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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

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Forwarded to:

Honorable Langhorne Bond
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-78-5 through 12

The National Transportation Safety Board has completed a special study, titled "Emergency Locator Transmitters - An Overview," which provides an overview of the current ELT situation. The study was prompted by the large number of false ELT signals and failures to activate during valid distress situations experienced with equipment designed under TSO-C91. For example, data provided by the Air Force Rescue Coordination Center at Scott Air Force Base, Illinois, show that of all the ELT signals reported to it in 1975 and 1976, less than 1 percent resulted in actually locating the crash sites with the aid of an ELT. The overwhelming majority of the ELT signals reported are false. Furthermore, nearly 90 percent of ELT signals emanate from the vicinity of airports.

National Transportation Safety Board data reveal that of 1,028 accident records in 1975 and 1,118 accident records in 1976, the ELT was used in locating the accident site in about 10 percent of these accidents and the ELT malfunctioned in about 30 percent of these accidents. The records further show that about 10 percent of the ELT's were not armed and, therefore, could not have automatically activated upon impact. The remaining records revealed that ELT's which functioned were not used in locating the accident site.

Controversy has surrounded the ELT since 1970 when Congress mandated its installation in most general aviation aircraft. The subsequent difficulties encountered by the ELT have been the subject of numerous studies by organizations concerned with search and rescue. In particular, the Radio Technical Commission for Aeronautics (RTCA), Special Committee 127 (SC 127), was convened at the request of the FAA in January 1975 to revise the Minimum Performance Standards of RTCA DO-145 and DO-147, which were incorporated in TSO-C91. This work has been performed and a draft of the revised specifications completed. The

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Safety Board believes that, although these efforts will result in a substantially improved ELT, some of the more persistent ELT systems problems have not been adequately addressed; this combined with insufficient field testing, might result in a second-generation ELT system which will not correct the current unsatisfactory performance of the ELT's. The Safety Board further believes that a well designed, well installed, and properly functioning ELT can be an effective tool in search and rescue.

The study revealed several areas in which corrective action is necessary.

Attachment of ELT -- Attachment of the ELT to the aircraft, including the type of mounting and the location within the aircraft, is a recognized ELT system problem. It is one, however, which the RTCA-SC 127 decided was outside its purview. If improperly mounted the ELT can break free from its mounting system on impact and its coaxial antenna cable can become disconnected. Should the mounting system be too flexible, the system can absorb a significant portion of the impact energy and then the crash sensor may not experience sufficient deceleration force to activate the ELT.

Should the ELT be mounted too far forward, its chances of surviving impact decrease. The unit might experience deceleration forces too severe for it to function properly. The farther aft the ELT is placed, the greater the probability of its survival in a crash if the attachment point withstands the crash forces. However, in typical nose-first impacts, the forward portion of the aircraft absorbs most of the energy of the impact, and if the ELT is mounted too far aft, the ELT may not experience sufficient decelerative forces to activate the crash sensor.

There are no standards that specify the type or location of attachment except for the requirement of the RTCA-SC 127 revised Minimum Performance Standards that the ELT shall have a means of attachment so that the ELT will withstand inertial forces of 100g downward, backward, and sideward and 100g forward and upward without breaking loose from the mounts, damaging the equipment, and causing the ELT to fail to activate. ELT's are attached in numerous locations, from the forward part of the cabin to the rear of the tail cone, and by a variety of mounting methods. Although NASA has performed and is continuing to perform light aircraft crash tests to examine the crash forces experienced at various locations within the aircraft, the mounting problem remains unsolved and virtually unaddressed.

Attachment of antenna -- Another problem area not adequately addressed is that of the attachment to the aircraft of the externally mounted antenna. Often high speed crashes will result in the failure of the antenna. Also, the antenna can be sheared off as the aircraft

descends through trees or other obstructions or by ground obstacles upon impact. Further, if the antenna were covered by wreckage or other debris, the signal would be significantly attenuated.

As in the case of the ELT, there are no standards specifying the attachment of an external antenna to an aircraft. The only requirement is that of the RTCA-SC 127 revised Minimum Performance Standards which require the ELT to be connected to the externally mounted antenna by a suitable RF cable using interlocking connectors. This problem remains unsolved and unaddressed.

Crash sensor -- The crash sensor, which responds to impact forces and activates the ELT when the design level is reached, has caused numerous false alarms and has failed to function when it should have functioned.

Many ELT experts have concluded that the original crash sensor design is, in effect, a vibration sensor. It is extremely sensitive to, and will activate when subjected to, high frequency vibrations. Such vibrations can be transmitted through the airframe when an aircraft experiences external forces, such as those experienced during hard landings, cabin door slamming, turbulence, and strong surface winds. All have been reported to cause unwanted ELT activations.

The crash sensor was a subject of standards in the revised Minimum Performance Standards of RTCA-SC 127. The proposed standards resulted from a study performed by the Crash Research Institute of Tempe, Arizona, which estimates that the current crash sensor will not respond to the deceleration forces in 80 percent of survivable crashes, although it is highly sensitive to vibrations. The CRI also estimates that the proposed standards of the revised Minimum Performance Standards should result in a crash sensor that will activate in 70 percent to 80 percent of these crashes with a small false alarm rate. However, crash sensors have not yet been tested, which leaves doubt as to whether the new design standards will, in fact, solve these persistent problems.

Some model ELT's have had crash sensors which failed to operate because the sensor jams, short circuits, or becomes corroded. Again, field testing of prototype second-generation ELT's will be necessary to determine if these problems have been solved by the redesign of the units.

Battery -- The revised Minimum Performance Standards of RTCA-SC 127 have specified inadequate operating life (50 hours) and low operating temperature (-20°C) for the requirements of search and rescue due in part to current technical limitations of nonlithium type batteries and the hazards associated with the lithium sulfur dioxide battery. Adequate standards for search and rescue are 100 hours operating life at a low temperature of -40°C. This low temperature requirement is absolutely

necessary to insure operation of the ELT during winter in many areas of the United States, particularly in rugged mountainous terrain where rapid rescue is essential for survival of the occupants of a downed aircraft.

Numerous solutions to this problem have been suggested, such as an insulated enclosure to contain the battery or a small heating element to keep the battery warm. A quick disconnect system to enable removal of the battery when the aircraft is not in use could help prevent cold soaking of the battery. Several lithium batteries, including the lithium thionyl chloride and the lithium monofluoride battery, are claimed to hold some promise for eliminating the venting and explosion hazards of the lithium sulfur dioxide battery. The lithium thionyl chloride battery has been tested by one ELT manufacturer, and none of the problems associated with the lithium sulfur dioxide battery have occurred. The Safety Board believes that technical alternatives must be examined and a safe and economical solution to this problem must be found.

Corrosion is another leading cause of battery malfunction. Undetected corrosion can be partially attributed to infrequent inspection. Since batteries are not always readily accessible, inspection is difficult. Batteries should be easily accessible for routine check and the FAR's should specifically require inspection of the battery during the annual or 100-hour maintenance inspection, or both.

Still another problem is failure to replace the battery at the required time. Easy accessibility and required inspections should help to alleviate this problem.

ELT arming and display -- Often, pilots fail to arm the ELT during the preflight check, either inadvertently or because they have become disenchanted or complacent because of the repeated malfunctions. Inclusion of arming as a specific step in the manufacturer's preflight checklist would remind the pilot to take this action before takeoff. This could also serve as a reminder to the pilot to check the remaining shelf life of the battery. The inclusion of the remote control in the cockpit, as proposed in the RTCA-SC 127 revised Minimum Performance Standards, will enable the pilot to easily perform this operation of arming the ELT. One glance at this control switch would enable the pilot to determine whether the ELT is set to "OFF," "MANUAL ON," or "ARMED" for automatic activation.

The problems associated with false alarms could also be alleviated by the remote control and the remote warning light in the cockpit, as required by the revised Minimum Performance Standards. The warning light would alert the pilot of the inadvertent operation of his ELT, and he could then easily silence the malfunctioning ELT with the cockpit control.

These persistent problems can have a negative effect on the national search and rescue program. Much effort has been put into the development of the revised Minimum Performance Standards and it is reasonable to expect that components will be satisfactorily produced in accordance with these new specifications. However, many systems problems that were not addressed remain unanswered. The Safety Board believes that the lack of system engineering and prototype field testing might well result in a second-generation ELT which will not correct the currently unsatisfactory operation of the ELT's.

In view of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Establish the location(s) and method of mounting an automatic fixed-type ELT in an aircraft so that they will properly operate consistent with the RTCA-SC 127 revised Minimum Performance Standards; include this in the Technical Standard Order which will incorporate the RTCA-SC 127 revised Minimum Performance Standards on ELT's. (Class III - Longer Term Action) (A-78-5)

Establish the location(s) and method of mounting a fixed-type antenna(ae) externally to an aircraft so that the ELT will properly operate consistent with the RTCA-SC 127 revised Minimum Performance Standards; include this in the Technical Standard Order which will incorporate the RTCA-SC 127 revised Minimum Performance Standards on ELT's. (Class III - Longer Term Action) (A-78-6)

Study existing and proposed batteries or undertake research to provide a battery or battery system that will provide useful operation of the ELT for at least 50 hours and -40°C and require its use within the second-generation ELT's. (Class III - Longer Term Action) (A-78-7)

Include a provision in the Technical Standard Order which will incorporate the RTCA-SC 127 revised Minimum Performance Standards on ELT's requiring that the ELT and battery be readily accessible for visual inspection. (Class III - Longer Term Action) (A-78-8)

Amend 14 CFR 43, Appendix D, to include a separate, specific line item in either the annual or 100-hour maintenance inspection, or both, to require a visual check of the ELT system, including the ELT, battery, antenna or antennae, cockpit control and warning light for indications of problems, including corrosion and improper connections and an operational check of the system. (Class III - Longer Term Action) (A-78-9)

Require engineering development and testing of all components which are the subject of standards in the RTCA-SC 127 revised Minimum Performance Standards for ELT's, including the crash sensor, to insure that these components perform as specified. (Class III - Longer Term Action) (A-78-10)

Field test preproduction ELT prototypes supplied by manufacturers to insure that these second-generation ELT's will perform satisfactorily under field conditions and will also meet RTCA-SC 127 Minimum Performance Standards. (Class III - Longer Term Action) (A-78-11)

Request general aviation aircraft manufacturers that provide preflight checklists with their aircraft, to include in their checklists, the statement "ELT ARMED" in the preflight section and "ELT OFF" in the shutdown and parking section. (Class III - Longer Term Action) (A-78-12)

BAILEY, Acting Chairman, McADAMS, HOGUE, and KING, Members, concurred in the above recommendations.

Kay Bailey

By: Kay Bailey
Acting Chairman