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Minimum Operational Performance Standard for Aircraft Emergency Locator Transmitters 406 MHz

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FOREWORD

This document was prepared by RTCA Special Committee 229 (SC-229) and EUROCAE Working Group 98 (WG-98). It is technically equivalent to EUROCAE ED-62B. It was approved by the RTCA Program Management Committee (PMC) EUROCAE Council on December 13, 2018.

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- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;

- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and

- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

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1 INTRODUCTION

1.1 Purpose and Scope

This document contains minimum operational performance specifications for Emergency Locator Transmitters, (ELTs), to ensure that they will:

- meet the activation specifications,
- meet environmental test conditions,
- meet Cospas-Sarsat system requirements for satellite processing of a distress signal (primary alert),
- be compatible with homing devices used for Search and Rescue (SAR),
- not adversely affect aircraft operations,
- not be adversely affected by the aircraft operations.

CHAPTER 1 of this document provides information needed to understand the rationale for the equipment characteristics and requirements stated in the remaining chapters. It describes typical equipment operation and goals, as envisioned by the members of EUROCAE Working Group 98 and RTCA Special Committee 229. Chapter 1 also establishes the basis for the standards stated in chapter 2. Definitions, a list of related documents and assumptions essential to proper understanding of this document are also provided in this chapter.

CHAPTER 2 contains the general Minimum Operational Performance Standards, (MOPS), General Design Specifications for the ELT system.

CHAPTER 3 describes ELT minimum performance specifications under standard conditions.

CHAPTER 4 provides minimum performance specifications under environmental test conditions.

CHAPTER 5 describes recommended bench level test procedures necessary to demonstrate the ELT system will meet the requirements stated in chapters 2 - 4.

CHAPTER 6 provides installed equipment performance as well as technical guidance equipment manufacturers can follow to write comprehensive installation manuals that contain best practices for automatic fixed, automatic portable, deployable, survival, and distress tracking ELTs.

CHAPTER 7 provides instructions to the ELT manufacturer on items that should be specified in documentation supplied to the customer to ensure ELT system continues to meet the performance standards throughout the life of the ELT system

APPENDIX A provides a comprehensive list of documents related to ELT systems to be included in the manufacturer's installation manuals.

1.2 Cospas-Sarsat System Overview

The International Cospas-Sarsat Program is a treaty-based, nonprofit, intergovernmental humanitarian cooperative of more than 40 nations and agencies dedicated to detecting and locating 406 MHz radio beacons activated from aircraft, vessels and by persons (e.g., backcountry hikers) in distress, and forwarding this alert information to SAR authorities that can take action for rescues. The system utilizes a network of satellites that provide coverage anywhere on Earth. Distress alerts are detected, located and forwarded to over 200 countries and territories at no cost to the receiving government agencies. Cospas-Sarsat

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was conceived and initiated by the founding Party States of Canada, France, the United States, and the former Soviet Union in 1979. (The Russian Federation succeeded the Soviet Union as a Party to the organization.)

406 MHz distress beacons capable of being detected by the Cospas-Sarsat System, ELTs for aviation use, Emergency Position Indicating Radio Beacons (EPIRBs) for maritime use and Personal Locator Beacons (PLBs) for individuals are available from multiple manufacturers and vendor chains.

The system consists of a ground segment and a space segment that include:

- distress radio-beacons to be activated in a life-threatening emergency;
- SAR signal repeaters (SARR) and SAR signal processors (SARP) aboard satellites;
- several satellite downlink receiving and signal processing ground stations called local user terminals (LUTs); and
- mission control centres (MCCs) that exchange, route and distribute the distress alert data (particularly beacon location data) provided by the LUTs.

The Cospas-Sarsat system space segment consists of SARR and SARP instruments aboard:

- satellites in polar low-altitude Earth orbit called LEOSARs;
- satellites in geostationary Earth orbit called GEOSARs; and
- satellites in medium-altitude Earth orbit called MEOSARs.

The distress-alert instruments are attached as secondary payloads to satellites that are being launched primarily for meteorological or navigation purposes.

Cospas-Sarsat provides a robust data distribution system for distress alerts and consists of:

- a network of more than 30 MCCs, operated by governments, and distributed world-wide; and
- communication links to global SAR authorities.

The Cospas-Sarsat system has the capability to both relay distress location data that is provided by the navigation or GNSS receiver data embedded in the beacon message, and to mathematically analyze the relayed beacon signal to calculate the distress location “independently” from location data in the distress message. Cospas-Sarsat is the only satellite distress-alerting system that is capable of this dual redundant means of locating an activated distress beacon. The independent calculation of the location is made from measurements of the Doppler-effect-induced frequency differences and/or distance-dependent time-of-arrival seen in the distress signal at the LUT receiver when relayed by LEOSAR and MEOSAR satellites.

Over time there will be more than 70 MEOSAR satellites, and the MEOSAR system will become the dominant space-segment capability of Cospas-Sarsat. MEOSAR consists of receivers aboard the following navigation-satellite constellations: the European Union’s Galileo, the Russian Federation’s Glonass, and the United States’ Global Positioning System (GPS). Operational distribution of MEOSAR alert data began in December 2016 in an early operational capability (EOC). The MEOSAR system will be able to provide near-instantaneous detection, identification, and location-determination of 406-MHz beacons.

For the 406-MHz distress signal received by the Cospas-Sarsat satellites there are two radio signal schemes: the original (referred to as “first generation”) narrowband (3 kHz) modulated signal compliant with document C/S T.001, with diversity of channels used

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within the satellite bandwidth (compliant with document C/S T.012); and a recent ("second generation") wideband ("spread spectrum") modulated signal compliant with document C/S T.018 that uses a single channel which utilizes most of the 100 KHz satellite bandwidth. Along with the difference in signal structure, "second generation" beacons also have additional features and can convey more information.

Some beacon models also can receive "return link messages" sent to them over the navigation channels of the Galileo satellite system to, for example, provide an indication to the beacon user that the distress signal has successfully been received. Many beacon models also include transmitters operating on other frequencies defined by national administrations for localized homing and on-scene locating purposes.

Further information on Cospas-Sarsat, the system and beacons can be found at http://www.Cospas-Sarsat.int.

1.3 Types, Classes, capabilities and applicability of ELT

This MOPS was created to permit ELT manufacturers, users, installers, operational and airworthiness authorities to determine the specifications of ELTs. These specifications are defined by introducing ELT types, classes and capabilities, that the ELT manufacturer must document in the installation manual. If approval authorities require a Declaration of Design and Performance (DDP) the types, classes and capabilities must also be documented in the DDP.

1.3.1 Types of ELT

Five basic types of ELT are described in this document. They are: Automatic Fixed (ELT(AF)), Automatic Portable (ELT(AP)), Automatic Deployable (ELT(AD)), Distress Tracking ELT (ELT(DT)) and Survival (ELT(S)). The type of ELT implies the compliance with a certain set of specifications from this document. The header of the subsection or the text of the specification may identify the ELT type(s) it applies to. If no type is identified, the specification applies to all ELTs.

An Automatic ELT as referenced in the ICAO SARPS is either an ELT(AF), ELT(AP), or ELT(AD). For these ELTs, the term automatic is used to identify ELTs which have the capability to determine that a crash or a ditching has occurred and either activate or deploy as required.

The five basic types of ELTs are described below:

Automatic Fixed (ELT(AF))

This type of ELT is intended to be permanently attached to the aircraft before and after a crash, to automatically activate upon a crash, and is designed to aid SAR teams in locating a crash site and/or survivor(s).

Automatic Portable (ELT(AP))

This type of ELT is intended to be rigidly attached to the aircraft before a crash, to automatically activate upon a crash, but is readily removable from the aircraft after a crash. If the ELT does not employ an integral antenna, the aircraft-mounted (external) antenna may be disconnected and an auxiliary antenna (stored on the ELT case) connected in its place. After removal from the aircraft, the ELT can be tethered to a survivor or a life raft. This type of ELT is intended to aid SAR teams in locating a crash site and/or survivor(s).

Automatic Deployable (ELT(AD))

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This type of ELT is intended to be rigidly attached to the aircraft before a crash or ditching and automatically deployed when a crash occurs or after activation by a water sensor. This type of ELT also operates while floating in water and is intended to aid SAR teams in locating a crash site and/or survivor(s). The ELT(AD) may be either a stand-alone beacon or may be an inseparable part of an Automatic Deployable Flight Recorder (ADFR).

Distress Tracking (ELT(DT))

This type of ELT is designed to be activated prior to a crash upon detection of a distress condition by logic such as that defined by EUROCAE MASPS ED-237. This type of ELT is intended to provide information prior to the crash to aid in locating a crash site and/or survivor(s).

Survival (ELT(S))

This type of ELT is intended to be removed from the aircraft after a crash and activated manually by survivors or automatically with the deployment of other survival equipment. There are two categories of ELT(S), Category A which is buoyant and designed to operate when floating in water and Category B which is not designed to operate when floating in water. This type of ELT is intended to aid SAR teams in locating survivor(s).

1.3.2 Classes

Three operational temperature classes of ELTs (Classes 0, 1 and 2) are described in § 4.2.1 and are consistent with the Cospas-Sarsat specifications.

1.3.3 Capabilities

In addition to the Types, Categories, and Classes, the ELT performance is also characterized by the following capabilities:

- First generation, when meeting the requirements of C/S T.001 Specification for Cospas-Sarsat 406MHz Distress Beacons.
- Second generation, when meeting the requirements of C/S T.018 Specification for Second Generation Cospas-Sarsat 406MHz Distress Beacons.
- RLS, when capable of receiving and processing a Return Link Message to provide the RLS Type-1 acknowledgment informing the user of the Cospas-Sarsat acknowledgment of the alert. RLS beacon requirements are contained in C/S T.001 or C/S T.018 as applicable.
- Internal/integral GNSS Receiver, when containing a GNSS receiver, transmitting GNSS coordinates in the distress signal and meeting the applicable requirements of C/S T.001 or C/S T.018 and §3.6 of this document. The receiver can be single or multi-constellation (e.g. GPS, Galileo, Glonass, Beidou).
- External Position Input, when capable of receiving position coordinates from an external position source and of transmitting them in the distress signal and meeting the applicable requirements of C/S T.001 or C/S T.018.
- Transmission of a 121.5 MHz homing signal, when meeting the specifications of § 3.8 of this document.
- Transmission of a 243 MHz homing signal, when meeting the specifications of§ 3.8 of this document.
- Transmission of a 406 MHz homing signal, when meeting the specifications of § 3.9 of this document.

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- Crash survivability, when meeting the specifications of group A and B tests as defined in CHAPTER 4.

These additional features and corresponding identification codes are summarized in the following Table 1-1:

Table 1-1: Capability ID Code

Capability	ID code
First generation	T.001
Second generation	T.018
RLS Type-1 acknowledgment	R1
Internal/integral GNSS Receiver	G
External Position Device Input	E
121.5 MHz homing	H1
243 MHz homing	H2
406 MHz homing	H4
Crash survivability	C

1.4 Definitions of terms

To ensure consistency of interpretation of performance requirements and test procedures contained in this MOPS, the following table of definitions is provided:

Table 1-2: Terms for Use in performance Requirements and Test Procedures

	Requirements	Good Industry Practice	Alternate Method
Word	Shall	Should	May
Meaning	Refers to a mandatory performance requirement or test procedure	Refers to a performance or test procedure recommendation that, although not mandatory, is considered good industry practice	With regard to performance requirements and test procedures, refers to an alternate approach for manufacturer consideration
Impact to design	Could result in inability to meet intended function or interoperability	Although not necessary to meet performance requirements, could	None. However, the alternate method should be followed in its

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	with other equipment	result in a deficiency to the end user or installation problems if not followed	entirety if the manufacturer chooses to use that method

The following definitions are provided for the terms that are used in this document.

( )	The use of ( ) for a standard indicates the latest available version of the document. For example, ED-14/DO-160 ( ) means the latest published version is expected to be used by the manufacturer.
ALIVENESS TEST	An aliveness test is intended to give a status of the ELT main parameters as defined in § 4.3.1.
ANTENNA GAIN	Directional gain of an antenna with respect to an isotropic radiator multiplied by antenna efficiency.
AUTOMATIC TRIGGERING SYSTEM	A system monitoring the aircraft state, for example as defined in ED-237, and triggering the command to the ELT(DT) to send or cancel a distress signal.
BATTERY	A connected assembly of one or more cells, which include provision for increased voltage, current, capacity, or additional protection, monitoring, or control functions as opposed to the capabilities of individual cells.
ELT BATTERY	Internal or integral battery
INTERNAL BATTERY	A battery completely enclosed within the ELT Unit.
INTEGRAL BATTERY	A battery external to the ELT unit, but still part of the ELT System.
COSPAS	COsmicheskaya Sistyema Poiska Avariynych Sudov (Space System for the Search of Distressed Vessels).
CRASH SENSOR	A deceleration-sensitive device which detects a crash and initiates the transmission of emergency signals. It is sometimes referenced as g-switch.
DETACHABLE ANTENNA	An antenna that is external to the ELT unit and that is attached directly to the ELT unit by such means as an RF connector without any intermediate cable and which can be removed and replaced by the user. (synonymous with Detachable Antenna in C/S T.018)
DUTY CYCLE	Duty Cycle = Transmit_ON_Time / (Transmit_ON_Time + Transmit_OFF_Time)

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EIRP	Effective Isotropic Radiated Power is the output power of the ELT in a given direction; made up of the output power at the transmitter terminal, minus feeder and mismatch losses, plus the antenna gain in that direction relative to an isotropic radiator, or: EIRP = PT - L + GA where PT (dBW) = output power, L (dB) = feeder and mismatch losses, GA (dB) = antenna gain
ELT	Emergency Locator Transmitter. When used without further qualifier, this refers to the ELT SYSTEM as defined below.
ELT SYSTEM COMPONENTS	ELT Unit and all components external to the ELT unit required for it to perform its intended function, e.g., remote indicator and control unit, mounting bracket, cabling, antenna(s), crash sensor, deployment mechanism, position data interface and storage. Some of the components can be optional. See Figure 1-1.
ELT SYSTEM	ELT System Components interconnected and supplied with power to perform the ELT intended function. See Figure 1-1.
ELT UNIT	That portion of the ELT system which contains at least the internal or integral battery, power switching and transmitter. See Figure 1-1.
EXTERNAL ANTENNA	An antenna intended for location and use external to the aircraft. Usually mounted on the exterior surface of the aircraft. (synonymous with Remote Antenna in C/S T.018 document)
EXTERNAL GNSS ANTENNA	A GNSS antenna for either the Internal or Integral GNSS Receiver that is external to the aircraft but forms a part of the ELT System. The External GNSS Antenna may be either a standalone unit or may be a part of the main ELT External Antenna.
EXTERNAL POSITION SOURCE	A device or system, external to the ELT System, which provides the position of the aircraft to the ELT system, which meets the C/S requirements, T.001 or T.018, as applicable, for an external Position device input.

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EXTERNAL POSITION SOURCE INPUT	The ELT system input intended to be connected to an external position source.
EXTERNAL POWER SOURCE	A source of power that is external to the ELT System, which is intended to power part of or all the ELT System, either prior to the ELT being activated and/or once it has been activated.
FIM	Field Intensity Meter: a calibrated radio receiver or other device used for measuring field intensity.
HYDROSTATIC SENSOR	A type of water sensor using pressure to detect immersion.
INSTALLATION MANUAL	Installation Manual, containing the installation instructions and limitations (see AC 21-46A § 3.8).
INTEGRAL ANTENNA	An antenna that is outside of the ELT unit and is permanently attached to the ELT unit and that cannot be removed by the user. (synonymous with External Antenna in C/S documents)
INTEGRAL GNSS ANTENNA	A GNSS antenna for either the Internal or Integral GNSS Receiver that is a part of the ELT System and which is internal to the aircraft.
INTEGRAL GNSS RECEIVER	A Global Navigation Satellite System (GNSS) Receiver (either Galileo, Glonass, GPS, Beidou or a combination of these) where the Receiver is external to the ELT Unit but is still a part of the overall ELT System. Integral GNSS Receivers may be connected to either an Integral or External GNSS Antenna.
INTEGRAL POWER SOURCE	A source of power that is external to the ELT Unit, but still forms a part of the ELT System, which is intended to power the ELT System once activated.
INTERNAL ANTENNA	An antenna that is contained within the ELT unit where the user has no access to the antenna. (synonymous with Internal Antenna in C/S documents)
INTERNAL GNSS ANTENNA	A GNSS antenna for the Internal GNSS Receiver that is internal to the ELT Unit.
INTERNAL GNSS RECEIVER	A Global Navigation Satellite System (GNSS) Receiver (either Galileo, Glonass, GPS, Beidou or a combination of these) where the Receiver is contained within the ELT Unit. Internal GNSS Receivers may be connected to either an Internal, Integral or External GNSS Antenna.

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INTERNAL POWER SOURCE	A source of power that is contained within the ELT Unit, which is intended to power part of the ELT System once activated.
RLS	Return Link Service.
SARSAT	Search and Rescue Satellite-Aided Tracking system.
SHOCK TESTER	A device for generating an appropriate impulse with adjustable magnitude, duration and shape (eg: ramp, drop tower, shock table).
SPOC	SAR Point of Contact
WATER SENSOR	A sensor detecting immersion, including at low depth.

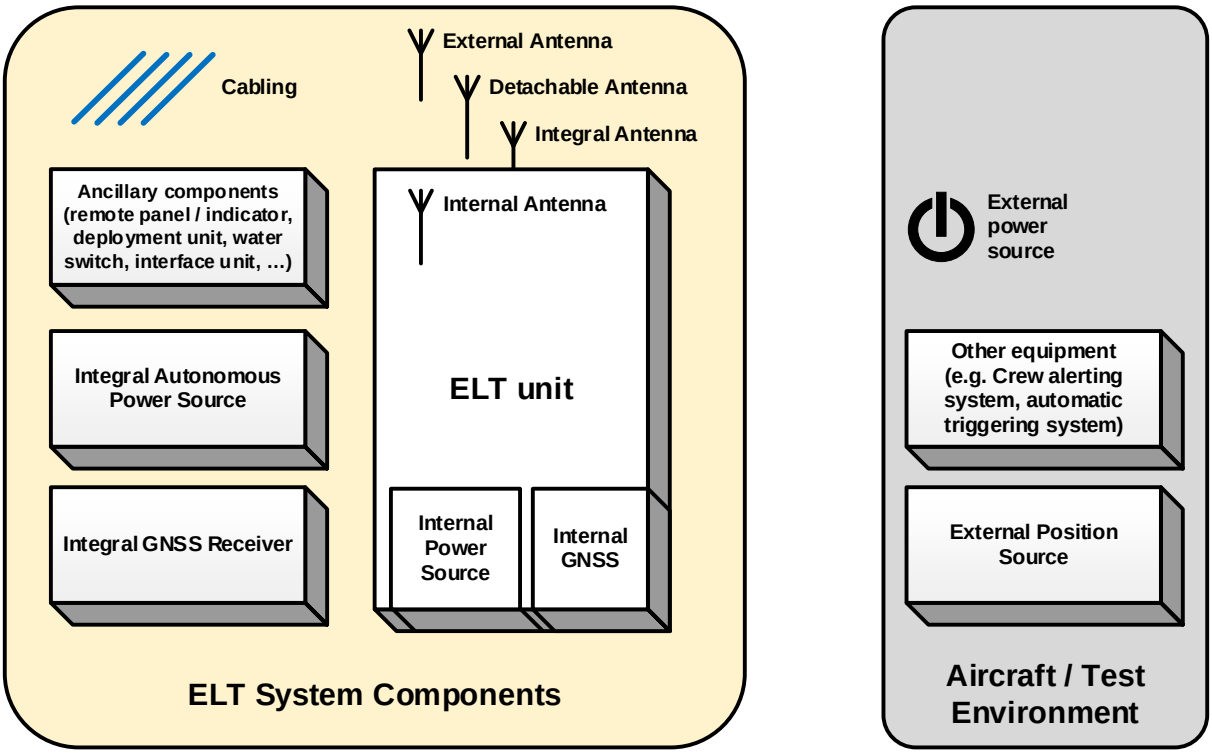


Figure 1-1: Definitions of the ELT Unit and ELT System Components

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