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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: EMERGENCY LOCATOR TRANSMITTERS AND RECEIVERS

1. PURPOSE. This advisory circular provides information concerning the design, installation and utilization of emergency locator transmitters. It reviews the experience of the past year and states solutions for existing problems. It discusses design features and production testing to minimize operational problems in future manufactured ELTs. Additionally, it sets forth installation and operational guidance with reference to monitoring, alert procedures, search procedures and action to be taken in the event of inadvertent activation.

2. DEFINITIONS.

   a. Emergency Locator Transmitter

      (1) This is a small radio transmitter radiating at least 75 milliwatts (peak effective radiated power) on 121.5 and 243 megahertz. It is modulated at least 85% by a downward sweeping audio tone over the spectrum of at least 700 hertz between 1600 hertz and 300 hertz, at a repetition rate of 2-4 times per second. It is activated by an inertial switch or equivalent system which will turn on the transmitter automatically when subjected to a force of $5\ ^{+2}_{-0}$ gravities and greater for a duration of $11\ ^{+5}_{-0}$ milliseconds and greater when the force is applied in a direction parallel to the longitudinal axis of the aircraft.

      (2) The exceptions to the inertial switch requirement and the output power requirement are found in the survival type ELT. This type is ordinarily stowed in life rafts and is activated by either a manual switch or by floating in water and there is no requirement for an inertial switch. Since the antenna on the survival type ELT will float only a few inches above the water and will often be below the crest of the waves, 225 milliwatts of radiated power is required.

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b. Airborne Homing and Alerting Equipment for Use with ELTs. These devices are divided into three categories as follows:

(1) Category A. The homing equipment covered by this category comprises a homing adaptor which provides steering information and which can be connected to an airborne communication receiver.

(2) Category B. The homing equipment covered by this category comprises a complete airborne homing system. It contains a fixed frequency receiver operating on 121.5 and/or 243 megahertz and provides an alerting signal when the signal from an ELT is detected and provides steering information to the source of the signal.

(3) Category C. This is an airborne alerting and search receiver operable on either batteries or an aircraft power supply. It is a fixed frequency receiver on 121.5 and/or 243 megahertz. It contains a device to signal an alert if a signal from an ELT is detected and provides signal strength indications for build and fade search procedures.

3. DISCUSSION. The operation of ELTs during the past year has brought to light several design deficiencies that should be avoided in future production. These deficiencies have resulted in inadvertent activation and in a few instances have compromised the safety of the airplane.

a. Automatic Activating Device. To meet the provisions of TSO-C91 an ELT (except the survival type) must activate when a force of $5\ ^{+2}_{-0}$ gravities and greater for a duration of $11\ ^{+5}_{-0}$ milliseconds or greater is applied in the direction parallel to the longitudinal axis of the aircraft and must not activate on any force less than this. In spite of this rule, many inadvertent activations have been caused by some manufacturers' utilization of inertial switches acting in a 360° plane. The inertial switch should be designed so that it cannot be activated by a force of any magnitude in any direction unless that force has a longitudinal vector component that equals or exceeds the prescribed parameters.

b. Radio Frequency Susceptibility.

(1) By far the most frequent cause of inadvertent activation of ELTs has resulted from poor radio frequency susceptibility characteristics. Some ELTs incorporate an electronic latching switch, and, in the presence of an r-f field, the ELT antenna conducts sufficient energy to activate the ELT. The FAA issued an airworthiness directive on 19 September 1972, and the deficiencies of the models known to be involved are being corrected. If this does not suffice, the FAA will issue further directives to control this problem.

(2) TSO-C91 does not refer to radio frequency susceptibility and it is not considered necessary to amend this document since only certain models are involved. It is recommended, however, that all ELT manufacturers production check their ELT products to be sure they cannot be activated by any signal fed directly into the ELT antenna output terminals when that signal is at least two watts and is varied over the range of 118 MHz. to 1000 MHz. to 118 MHz.

(3) Installed ELTs should be tested by switching the installed communications transmitters through every megahertz channel starting at the lowest and going to the highest and back down again from the highest to the lowest channel and on any one megahertz channel through every fractional channel, while listening for an ELT signal on 121.5 or 243 megahertz. This test is recommended because switching transients have been known to generate radio frequency interference and to activate certain ELTs.

c. Controlling Inadvertent Activation. Once the inertial switch and r-f susceptibility problems are under control, there will be occasional installations that will be prone to inadvertent activations. These situations are caused by certain combinations of airframes and ELTs. The radio frequency interference inherent in some airframes and the marginal r-f susceptibility characteristics of some ELTs work together to produce a situation in which the installed ELT can be inadvertently activated and cause a serious safety hazard since the close proximity of the ELT antenna to the other VHF antennas can jam communications and navigation signals. Each such case should be reported to FAA through the "Malfunction Defects" program to provide a factual basis for corrective action. Contact any General Aviation District Office for "M or D" forms.

4. INSTALLATION AND OPERATION CRITERIA.

a. Installation Criteria. Experience has shown that ELTs should be attached to airframes or other solid structures. Those installed or attached on panels such as the sides of baggage compartments are prone to activate due to the vibrations of the panels exceeding the g forces of the inertial switch lower limits. Such installations should be avoided. ELT antennas should be located as far as practicable from other installed antennas.

b. Monitoring 121.5 MHz.

(1) The FAA has equipped its facility flight check aircraft with ELT monitor receivers and alerting indicators.

(2) Extremely sensitive ELT monitor receivers (0.07 uv) are now available. They are highly discriminatory and will respond

to a bonafide ELT signal while rejecting all other types of signals, including voice. As they are fixed frequency on 121.5MHz, are normally silent, and give a sound and/or light warning only when a prolonged ELT signal is received, there is no additional cockpit workload created. Less sophisticated ELT monitor receivers are also available, at lower cost.

(3) It would be highly beneficial and cost effective if all airline aircraft would monitor 121.5 MHz while in flight. The high cruise altitudes and the great activity of the airlines combine to enable them to efficiently cover most of the country, and all pilots should be willing to notify the nearest ground communications station when a distress signal is received.

(4) It is highly advisable for the pilots of all aircraft to monitor 121.5 MHz while in flight when a receiver is available for that purpose. Even better would be the installation of one of the lower cost ELT monitor receivers so that monitoring would be full time. There are two reasons for this: First, it is an excellent means to determine if your own ELT has accidentally activated. Second, you will be providing a vital service to the entire aviation community by increasing the chances that a flyer in distress will be located quickly.

(5) When ELTs are being handled during installation or maintenance a monitor receiver should be used to determine immediately if accidental activation occurs, and appropriate action taken.

(6) Ground crews that move airplanes should monitor 121.5 MHz. to determine immediately if the movement of an airplane in the ramp and hangar areas activates a sensitive inertial switch and turns on the installed ELT. Prompt action should be taken to shut off the activated ELT.

c. Alert Procedures. The 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, however, offers the following suggestions if an ELT signal is heard:

(1) Notify the nearest or most convenient FAA ground facility, stating your position when the ELT signal was first heard and your position when it was lost. You need do nothing more unless requested by the ground facility, and then at your option. Most flyers, however, will be good Samaritans and extend whatever aid is requested. If you have actually discovered the site of the crash, you may want to circle it to guide rescue teams. You may be requested to gain altitude and transmit for a fix, or to activate your transponder, if you have one.

(2) If you are flying a light airplane and hear an ELT signal, do not try to be a hero and complete the search alone unless circumstances are such that it is logical to do so. In any event, notify the local FAA ground facilities that you hear an ELT signal and give your position or other requested information.

d. Search Procedures.

(1) If your airplane is equipped with a VHF homing system, flying to the source of an ELT signal is simple and the procedures are well known. 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 (AGC) meter.

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

(b) If the signal strength is increasing, continue on course. If the signal strength is dropping, make a 180° turn and fly back along the same track. In most signal strength meters, the pointer will approach zero as signal strength increases and will read higher as the signal strength gets weaker.

(c) At some point along the original track, the signal strength will reach maximum (minimum meter reading) and then start to diminish. Make a 180° turn and fly back along the same track until you reach the point of maximum signal strength. At this point the ELT is either 90° to the right or 90° to the left of your position.

(d) Make either a 90° right or left turn and note the meter readings. If the signal strength diminishes you are flying away from the ELT. Make a 180° turn and fly back along the track. You will fly directly to the source of the ELT signal.

(e) Passage over the source of the ELT signal will be indicated by either a sharp rise in signal strength immediately followed by a sharp drop in signal strength or a complete momentary loss of signal. In some instances, the signal strength rapidly fluctuates between maximum and minimum several times before becoming steady again as the 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. If on approaching close to the source of the ELT signal your receiver appears to be saturated with the signal, turn your receiver to an adjacent channel. This reduces the sensitivity of your receiver to the signal. Appendix 1 illustrates this procedure. See Figure 1.

(2) Another build and fade method can be used to locate the source of an ELT signal if your receiver is not equipped with a signal strength meter. This method takes a little more practice but is very effective and is illustrated in Figure 2, Appendix 1.

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

(b) Continue on the same course. If the signal from the ELT immediately cuts out you are flying away from the ELT. In this case, make a 180^{o} turn and fly back along the same track. If the signal continues to be heard, you are in good shape. Continue along the same track until the signal cuts out (usually greater than 10 miles).

(c) Note your position over the ground when the signal cuts out, make a 180^{o} turn and fly back along the same track. Half way between the points where you adjusted the squelch and where it cut out will be the closest point to the ELT along your original track. The ELT will be approximately 90^{o} to the left or 90^{o} to the right of this mid point.

(d) Make a 90^{o} right or left turn and the signal will either cut off as you continue on the new heading or continue to be heard. If the signal cuts off you are flying away from the ELT. In this case make a 180^{o} turn and fly back along the same track. This course should bring you approximately over the site of the ELT signal.

(e) To assist in pinpointing the ELT location it may help to tune your receiver to an adjacent channel (in the vicinity of the ELT) to reduce the receiver sensitivity on 121.5 MHz.

(3) There is still another search method that may be used to locate the general direction of an ELT signal and the general area in which the ELT is located. This method may be used when the receiving antenna is located approximately in the center of the wing span (either top or bottom of the airframe). It works most satisfactorily when the wings are all metal.Fig. 3,App. 1.

(a) 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.

(b) 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.

e. Use of Airworthiness Directives to Correct Design Deficiencies. By Federal law, most airplanes must be ELT equipped by 30 December 1973 and may not be operated after that date without an operable ELT except when flying to a point where the ELT is to be repaired or installed. The FAA keeps computer records of inflight and other accidental activations of ELTs and if the read-out shows an increasing trend immediate action will be taken to reverse the trend. This may be in the form of an airworthiness directive issued against the ELT, the aircraft or both, as appropriate, to correct design and/or installation deficiencies. Immediate corrective action will be required of a manufacturer, however, aircraft operators are responsible for AD compliance. Refusal of a manufacturer to correct the design of an ELT which continues to activate in flight because of design deficiencies may result in the revoking of his authority to manufacture under the TSO system.

f. Recurring ELT Problems. For the guidance of ELT manufacturers and those involved in the ELT program, the following typical problems which have been reported during the past year are listed. It is suggested that all involved persons take appropriate means to eliminate these problems.

Unwanted activations
Interference with navigation systems
Premature battery failures
Antennas broken off during flight
Batteries leaking

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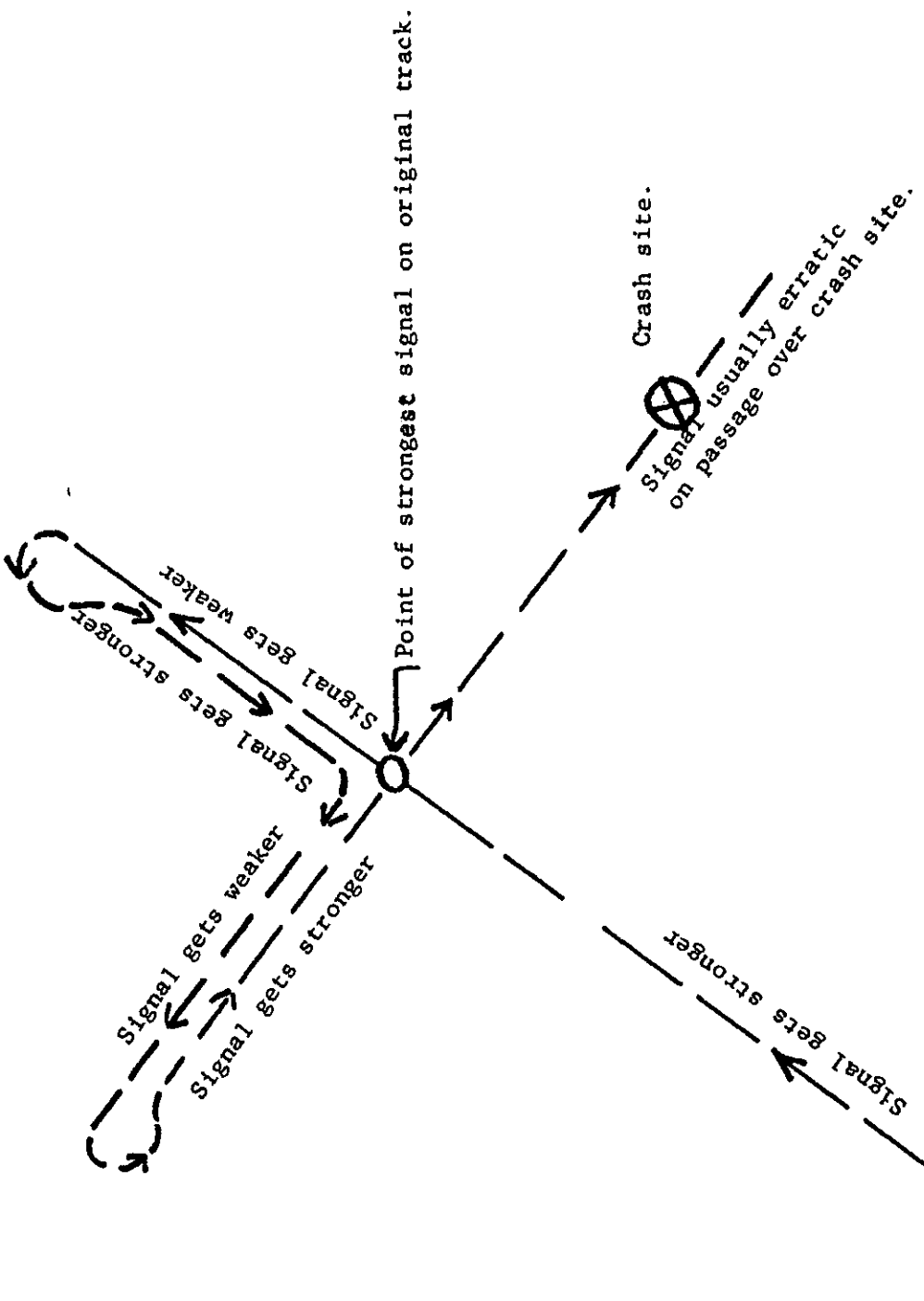

FIGURE 1. Flight proceedure for locating ELT using signal strength meter. The build and fade method.

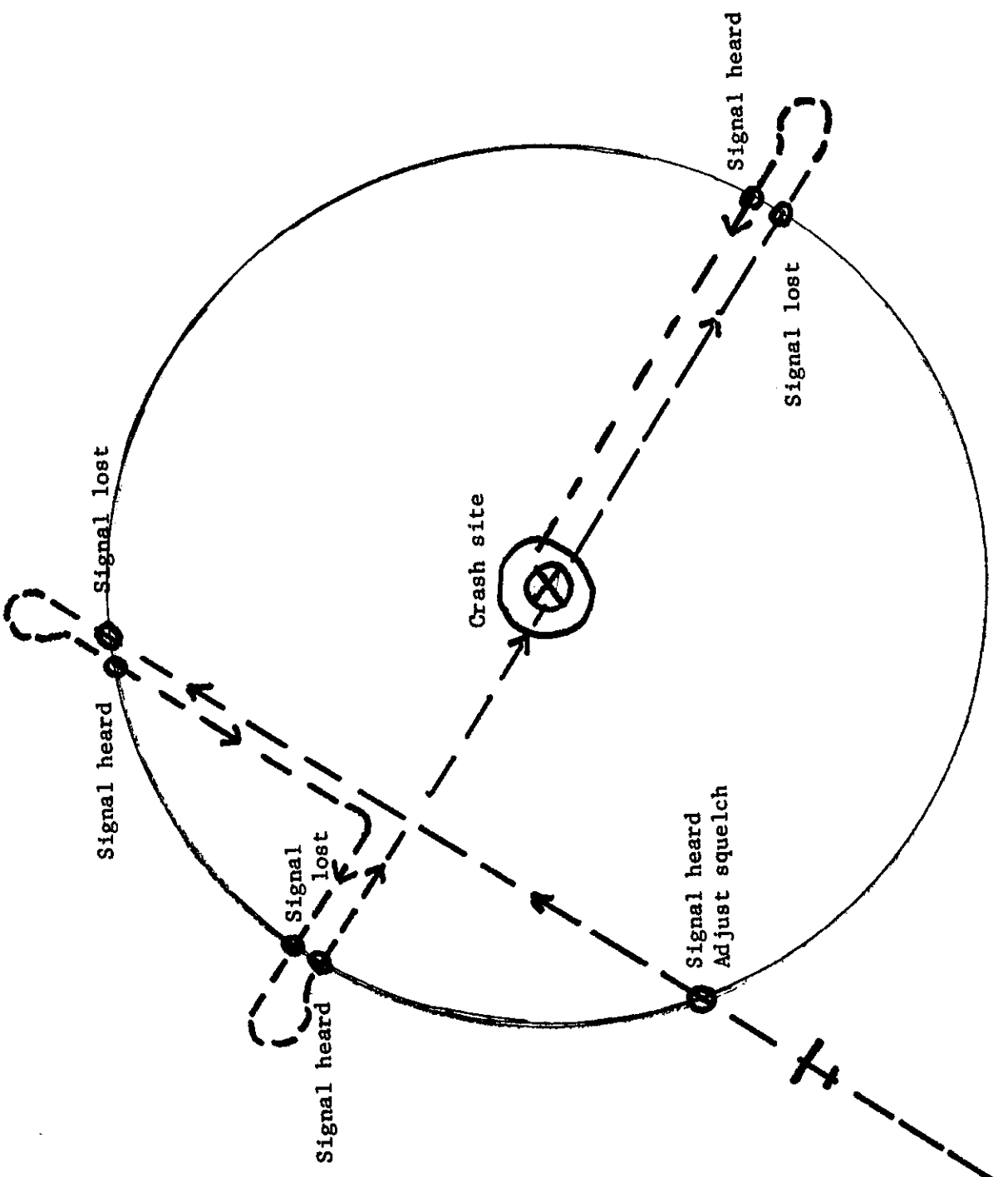

FIGURE 2. Build and Fade method of locating ELT using Squelch

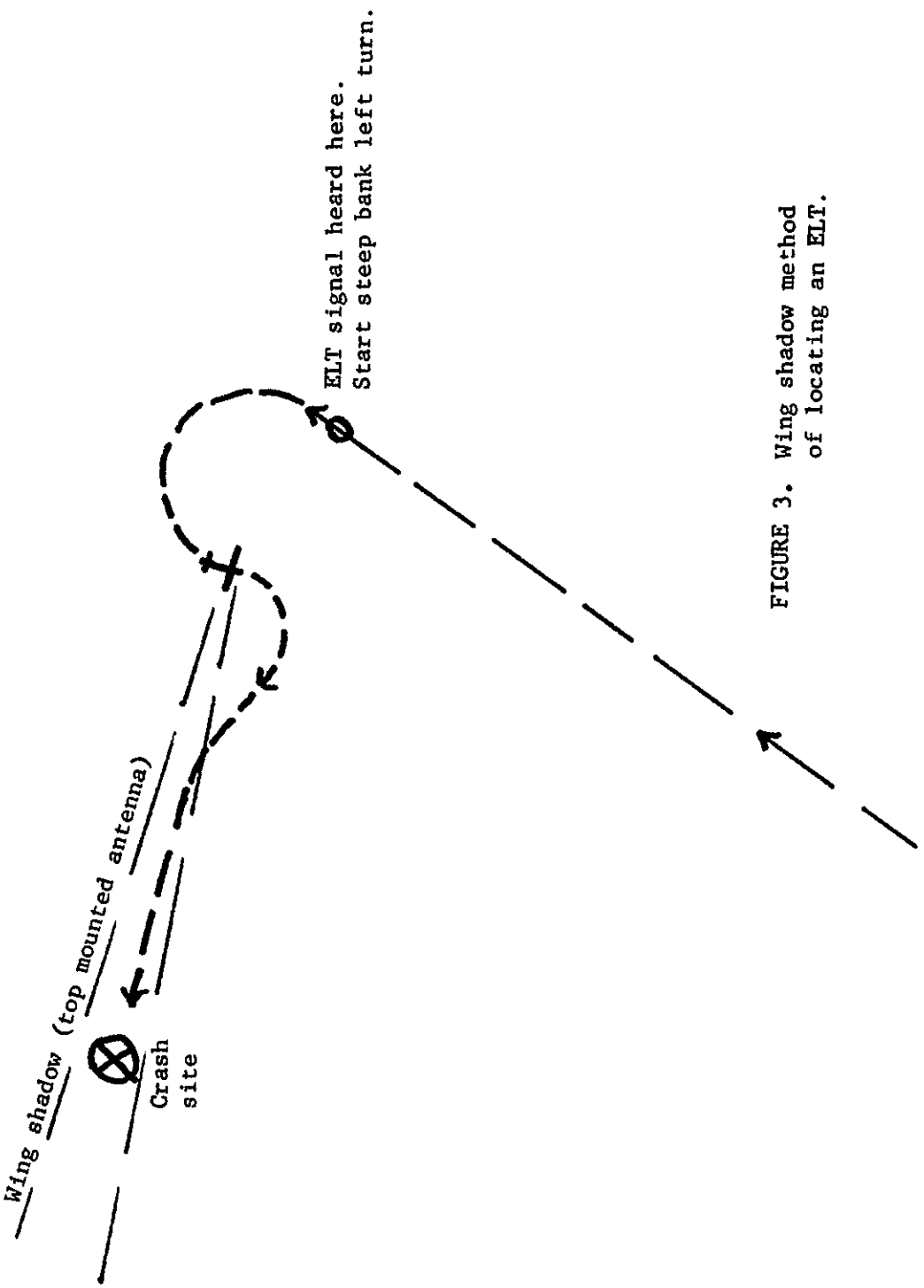

FIGURE 3. Wing shadow method of locating an ELT.

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