ELT SYSTEM DESCRIPTION

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Definitions

Acronyms

COSPAS	**CO**smicheskaya **S**istyema **P**oiska **A**variynych **S**udov (Space System for the Search of Distressed Vessels)
ELT	**E**mergency **L**ocator **T**ransmitter
ESA	**E**uropean **S**pace **A**gency
LUT	**L**ocal **U**ser **T**erminal
MCC	**M**ission **C**ontrol **C**enter
MOPS	**M**inimum **O**perational **P**erformance **S**tandards
RCC	**R**escue **C**oordination **C**enter
RTCA	**R**adio **T**echnical **C**ommission for **A**eronautics
SAR	**S**earch **A**nd **R**escue
SARSAT	**S**earch **A**nd **R**escue **S**atellite-**A**ided **T**racking
TSO	**T**echnical **S**tandard **O**rder

Types of ELTs

The following four basic types of ELTs are defined in the MOPS (Minimum Operational Performance Standards) for TSO-C126 (RTCA DO-204) and TSO-C91a (RTCA DO-183). They are discussed below:

Automatic Fixed - ELT (AF)

This type of ELT is intended to be permanently attached to the aircraft before and after a crash and is designed to aid SAR (Search and Rescue) teams in locating a crash site.

Automatic Portable – ELT (AP)

This type of ELT is intended to be rigidly attached to the aircraft before the crash, but readily removable from the aircraft after a crash. It may also function as and ELT (AF) during the crash sequence. This type of ELT is intended to aid SAR teams in locating the crash site or survivors.

Note: AP & AF have the same indication and installation requirements except AP can be removed from aircraft.

Survival - ELT (S)

This type of ELT does not normally activate automatically and is intended to be removed from the aircraft and used to assist SAR teams in locating survivors of a crash. It can be tethered to a life raft or a survivor.

Note: The ELT (S) generally does not meet specific requirements in regard to mandatory carriage of automatically activated ELTs on aircraft.

Automatic Deployable - ELT (AD)

This type of ELT is intended to be rigidly attached to the aircraft before the crash and automatically ejected and deployed after the crash force sensor has determined that a crash has occurred. This type of ELT should float in water and is intended to aid SAR teams in locating the crash site.

ELT Frequencies

In order to alert rescue crews, the ELT may transmit on 121.5 MHz, 243.0 MHz, and 406 MHz. Two types of ELTs installed on commercial jet transports include the 2-frequency ELT, and 3-frequency ELT. The 2-frequency ELT transmits on 121.5 MHz and 243.0 MHz, where the 3-frequency transmits on all three frequencies.

121.5 MHz is continuously monitored by traffic control towers, airports, etc. and is recognized as an emergency frequency worldwide. When activated the ELT transmits a 'warble' tone on the frequency to alert listening parties an ELT has been activated. Using a special receiver, the rescue crews can 'home in' on the transmitting ELT. The major constraint to this frequency is the limited range of the transmission (approx. 70 miles in air).

243.0 MHz is primarily a military rescue frequency.

406 MHz is a relatively new SAR frequency, geared towards utilizing the capabilities of satellites. The ELT transmits a digitally encoded message on 406 MHz, to be received by satellites. The encoded message contains the following information:

- Aircraft or ELT identification
- Country code of registration
- Type of ELT

In addition to receiving vital information, the satellite system can determine the position of an ELT transmitting on 406 to within 2km using the Doppler effect.

System Description - Automatic Fixed

The following section provides a typical ELT System Description.

ELT System Components

Airplane Components

Item	Function	Location
ELT (Emergency Locator Transmitter) & ELT Antenna	Transmission of 121.5/243 MHz Homing Signals and 406 MHz Digital Message	Aft top section of fuselage
Control Panel	Manual activation of ELT. Deactivation (return to "Armed" mode) following any activation. Annunciation of ELT Activation and Interface with Master Caution System	Flight Deck (Pilot's Overhead Panel)

ELT System Components (continued)

External Components

Item	Function	Location
COSPAS/SARSAT Satellites:		
Low Earth Orbit Satellites	Detect distress signals and pass emergency information to ground stations called LUTs (Local User Terminals)	4 Polar Orbiting (2 US @ 850 km altitude, 2 Russian @ 950 km)
Geosynchronous Satellites	406 MHz repeater. Provides real-time alert notification over a large area (within 70° N to 70° S Latitude), but not location data.	1 Indian, 2 US, 1 ESA @ 36,000 km altitude
LUT (Local User Terminal)	Ground stations that receive and process distress signals and determine geographical location of the distress. Typical accuracy: 121.5/243 MHz - 20 km 406 MHz - 3 km	Numerous locations worldwide.
MCCs (Mission Control Centers)	Collect and sort information generated by LUTs and forward alert data to the appropriate RCC (Rescue Coordination Center)	Numerous locations worldwide.

Operation

The fundamental purpose of the ELT system is to alert to rescue crews in the event of an accident and to help SAR teams to locate the aircraft.

The ELT contains an internal G-Switch, designed to activate the ELT in the event of an accident. When the G-Switch detects an acceleration that exceeds a pre-determined curve, the ELT will be activated. This provides the 'automatic' function of the ELT.

ELTs broadcasting on a frequency of 121.5 and 406 MHz are detected by COSPAS/SARSAT satellites equipped with the appropriate receivers. The SARSAT satellites also receive and relay 243 MHz signals. However, the 243 MHz frequency is not an official part of the COSPAS/SARSAT system. The broadcast signals are relayed to the nearest Local User Terminal (LUT) where the location of the emergency is determined by measuring the Doppler shift caused by the movement of the satellite relative to the location of the distress beacon.

The following additional information was provided by the SARSAT Operations Division of NOAA:

Location determination of 121.5 MHz beacons is accomplished by digital signal processing algorithms. First, the satellite relayed data is received, down-converted, and demodulated. The signal is next digitized and transformed into discrete frequency spectra. The resultant data from a beacon appears as an S-like curve of beacon frequency versus time. The curve is properly matched with computer generated reference curves by using correlation techniques. There is a different reference curve for every possible beacon location on a line that passes through the sub-satellite point perpendicular to the satellite's ground track. Initial beacon locations are estimated by matching the processed Doppler curve to the closest computer curve and using the satellite's position at the time of detection. This initial estimate is put to an algorithm, which compensates for beacon frequency drift rate and the earth's rotational effects, and then computes a final position.

The system produces two positions, the real one and an image on the opposite side of the satellites ground track. It is the calculation of the earth's rotational effect that allows the processor to determine the probability of either position being the actual solution. The received beacon signals are intermixed with random noise and may also contain interference from non-beacon sources, such as voice transmission. These signal contaminants complicate data analysis. When strong interferers are present, weak beacon signals may be suppressed below the threshold of the processing algorithms. Identification of signals coming from individual beacons is also made more difficult by the presence of multiple signal sources and by solutions produced by sidebands from individual beacons. The single pass location accuracy of 121.5 MHz alert date is estimated at 10-20 km.

The processing of 406 MHz data is far simpler because each transmission received contains beacon identification in the digital data field. Also, because the data is already frequency-measured and time tagged aboard the spacecraft, time and frequency values are provided for the position determination algorithm, thus greatly reducing the ground processing required.