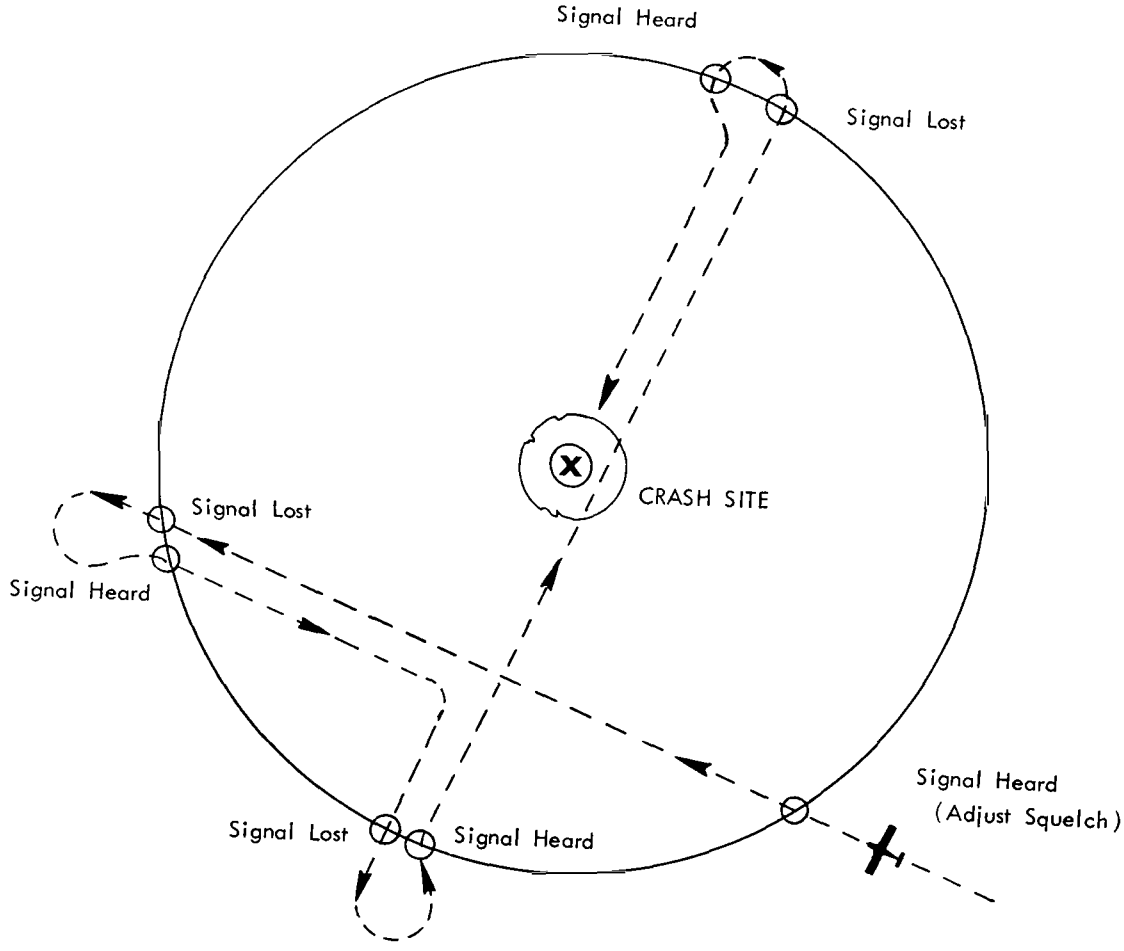

FIGURE 3

BUILD AND FADE METHOD USING SQUELCH

FAA FREQUENCY MANAGEMENT OFFICES

Alaskan Region - Anchorage

Frequency Management Office, AAL-430B
DOT, Federal Aviation Administration
P. O. Box 14, 701 C Street
Anchorage, AK 99513
Tel: (907) 271-5343

Central Region - Kansas City

Frequency Management Office, ACE-432
DOT, Federal Aviation Administration
601 East 12th Street, Room 1625
Kansas City, MO 64106
Tel: (816) 374-2643

Eastern Region - New York

Frequency Management Office, AEA-426
DOT, Federal Aviation Administration
JFK International Airport, Fed. Bldg.
Jamaica, NY 11430
Tel: (212) 995-3341

Great Lakes Region - Chicago

Frequency Management Office, AGL-437
DOT, Federal Aviation Administration
2300 East Devon
Des Plaines, IL 60018
Tel: (312) 694-4500

New England Region - Boston

Frequency Management and Leased
Communications Staff, ANE-464
DOT, Federal Aviation Administration
12 New England Executive Park
Burlington, MA 01803
Tel: (617) 273-7256

Northwest Region - Seattle

Frequency Management Office, ANW-426
DOT, Federal Aviation Administration
FAA Building, Boeing Field
Seattle, WA 98108
Tel: (206) 767-2653

Pacific Region - Honolulu

Frequency Management and Leased
Communications Staff, APC-430.3
DOT, Federal Aviation Administration
P. O. Box 50109
Honolulu, HI 96850
Tel: (808) 546-8378

Rocky Mountain Region - Denver

Frequency Management and Leased
Communications Staff, ARM-406
DOT, Federal Aviation Administration
10455 East 25th Avenue
Aurora, CO 80010
Tel: (303) 837-3571

Southern Region - Atlanta

Frequency Management Office, ASO-434
DOT, Federal Aviation Administration
P. O. Box 20636
Atlanta, GA 30320
Tel: (404) 763-7386

Southwest Region - Fort Worth

Frequency Management and Leased
Communications Staff, ASW-406
DOT, Federal Aviation Administration
P. O. Box 1689
Fort Worth, TX 76101
Tel: (817) 624-4911, Ext. 374

Western Region - Los Angeles

Frequency Management and Leased
Communication Staff, AWE-406
Worldway Postal Center
P. O. Box 92007
15000 Aviation Blvd.
Los Angeles, CA 90009
Tel: (213) 536-6164

FAA Technical Center - Atlantic City

Frequency Management Office, ACT-151
DOT, FAA Technical Center
Building 201
Atlantic City, NJ 08405
Tel: (609) 641-8200

Aeronautical Center - Oklahoma City

Frequency Management Office, AAC-453
DOT, Federal Aviation Administration
Mike Monroney Aeronautical Center
P. O. Box 25082
Oklahoma City, OK 73125
Tel: (405) 686-2781

Headquarters - Washington, D.C.

Frequency Engineering Branch, AAF-730
DOT, Federal Aviation Administration
800 Independence Avenue SW.
Washington, DC 20591
Tel: (202) 426-3597

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981 — 341-428/481