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SWITCH TO 406
Your Lifeline to Survival

COSPAS-SARSAT: SAVING LIVES WITH HIGHER FREQUENCY

Information for the Canadian aviation community about the Switch to 406 MHz

Every minute counts

Canada

List of Abbreviations

AME	Aircraft Maintenance Engineer
AMO	Approved Maintenance Organization
CASARA	Civil Air Search and Rescue Association
CF	Canadian Forces
CMCC	Canadian Mission Control Centre (Trenton, Ontario)
COSPAS-SARSAT	Acronym for the international satellite system for search and rescue
CSAD	Canadian Search Area Definition
ELT	Emergency Locator Transmitter (aviation distress radio beacon)
EPIRB	Emergency Position-Indicating Radio Beacon (marine distress radio beacon)
GEOSAR	Geostationary Earth Orbit Search and Rescue Satellite
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
JRCC	Joint Rescue Coordination Centre (Victoria, Trenton, Halifax)
LEOSAR	Low Earth Orbit Search and Rescue Satellite
LUT	Local User Terminal (COSPAS-SARSAT ground station)
MCC	Mission Control Centre (processes COSPAS-SARSAT alerts)
MEOSAR	Medium Earth Orbit Search and Rescue Satellite
NSS	National Search and Rescue Secretariat
PLB	Personal Locator Beacon
SAR	Search and Rescue
TSO	Technical Standards Order
VFR	Visual Flight Rules

Questions, comments, and suggestions related to this document; or requests for printed or electronic copies may be sent to:

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COSPAS-SARSAT : Sauver des vies à une fréquence supérieure
Renseignements pour les membres de la communauté aéronautique canadienne à propos du passage à la fréquence 406 MHz

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1 Introduction

1.1 COSPAS-SARSAT: Saving lives with higher frequency

Created during the Cold War era by the governments of Canada, the United States, France, and the former Union of Soviet Socialist Republics, COSPAS-SARSAT is a remarkable humanitarian program aimed at saving people in distress. The rapid satellite detection and location of emergency radio beacons helps search and rescue (SAR) services worldwide respond more effectively to aviation, maritime, and land-based emergencies.

After almost 27 years of service, COSPAS-SARSAT completed its transition to the digital age on February 1, 2009. Analog service on the 121.5 and 243 MHz frequencies was discontinued, and the system moved to the exclusive processing of digital 406 MHz alerts. With almost one million 406 MHz emergency beacons in use worldwide as of December 2009, and a third constellation of medium-earth orbit COSPAS-SARSAT satellites under development, the international satellite system for SAR promises to continue saving lives well into the 21st century.

1.2 Purpose of this document

This document is intended to provide the aviation community in Canada with general information about:

- COSPAS-SARSAT, the international satellite system for SAR, and the emergency locator transmitters (ELTs) that work with it;
- COSPAS-SARSAT's transition to digital-only service (406 MHz) that occurred on February 1, 2009, and the end of satellite monitoring of analog 121.5 and 243 MHz frequencies; and
- How pilots and aircraft owners can continue taking advantage of the COSPAS-SARSAT system post-February 1, 2009, by using a digital emergency beacon that operates on a primary frequency of 406 MHz.

While this guide provides information about ELT systems and options, it is not intended to replace the standard research that an aircraft owner or maintenance engineer undertakes when considering the installation of equipment in a specific aircraft.

Since regulatory, technical, and product data changes frequently, readers also are encouraged to contact the government authorities, manufacturers, and distributors identified in this guide for the most current and complete information available.

2 The International Satellite System for Search and Rescue: COSPAS-SARSAT

2.1 Origin and structure

The International Satellite System for Search and Rescue, COSPAS-SARSAT, was originally founded through a Memorandum of Understanding signed in 1979 by Canada, France, the United States, and the former Union of Soviet Socialist Republics. In July 1988, these four states ratified the *International COSPAS-SARSAT Programme Agreement*, which ensures the continuity of the system, and makes it available to all nations on a non-discriminatory basis. The program now includes 43 participating countries and organizations worldwide.

COSPAS is the acronym for the Russian phrase "Space System for the Search of Vessels in Distress" (Cosmicheskaya Sistyema Poiska Avariynich Sudov), while SARSAT is the English contraction of "Search and Rescue Satellite-Aided Tracking". As of December 2009, the system had provided assistance in saving over 28,000 lives. The COSPAS-SARSAT Secretariat, which coordinates program activities, is located in Montréal, Canada. More information about the structure and origins of the program may be consulted at **www.cospas-sarsat.org**.

There are three main components to the COSPAS-SARSAT system:

1) The **emergency radio beacons** that transmit the distress signals;

2) The **satellites** that detect the emergency radio beacon signals; and

3) The **ground component** that includes the land-based stations that automatically receive and distribute the satellite-captured alerts to mission control centres worldwide.

First COSPAS-SARSAT rescue: British Columbia, 1982.

The first recorded aviation rescue aided by the COSPAS-SARSAT system was the crash of a light aircraft in Canada on September 9, 1982—just a few days after system testing and evaluation had begun.

After an ELT signal was received by an overflying Russian satellite and relayed to a Canadian ground station, three people were rescued from the mountains of British Columbia. Their Cessna 182 aircraft had crashed in a mountain valley near Dawson Creek, 80 kilometres off their flight-planned route. The aircraft had been searching for another plane that had gone missing almost two months earlier.

Without the aid of the COSPAS satellite, it is uncertain if rescuers would have found the downed aircraft and its injured occupants as quickly, or at all.

Twenty-five years later, the pilot of the aircraft, Jon Ziegelheim, helped celebrate the 25th anniversary of COSPAS-SARSAT at a special ceremony in Victoria, British Columbia.

2.2 Emergency beacons

The radio beacons designed exclusively for use with the COSPAS-SARSAT system include emergency position-indicating radio beacons (EPIRBs) used on vessels, emergency locator transmitters (ELTs) used in aircraft, and personal locator beacons (PLBs) used by individuals in all environments. Table 1 provides an overview of each type of beacon. As of December 2009, COSPAS-SARSAT reported that there were approximately 950,000 406 MHz beacons in use worldwide.

Table 1: Types of COSPAS-SARSAT Emergency Beacons

Beacon type & primary use	Description	Radio Frequencies
Emergency Locator Transmitter (ELT) ***Aviation use*** 	• Purpose-built for use on aircraft. • Automatic activation (crash force sensor); and • Manual activation. In addition to an external switch on the ELT itself, 406 MHz ELT systems also include a remote switch in the cockpit, which allows the pilot to activate the ELT as soon as a serious in-flight emergency is detected. • 406 MHz models transmit a unique identification code that can be matched to the registered aircraft and owner. • Some models also transmit their global positioning system (GPS) coordinates along with the distress signal.	406 MHz with 121.5 MHz homing signal (*some models also have 243 MHz*) or 121.5 and/or 243 MHz only
Emergency Position-Indicating Radio Beacon (EPIRB) ***Marine use*** 	• Purpose-built for use on vessels. • Category/Class 1 EPIRBs are mounted in a special holder. If a vessel sinks, contact with the water will trigger the release mechanism, allowing the EPIRB to float free of the vessel and continue broadcasting its emergency signal. • Category/Class 2 EPIRBs are manually activated; and most are also designed to activate upon contact with water. • Each transmits a unique identification number that can be matched to the registered vessel and owner. • Some models transmit their GPS coordinates along with the distress signal.	406 MHz with 121.5 MHz homing signal
Personal Locator Beacon (PLB) ***Personal use*** 	• Small, lightweight beacon purpose-built for individuals. • Manual activation only. • Designed to be carried on the person, or in a lifejacket, equipment vest, survival suit, or pack. • Many models are equipped with an internal GPS receiver, or can be connected to one. Most PLBs therefore transmit their GPS location as part of the digital 406 MHz distress signal. • Each transmits a unique identification number that can be matched to the registered owner.	406 MHz with 121.5 MHz homing signal *(243 MHz may also be present)*

2.3 Satellites

Two types of COSPAS-SARSAT satellites work together to provide global coverage for 406 MHz emergency beacons.

(i) Low-earth orbiting Search and Rescue (LEOSAR) satellites

- LEOSAR satellites fly 850–1,000 kilometres above the earth's surface. They are in a polar orbit, meaning that they track roughly north-south, passing overhead the poles. In addition to capturing position information from GPS-equipped beacons, LEOSAR satellites can also use the 406 MHz signal to independently calculate the location of a beacon through Doppler processing. If a ground station is not within view of the LEOSAR satellite when it passes overhead the beacon, the digital data can be stored in an on-board processor until one comes into range. This feature was not available to 121.5 MHz beacons, since they only transmit analog signals. Although the system's nominal configuration of LEOSAR satellites is four, in 2010 there were six fully operational LEOSARs.

(ii) Geostationary Search and Rescue (GEOSAR) satellites

- GEOSAR satellites orbit the earth at approximately the same speed as it rotates, and therefore appear stationary relative to its surface. GEOSAR satellites are in high-altitude orbit, at about 36,000 kilometres above the surface. This large footprint provides continuous global coverage for 406 MHz beacons between about 70 degrees north latitude and 70 degrees south latitude. Although three GEOSAR satellites can cover the earth's surface, five were fully operational in 2010, with a newly-launched sixth satellite undergoing testing. Another two back-up satellites are available in orbit if required. Since they are stationary relative to the earth's surface, GEOSAR satellites cannot calculate the position of a beacon using the Doppler Effect. However, they can capture and relay a 406 MHz distress transmission to SAR authorities within a few minutes. Also, if the beacon is GPS-enabled, the location will be transmitted, effectively taking the 'search' out of 'search and rescue'.

Fig. 1: LEOSAR and GEOSAR satellites work together to provide global 406 MHz coverage
(relative altitudes are not to scale)

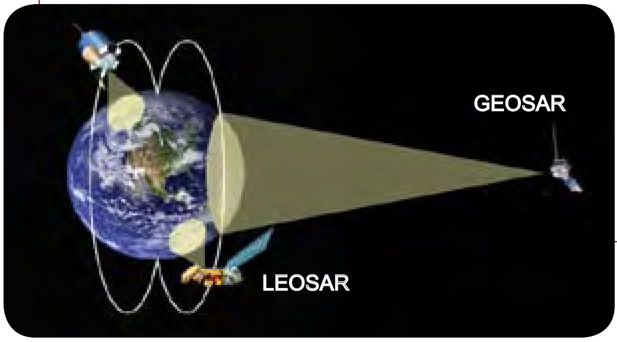


Fig. 2: Depiction of MEOSAR "Galileo" satellite (European Space Agency)

Future enhancements: MEOSAR

- A third constellation of COSPAS-SARSAT satellites is under development, with service expected to begin in 2014. Medium-earth orbit SAR (MEOSAR) payloads will fly approximately 20,000 kilometres above the earth's surface, on board European, American, and Russian navigation satellites. The MEOSAR satellites combine the best of LEOSAR and GEOSAR capabilities, being able to independently calculate the position of 406 MHz beacons based on their signal, as well as covering a large area of the earth's surface and permitting almost instantaneous alerting. Instead of using Doppler processing, the MEOSAR system will use more precise time and frequency measurements to calculate beacon location to an expected accuracy of one kilometre or less.

2.4 Ground component

The ground component of the COSPAS-SARSAT system includes:

- the ground-based stations that receive and process the satellite signals, called Local User Terminals or LUTs;
- the automated data distribution network that relays data from the LUTs to mission control centres (MCCs) around the world; and
- the MCCs that receive the LUT data and forward beacon alerts to the appropriate SAR point-of-contact for action (e.g. a Joint Rescue Coordination Centre).

The Canadian Mission Control Centre (CMCC) is located in Trenton, Ontario. It receives all 406 MHz beacon alerts that fall within Canada's area of SAR responsibility, and is also supplied with data about Canadian-registered 406 MHz beacon alerts that occur worldwide.

When CMCC Trenton receives an alert, it is cross-referenced with the Canadian 406 MHz Beacon Registry also maintained at the centre. If the beacon is properly registered, the CMCC will be able to compile important information about: the nature of the distress (e.g. aviation, maritime, or land-based); the owner of the beacon; descriptive information about the vessel or aircraft (as applicable); and emergency contact information. GEOSAR satellites detect 406 MHz beacon transmissions almost immediately. A Canadian 406 MHz ELT alert, for example, will be received within minutes at CMCC Trenton.

2.5 SAR response in Canada

Across Canada, a network of government, military, private sector, and volunteer organizations work together to provide SAR services to the public. In order to ensure effective coordination and an appropriate response,

Table 2: Canada's shared SAR response system

<table>
<tr><th>Type of SAR incident</th><th>Lead authority</th><th>Contact information</th></tr>
<tr><td>Aircraft incidents
• Anywhere in Canada
• Often signalled by an ELT</td><td>Canadian Forces</td><td rowspan="2">Joint Rescue Coordination Centre (JRCC) – Canadian Forces and Canadian Coast Guard:
JRCC Victoria (BC & YT): 1-800-567-5111
JRCC Trenton (NT, AB, SK, MB, ON, Western parts of QC and NU): 1-800-267-7270
JRCC Halifax (NB, NL, NS, PE, Eastern parts of QC and NU): 1-800-565-1582</td></tr>
<tr><td>Marine incidents
• On the oceans
• Within the federal waters of the Great Lakes/St. Lawrence River system
• Often signalled by an EPIRB</td><td>Canadian Coast Guard, with air support from the Canadian Forces</td></tr>
<tr><td>Persons who are lost, missing, or in distress
• On land (e.g. hikers, hunters, persons with Alzheimer's disease who wander from home)
• On inland waterways (e.g. pleasure boaters, anglers, paddlers)
• May be signalled by a PLB</td><td>Provincial/territorial governments; usually delegated to the police force of jurisdiction.
Note: For ground and inland water incidents that occur within National Parks, Parks Canada has the lead for search and rescue.</td><td>The appropriate police agency's emergency number
(911 or direct dial number)</td></tr>
</table>

specific authorities have been given the lead for the specific types of SAR incidents, as shown in Table 2.

The areas of responsibility for the three federal JRCCs – Victoria, Trenton, and Halifax – are shown in Figure 3.

Due to weather, distance, or equipment availability, the primary SAR authority may not always be the closest responder to a SAR incident. Since time can make the difference between life and death, SAR authorities frequently call upon other agencies to help with missions. This type of mutual assistance is a critical component of Canada's National Search and Rescue Program, giving it added strength and flexibility.

Fig. 3: Canada's SAR Regions

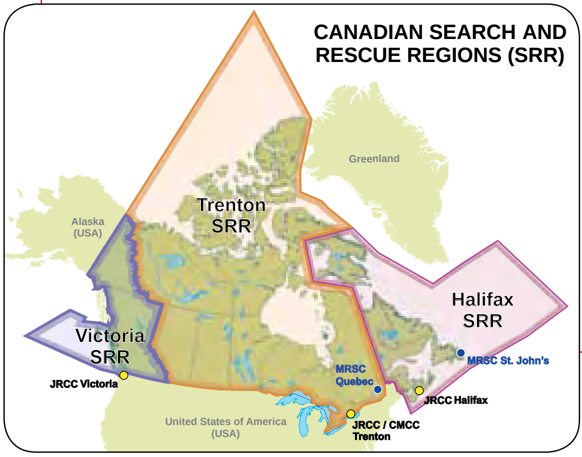
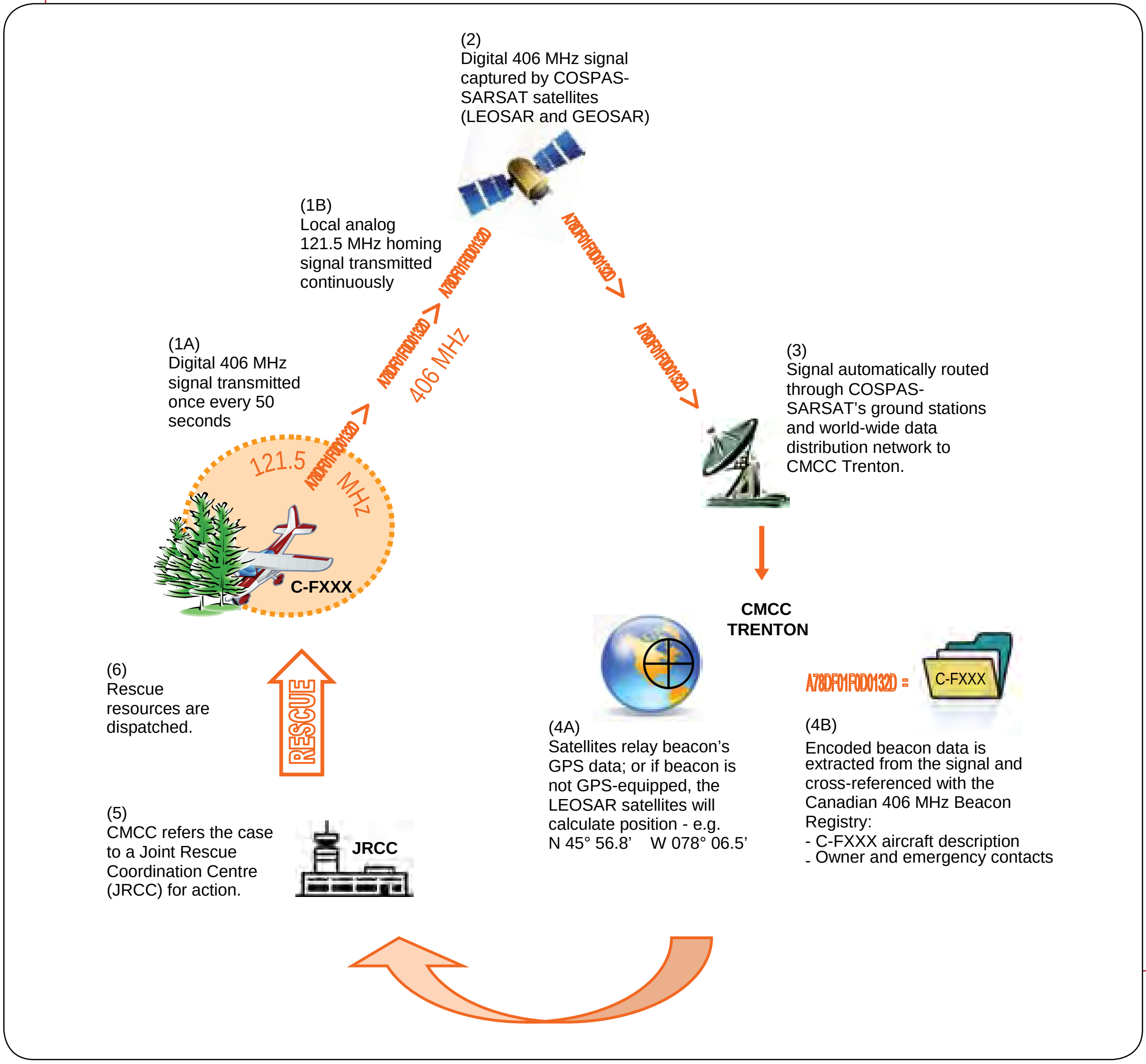


Fig. 4: From alert to rescue: How a 406 MHz ELT signal is captured and relayed through the COSPAS-SARSAT system to Canadian SAR authorities for response.



3 THE SWITCH TO 406: More than just a frequency change

3.1 What happened on February 1, 2009, and why?

When the COSPAS-SARSAT system became fully operational in the 1980s, it served primarily analog radio beacons operating on 121.5 MHz and related frequencies (e.g. 243 MHz). These emergency beacons were originally designed in the 1950s for military aircraft and pre-dated the era of satellite alerting. Since the commissioning of the COSPAS-SARSAT system, technological advancements have been continuously incorporated to improve its reliability and functionality.

Digital beacons operating on a primary frequency of 406 MHz are now the system standard, offering more rapid, reliable, and accurate position information, as well as the ability to uniquely identify the specific vessel, aircraft, or individual to which each beacon is registered. The basic tenet of the 406 MHz technology is to take the 'search' out of 'search and rescue'.

The International Civil Aviation Organization and the International Maritime Organization mandate safety requirements for aircraft and maritime vessels, and work closely with the COSPAS-SARSAT program. After recognizing the limitations of the 121.5 MHz beacons, and the superior capabilities of the 406 MHz alerting system, these organizations recommended to COSPAS-SARSAT that a system-wide transition be made. In October 2000, following detailed deliberations, the COSPAS-SARSAT Council made the decision to cease satellite processing of 121.5 MHz signals on February 1, 2009—a date approximately nine years into the future.

As a result of this decision, a number of participating countries enacted legislation in support of the transition to 406 MHz, and millions of dollars have been invested in redesigning satellite payloads.

In Canada, the marine community made the transition to the use of 406 MHz distress beacons soon after the phase-out date was announced. On February 1, 2009, however, over 80% of Canadian-registered aircraft were still using 121.5 MHz beacons. For most of these aircraft, aeronautical SAR alerting effectively reverted to the pre-1980s era, when the early detection and location of airplane crashes by satellite was not yet available.

3.2 Comparing 121.5 MHz and 406 MHz capabilities

The switch to 406 MHz represents more than just a frequency change. An anonymous analog 121.5 MHz distress signal has been replaced by a uniquely-coded digital signal transmitting on 406 MHz. Beacons transmitting on 406 MHz are captured almost instantaneously by the GEOSAR system—an entire constellation of satellites not available to 121.5 MHz beacons. Location accuracy has improved from +/- 20 kilometres for 121.5 MHz beacons, to less than five kilometres on average for 406 MHz units. Digital 406 MHz beacons can also re-transmit GPS coordinates, embedding the location of the beacon in the distress message. A 406 MHz beacon transmits its primary signal at 5 Watts; whereas a 121.5 MHz unit transmits at 0.05 to 0.1 Watt.

These enhancements are presented in the following comparison of a typical 121.5 MHz ELT with a 406 MHz model (Table 3).

Table 3: Comparing 121.5 MHz and 406 MHz Emergency Locator Transmitters (ELTs)

	Primary Frequency 121.5 MHz ELTs	Primary Frequency 406 MHz ELTs
Signal type and strength	Analog, continuous swept tone on 121.5 MHz (and/or 243 MHz). Minimum of 0.05 Watts radiated power.	1. Primary signal: Digitally-encoded 5 Watt transmission on 406 MHz, once every 50 seconds. 2. Secondary signal: Continuous analog homing signal on 121.5 MHz, and 243 MHz for some models, at 0.025 to 0.1 Watt (power output varies by manufacturer). This helps searchers pinpoint a downed aircraft in conditions of darkness or reduced visibility, such as fog, snow, or dense forest cover.
Satellite detection	**As of February 1, 2009, 121.5 MHz ELTs are no longer monitored by SAR satellites.** However, when they were, both the ELT and the ground station had to be within view of a LEOSAR satellite, since the analog signal could not be stored onboard. This lengthened the time required to determine a position.	406 MHz ELTs can be detected almost immediately by geostationary SAR satellites. Digital signals from 406 MHz ELTs can be stored on board low earth-orbiting SAR satellites passing overhead, and forwarded to the first ground station that comes into view. Location can therefore be determined more quickly than was possible with 121.5 MHz units.
Beacon identification	Anonymous signal. Overflying aircraft monitoring 121.5 MHz, or a nearby air traffic services unit may overhear the transmission. The signal provides no useful information as to the source of the transmission.	Each 406 MHz ELT is uniquely identified and can be cross-referenced with the owner and aircraft data, if the 406 MHz ELT is properly registered. Using the registration data, the rescue centre can begin a communications search even while the satellites are calculating the aircraft's position.
Position information	**Since February 1, 2009, no satellite-provided position data is available for 121.5 MHz ELTs.** If ELT signals are reported by high-altitude aircraft, search areas are usually vast and imprecise (e.g. several thousand square kilometres).	Average 2–5 km location accuracy; can be reduced to within 0.1 km (100 metres) if the 406 MHz ELT is GPS-enabled and transmits these coordinates via satellite. Average search area: 38 square kilometres (or 0.3 km^2 if GPS-enabled).
False alerts	Since 121.5 MHz ELTs transmit only an anonymous analog signal, it is not possible for SAR to determine which reports are false alarms, or which may be linked to an actual distress situation.	All alerts received originate from beacons. False alerts are usually related to human factors, such as improper beacon installation or testing. Using registration information, the owner may be contacted by telephone to resolve these false alerts, saving resources for actual emergencies.

3.3 Three generations of Emergency Locator Transmitters

Since their introduction, there have been three primary generations of ELTs, each improving upon the previous one. Since TSO-C126 and TSO-C91a ELTs are relatively new, many statistics claiming high ELT failure rates are based on first generation ELTs.

Table 4: Comparing 121.5 MHz and 406 MHz Emergency Locator Transmitters (ELTs)

Gen	Standard	Description	Frequencies
1st	**TSO-C91 (1970)** Satellite monitoring ended Feb. 1, 2009.	These were the first-generation ELTs. Some were prone to failure and false alerts, with certain models having sulphur-based batteries that were at risk for leakage, corrosion, and combustion.	**121.5 MHz** and/or **243 MHz** 0.05 – 0.1 W
2nd	**TSO-C91a (1985)** Satellite monitoring ended Feb. 1, 2009.	ELTs built and installed to this standard are more robust and less prone to failure and false alerts. An ELT manufactured and installed to the TSO-C91a standard also requires a remote switch to be installed in the cockpit, within reach of the pilot. This allows the aircrew to trigger the ELT as soon as a serious airborne emergency is detected (e.g. engine failure at altitude; gyro failure or VFR flight into instrument meteorological conditions).	**121.5 MHz** and/or **243 MHz** 0.05 – 0.1 W
3rd	**TSO-C126* (1992)** **TSO-C126a (2008)** **Note: The TSO-C91a standard still applies to the 121.5/243 MHz homing signal component.*	These 3rd-generation ELTs are the most durable and functional yet, and include the ability to transmit a 5W digital signal on 406 MHz that uniquely identifies each beacon. 406 MHz ELTs work with both types of COSPAS-SARSAT satellites, enhancing alerting capabilities. These ELTs also include a homing signal on 121.5 MHz (and 243 MHz in some models), to guide ground and air rescue units the final distance to accident sites during periods of darkness or reduced visibility due to weather, terrain, or dense vegetation. Unless the unit is within reach of the pilot, a cockpit remote switch is also mandatory for TSO-C126 and TSO-C126a ELT installations, enabling the crew to trigger the ELT as soon as a serious airborne emergency is detected. The 406 MHz ELT is also equipped with an audible buzzer installed on or near the ELT itself, to alert pilots and maintenance personnel of an unintentional activation of the ELT on the ground. Some 406 MHz ELT packages may be capable of re-using some components from a TSO-C91a (121.5 MHz) ELT installation. The remote switch cut-out in the panel may also be compatible. These details should be confirmed with the manufacturer and installer.	**406 MHz** (primary) 5.0 W **121.5 MHz** **(and some with 243 MHz)** (secondary homing frequencies) 0.025 – 0.1 W

Fig. 5a: 1st Generation ELT: TSO-C91

121.5 and/or 243 MHz only

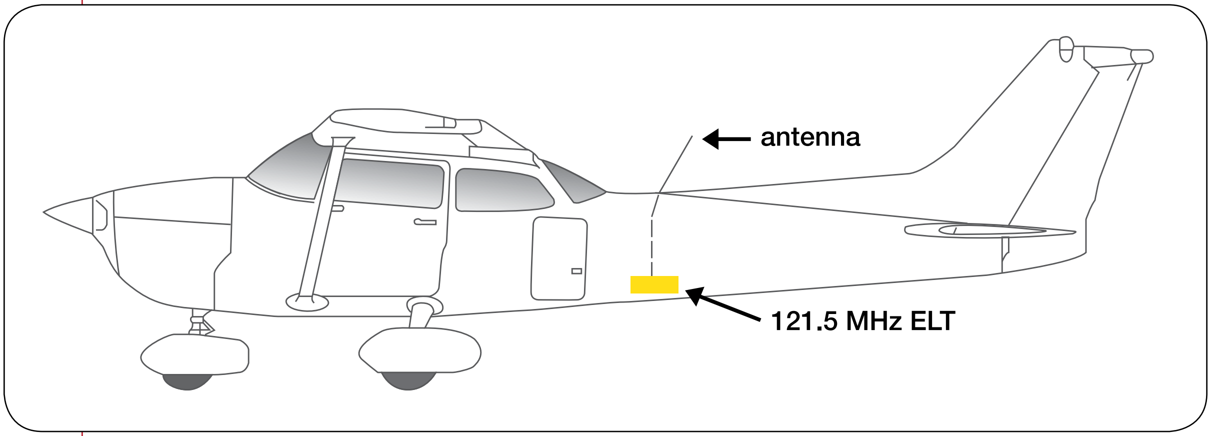


Fig. 5b: 2nd Generation ELT: TSO-C91a

121.5 and/or 243 MHz only, with cockpit remote switch

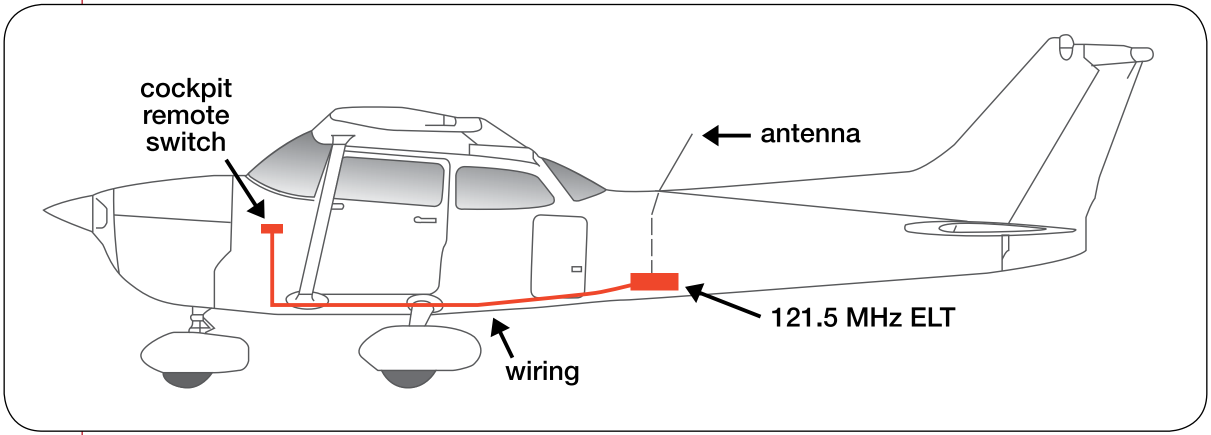
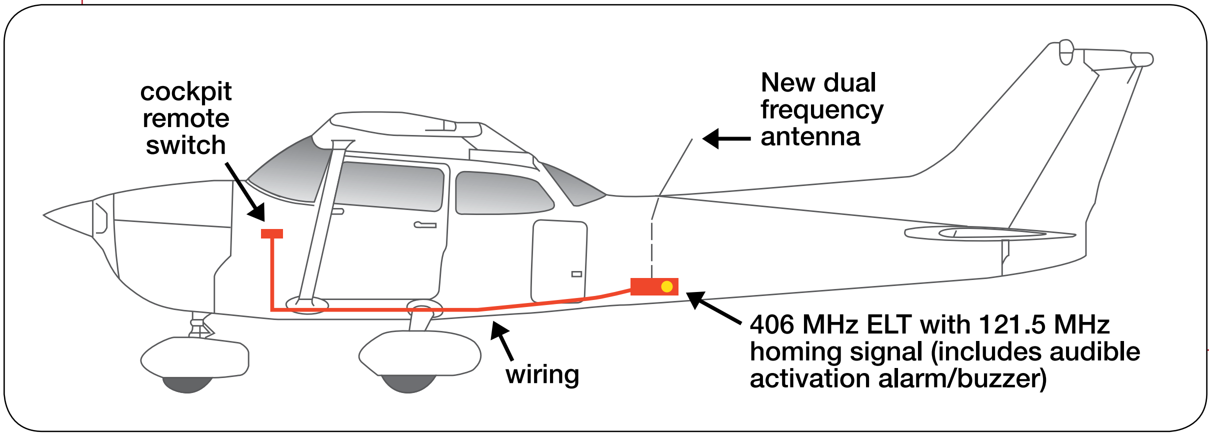


Fig. 5c: 3rd Generation ELT: TSO-C126 / C126a

406 MHz with cockpit remote switch, and 121.5 homing frequency



3.4 Regulations

In Canada, the requirements for the carriage of SAR alerting devices by aircraft are outlined in the *Canadian Aviation Regulations* and associated standards, maintained by Transport Canada:

Canadian Aviation Regulations

- Part VI — General Operating and Flight Rules
  - Subpart 5 — Aircraft Requirements
    - Division II — Aircraft Equipment Requirements
      - Emergency Locator Transmitter

Since these regulatory requirements are subject to change, either consult them online at Transport Canada's Regulatory Affairs Web site, or contact your regional Transport Canada Civil Aviation service centre for up-to-date information.

4 MAKING THE SWITCH TO 406

4.1 Selecting, coding, registering, and installing a 406 MHz ELT

STEP 1: COLLECT INFORMATION ABOUT THE AIRCRAFT'S EXISTING 121.5 MHZ ELT

Manufacturer and model of ELT currently installed

- Record the manufacturer and model number of the ELT currently installed in the aircraft.
- Which generation of 121.5 MHz ELT is it—TSO-C91 or TSO-C91a? If there is a remote switch in the cockpit, it is probably a 2nd generation TSO-C91a ELT. Some ELT manufacturers are now offering 406 MHz ELT packages that are designed to re-use various TSO-C91a components to help reduce cost. Before deciding to re-use any components, a qualified person, such as an aircraft maintenance engineer (AME), should inspect the installation and verify that the components are in good working order and that the mounting bracket meets specifications. See Step 6 (Installation) for more details.
- Cross-reference the ELT information with the list available from Transport Canada's National Aircraft Certification Web site. This will confirm which generation of ELT is currently installed in the aircraft.

Speed of aircraft

- What is the cruising speed of the aircraft? This speed will determine whether a whip, rod, or blade antenna is required for the 406 MHz ELT. A new dual-frequency antenna is needed to optimize the ELT's transmissions on both 406 MHz and 121.5 MHz.

Helicopter or fixed-wing aircraft

- Special ELTs have been designed to better fit the unique flight characteristics of helicopters. These units have multi-directional crash sensors, rather than the single longitudinal axis crash sensor found in most airplane ELTs. Helicopter ELTs can often be identified by an "H" designation included in the model number.

STEP 2: DETERMINE WHAT FEATURES/CAPABILITIES THE NEW 406 MHZ ELT SHOULD HAVE

All 406 MHz ELTs have the same basic features. They:

- transmit a coded distress message on the primary 406 MHz frequency, and a continuous analog homing signal on 121.5 MHz;
- can be located within 2–5 km by satellite, independent of the availability of GPS data;
- can be activated both manually and automatically (crash sensor);
- require a remote switch in the cockpit, unless the ELT is within reach of the pilot (special circumstances);
- produce an audible tone when the ELT is activated, to help detect inadvertent activations on the ground; and
- have a self-test function.

There are additional features available, however, that may be desirable for a particular aircraft and/or operator:

GPS capability?

- A GPS-enabled ELT can transmit the aircraft's actual latitude and longitude directly to the SAR satellite system, along with the aircraft's registration data. SAR authorities will not only know that the aircraft may be in distress, but they will also have its location—without having to wait for the LEOSAR satellites to calculate a position. If this feature is desired, an ELT capable of handling GPS inputs from an on-board navigation system is required.
- From a cost perspective, an ELT designed to handle GPS inputs is generally more expensive than a non-GPS-enabled model. Installing a 406 MHz ELT that will be connected to an on-board navigation system is also considered specialized maintenance, which requires an Approved Maintenance Organization (AMO) or AME with an avionics endorsement.
- It is worth noting that 406 MHz ELTs equipped with *internal* GPS receivers are being developed, eliminating the need for an external navigation interface or specialized installation. As of March 15, 2011, however, none of these models had obtained COSPAS-SARSAT or Canadian certification.

Portable or Fixed ELT?

- Is the flexibility of having a portable ELT desired? In the event of a crash, an "automatic portable" or "AP" ELT can be removed from the aircraft, and used independently of aircraft systems.
- A portable unit may be particularly advantageous in conditions in which the aircraft may not be in a stable location (e.g. avalanche-prone area; melting ice); or in which the aircraft has come to rest in a position that may not be optimal for the externally-mounted antenna.
- Since it comes with a second antenna, an AP ELT package is usually slightly more expensive than a standard "automatic fixed" (AF) unit.
- Some 406 MHz AF units, however, are held in their mounts with a wide Velcro band. These AF models can therefore be removed relatively easily from their mounting bracket, although a portable antenna meeting the correct specification would still be required to use the ELT outside the aircraft.

Remote switch power source?

- The cockpit remote switch required for all 406 MHz ELT installations (except for those special circumstances where the ELT is mounted within reach of the pilot) may be powered using different means. This varies by manufacturer, make, and model. For example, some remote switches are:

  a) tied into the aircraft's electrical system in the front panel;
  b) powered by alkaline batteries (that must be replaced at regular intervals); or
  c) powered by the ELT battery itself.

- When making a 406 MHz ELT purchase, consider what type of remote switch would be the most suitable both for the aircraft, and for the operator.

Fleet operation?

- Aircraft owners operating several aircraft should consider selecting a 406 MHz ELT system that uses programmable "dongles". These dongles are fixed to the aircraft and are pre-programmed with each aircraft's registration (see Step 4—Beacon coding).
- This permits ELTs to be moved between different aircraft without needing to reprogram each ELT individually. As soon as an ELT is plugged into the dongle, the old data is reset, and the correct programming is automatically transferred to the ELT.
- This feature should save time and resources over the long term, particularly during annual ELT recertification.

STEP 3: CONFIRM THAT THE PREFERRED 406 MHZ ELT MODEL IS APPROVED FOR USE IN CANADA

List of Canadian-approved 406 MHz ELTs

- Once a preferred ELT model has been selected, the latest list of Canadian-approved ELTs should be consulted to verify that it is certified for use in Canada.
- This list can be found online at Transport Canada's National Aircraft Certification Web site or by consulting the nearest Transport Canada Civil Aviation regional office. Only those ELTs that have a TSO-C126 or TSO-C126a certification operate on 406 MHz.

Distributors/retailers of 406 MHz ELTs

- The 406 MHz ELT manufacturer should be able to provide a list of distributors or retailers where the unit may be purchased. Special shipping will likely be required due to the fact that the ELT battery is probably classified as dangerous goods. Special attention to detail is also required if purchasing a 406 MHz ELT from outside Canada (see Step 4—Beacon coding).

ELT batteries

Although Transport Canada prohibited the use of lithium **sulphur** dioxide (**$LiSO_2$**) batteries after some problems with earlier generations of ELTs, these batteries are now permitted, providing they meet the requirements of TSO-C142.

However, most compact 406 MHz ELTs now being manufactured for the general aviation market have lithium **manganese** dioxide (**$LiMnO_2$**) batteries. There are no special restrictions or qualifiers on the use of these batteries for aviation use. *Most, however, still require special shipping and handling as dangerous goods.*

406 MHz ELT Certification

In order to be certified for use in Canada, "3rd generation" 406 MHz COSPAS-SARSAT emergency beacons must meet a series of international, industry, and Canadian standards and regulations. For ELTs, these include:

- COSPAS-SARSAT Type Approval Certificate
  Including:
  - COSPAS-SARSAT C/S T.001 — *Specification for Cospas-Sarsat 406 MHz Distress Beacons*
  - COSPAS-SARSAT C/S T.007 — *Cospas-Sarsat 406 MHz Distress Beacons Type Approval Standard*
- Transport Canada, Canadian Aviation Regulations, Part V — Airworthiness Manual, Chapter 551.104 — Emergency Locator Transmitter
  Including:
  - FAA Technical Standard Order TSO-C126a, *406 MHz Emergency Locator Transmitter (ELT)*; and
  - Radio Technical Commission for Aeronautics (RCTA) DO-204: *Minimum Operational Performance Standards for 406 MHz Emergency Locator Transmitters*.
- Industry Canada, Radio Standards Specification RSS-287: *Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD)*.

The list of ELTs currently approved for use in Canada can be consulted online at the Transport Canada's National Aircraft Certification Web site.

STEP 4: HAVE THE 406 MHZ ELT PROGRAMMED FOR THE AIRCRAFT

Beacon coding/programming

- Once an ELT is purchased, the beacon manufacturer or distributor normally ensures that it is properly coded for the customer's aircraft. However, here are some basic facts to be aware of:
  - Every 406 MHz ELT is unique, and has its own 15-character unique identification number (UIN) or "hex" code
  - Only ELTs with a UIN beginning with **278**, **279**, **A78**, or **A79** can be registered with the Canadian 406 MHz Beacon Registry. If a 406 MHz ELT is not Canadian-coded, it must be re-coded for Canada. The manufacturer and some distributors/retailers are able to provide this service. Registering an emergency beacon with a foreign registry service is not recommended, as distress alerts will not necessarily be routed to CMCC Trenton first. Delays could result.
  - To program a 406 MHz ELT (or dongle), the aircraft's 24-bit ICAO address is required. This code—a series of twenty-four 1s and 0s—is listed for each aircraft on Transport Canada's Canadian Civil Aircraft Register. This may be consulted online at Transport Canada's Web site.

STEP 5: REGISTER THE 406 MHZ ELT

Initial registration

- It is up to the aircraft owner (or designate—e.g. maintenance department) to ensure that a 406 MHz ELT is registered with the Canadian 406 MHz Beacon Registry. Registration should be completed immediately after the beacon is programmed for the aircraft, even before installation, if practicable. Why? If the ELT is accidentally triggered during installation, SAR authorities will be able to resolve the false alert with a telephone call to the registered owner, rather than by dispatching SAR resources that might be needed elsewhere for a real emergency.
- There are various ways to register free of charge a 406 MHz beacon:

Internet:	www.canadianbeaconregistry.forces.gc.ca
E-mail:	beacons@sarnet.dnd.ca
Telephone:	1-877-406-7671
Fax:	1-877-406-3291
Regular mail:	Canadian 406 MHz Beacon Registry—CMCC Trenton P.O. Box 1000, Station Forces Astra, ON K0K 1W0

Ongoing free of charge maintenance of your registration record

- Owners should update their ELT registration record(s) whenever information about the aircraft (e.g. colour, configuration) or the owner or emergency contacts changes. Missing or outdated information may confuse or delay search and rescue response.
- Upon initial registration, the owner will receive a login and password for the online Canadian 406 MHz Beacon Registry system, which may then be accessed 24/7.
- The registration record should also be updated when the aircraft is sold, leased, exported, placed in long-term storage, or permanently decommissioned.

STEP 6: INSTALL THE 406 MHZ ELT

Installation—Qualified personnel

- If a 406 MHz ELT is not going to be connected to an on-board GPS or other navigation system, it may be installed by an AME or AMO with an applicable aircraft type rating. These ELTs are sometimes referred to as non-GPS or non-location protocol beacons.
- If a 406 MHz ELT is to be connected to an on-board navigational system, it is considered specialized maintenance, and an avionics-rated AME or AMO will have to do the work.
- Transport Canada Civil Aviation should be contacted with any questions regarding the installation or maintenance of ELTs. A list of regional offices is available at **www.tc.gc.ca**.

Installation – Complexity and Cost

- TSO-C91a (121.5 MHz) ELT systems and TSO-C126 (406 MHz) ELT systems are very similar in configuration – both require a cockpit remote switch, wiring to the ELT, and an external antenna. Upgrading a TSO-C91a system to a TSO-C126 system should therefore be relatively straightforward, particularly if the owner purchases a 406 MHz package designed to retrofit an existing 121.5 MHz ELT model (see Step 1).
- Although existing 121.5 MHz TSO-C91a installations are required to have mounting brackets that meet the “100 pound pull test” specified in RTCA DO-183*, some aircraft owners have discovered that these specifications have not yet been adequately fulfilled. Additional reinforcement of the mounting bracket location may therefore be required before a 406 MHz ELT can be installed in its place.
- For those owners who still have a 1st generation TSO-C91 ELT, the installation costs for a 406 MHz TSO-C126 system should be similar to what it would have cost to upgrade to a TSO-C91a, unless major structural work is required. As each aircraft is unique, costs and options for installation should be discussed with a knowledgeable individual (e.g. AME) in advance. Pressurized aircraft may require special positioning of the ELT and associated wiring relative to the pressure bulkhead.

***Excerpt from RTCA DO-183, *Minimum Operational Performance Standards for Emergency Locator Transmitters* (May 1983)**
[As incorporated in TSO-C91a, TSO-C126]

Section 3.1.8 — ELT Mounting. “The ELT shall be mounted to primary aircraft load-carrying structures such as trusses, bulkheads, longerons, spars, or floor beams (not aircraft skin). The mounts shall have a maximum static load deflection no greater than 2.5 mm (0.1 inch) when a force of 450 Newtons (100 lbf) is applied to the mount in the most flexible direction. Deflection measurements shall be made with reference to another part of the airframe not less than 0.3 meter (1 foot) nor more than 1.0 meter (3 feet) from the mounting location.”

Installation – Scheduling

- Like most upgrades or repairs, planning a 406 MHz ELT installation to coincide with an aircraft's annual inspection can be advantageous, particularly if:
  - The aircraft does not already have a cockpit remote switch and the associated wiring, and seats and/or panels have to be removed to install it.
  - The aircraft has a remote switch and associated wiring, but the owner wishes to change or upgrade it for the new 406 MHz system.
  - Repair or strengthening work is required at the ELT mounting location.
  - A backing plate or doubler is required for the installation of a rod antenna; or if a ground plane must be created for a new antenna installation on a composite aircraft.
- If an owner is not yet ready to purchase a 406 MHz ELT, but plans to do so in the future, the wiring that connects the cockpit remote switch to the ELT may be installed during the annual inspection. When the ELT and remote switch are ready to be added, no major disruption of seats, carpeting, or panels will therefore be required.

4.2 Testing 406 MHz ELTs

Every 406 MHz ELT is equipped with an internal self-test function. These routine operational checks should be conducted in strict accordance with the manufacturer's instructions, as each model has its own unique test procedure. This protocol should be built into operating checklists, as/if applicable. The manufacturer's documentation will also indicate how often these checks should be carried out, to ensure that the maximum battery life of the unit is preserved.

Routine 406 MHz ELT tests that involve transmission of the 121.5 MHz homing signal should only be carried out during the first five minutes of every UTC (Zulu) hour, and for a duration of five seconds or less. Since air traffic controllers, flight service specialists, and many pilots still monitor 121.5 MHz, an ELT signal heard outside this test window will be reported as a possible emergency.

The digital signal from a 406 MHz ELT that is turned on for approximately 50 seconds or more will be captured by the COSPAS-SARSAT satellites, and interpreted as a distress transmission. If it is believed that this may have happened in error, **CMCC Trenton** should be contacted without delay at **1-800-211-8107**. The staff will welcome such calls, and there is no fine or charge levied by the SAR system for inadvertent activations of this kind. The aircraft registration, location, and the approximate time and duration of the inadvertent ELT transmission are some of the details that should be provided to the CMCC staff.

4.3 Disposing of 121.5 MHz ELTs

As aircraft are fitted with newer 406 MHz ELTs, an increasing number of 121.5 MHz ELTs are being removed from service. It is important to ensure that these 121.5 MHz units are properly decommissioned, including removing the battery and disabling the electronics.

Several unnecessary searches have concluded at local garbage dumps, due to an emergency beacon that had been improperly discarded. Curious children—and adults with a child-like sense of curiosity—have also mistakenly activated ELTs and other types of emergency beacons after finding them around the house, workshop, or airport.

4.4 Other distress-alerting and locating technologies

In addition to ELTs, other distress-alerting and locating technologies are now available. These include 406 MHz Personal Locator Beacons that operate with the COSPAS-SARSAT system, as well as commercial satellite tracking and messaging technologies.

In general, pilots and aircraft owners who are considering alternative technologies for search and rescue alerting are encouraged to research the following:

- What is the extent of the satellite or system coverage in the area in which the device will be used?
- Is the device designed for the environment in which it is going to be used most often (i.e. aviation), and to what standard(s)?
- Is the device approved for use in Canada?
- Who will receive the message that an emergency situation exists, and who will respond?
- What is the battery life or power source for the device; and what is its optimum operating temperature range?
- Does the device have to successfully receive a GPS position to determine its location, or can its location be calculated through other means?
- Does it have a secondary radio homing signal that SAR units can use to pinpoint the position of a downed aircraft (e.g. at night or in low visibility)?
- Is the system that supports the device monitored continuously by the service provider? In other words, will any problems or outages with the system be promptly detected and remedied?
- Is the company monitoring the aircraft or commercial device well-acquainted with Canada's SAR system, and does it have the appropriate contact numbers? As toll-free (1-800) numbers may not work in all areas, direct-dial emergency numbers including the area code should be supplied for the region in which the aircraft will be operating.

The following table provides a comparison of the features of some of these units, relative to their performance in an aviation environment, and the capabilities of the COSPAS-SARSAT system.

TECHNOLOGY COMPARISON MATRIX Post February 1, 2009 (see notes below)	**121.5 MHz ELT** (TSOC91a model)	**406 MHz ELT** (model without GPS interface	**406 MHz PLB** (model with GPS interface)	**Personal satellite messenger device**
Estimated Cost				
a. Initial cost	$250[1]	$900[2]	$400–$600[3]	$169[4]
b. Installation cost	$800	$200–$1000	n/a	n/a
c. Annual system access fee	$0	$0	$0	$99/year[4]
d. Annual certification cost	$30–50	$80–150[5]	n/a	n/a
e. Annual cost for tracking service	n/a	n/a	n/a	$50/year[4]
Aviation Performance				
f. Distress signal can be activated manually while airborne, in case of an in-flight emergency	**YES** (cockpit switch)	**YES** (cockpit switch)	**YES** (if within reach)	**YES** (if within reach)
g. Activates automatically as a result of crash-like forces; no crew intervention required	**YES**	**YES**	**NO**	**NO**
h. Distress signal is automatically identified to the SAR response system as an aviation emergency	**YES**	**YES**	**NO**	**NO**
i. Designed & tested specifically for aviation use	**YES**	**YES**	**NO**	**NO**
j. Fixed to aircraft structure (TSO-compliant)	**YES**	**YES**	**NO**	**NO**
System Performance				
k. All system components (satellites, ground stations, mission control) monitored by SAR authorities	**NO***	**YES**	**YES**	**NO**
l. Device is equipped with a homing signal to guide rescuers to the distress location	**YES**	**YES**	**YES**	**NO**
m. Distress alert is automatically routed to appropriate SAR response centre worldwide	**NO***	**YES**	**YES**	**NO**
n. Canadian SAR system is alerted within a few minutes of a distress transmission	**NO***	**YES**	**YES**	**NO**
o. Global satellite coverage	**NO***	**YES**	**YES**	**NO**
p. Owner can update contact information directly with Canadian SAR database	**NO**	**YES**	**YES**	**NO**
q. Device is uniquely identifiable and registered to the owner	**NO**	**YES**	**YES**	**YES**
r. Option for real-time tracking of aircraft during normal flight operations	**NO**	**NO**	**NO**	**YES**

Notes from table:

[1] Basic TSO-C91a model (e.g. ACK Technologies E-01)
[2] Compact TSO-C126 / C126a model designed for light airplanes (e.g. Artex ME406AF; Kannad 406 AF)
[3] GPS-enabled PLB (e.g. ACR SARLink)
[4] From SPOT, Inc retailer site
[5] Based on an informal survey of five avionics shops (January 2010); may vary based on model of ELT.

* Response was “YES” prior to February 1, 2009.

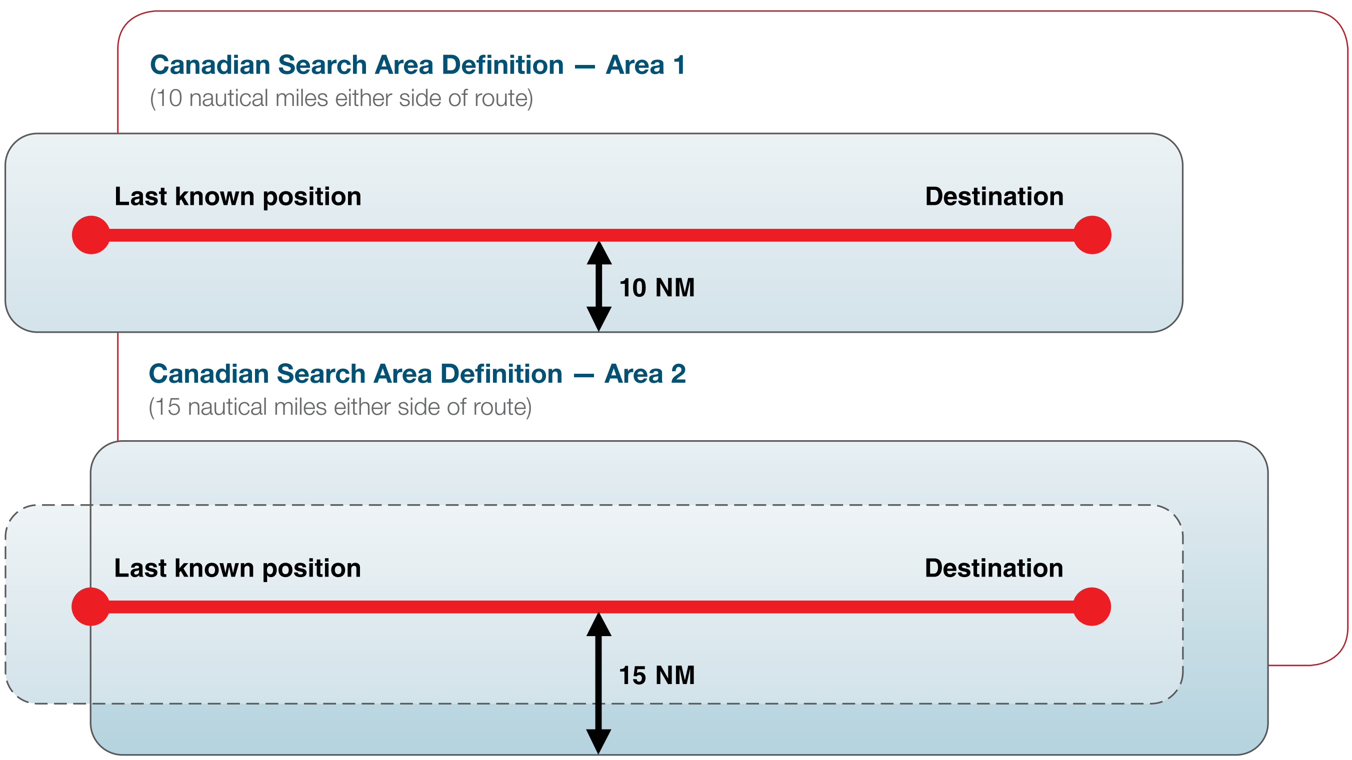
5 SEARCH AND RESCUE: A shared responsibility

SAR is a shared responsibility. Pilots and aircraft owners are encouraged to make best use of available technology—including 406 MHz ELTs—to increase their odds of survival should an emergency situation occur.

If an aircraft is equipped with a 406 MHz ELT system, the use of the cockpit remote switch should be built into emergency checklists and procedures as appropriate. Any serious in-flight emergency that could result in a forced landing should require the aircrew to activate the ELT while in flight, to ensure that search and rescue is alerted as early as possible. This is a critical benefit of the 406 MHz system that should not be overlooked. If the emergency situation is safely resolved, the ELT can be shut off, and CMCC Trenton advised that search and rescue assistance is not required.

Technology aside, filing flight plans and flight itineraries, and making regular position reports remain key elements in an effective SAR response. In Canada, the area covered in a visual search will typically extend to a **maximum of 15 nautical miles on either side of the flight-planned route**, starting from the aircraft's last known position and extending to its destination. In mountainous regions, search areas will be defined to best suit the terrain and the planned route of flight. It is therefore critical to the safety of pilots that they maintain their route as filed, and advise air traffic services of any en route changes or deviations as soon as practicable.

These standard areas may of course be adapted to best fit the variables unique to each search mission.



6 ADDITIONAL INFORMATION

1) COSPAS-SARSAT
   International Satellite System for Search and Rescue
   www.cospas-sarsat.org

2) National Search and Rescue Secretariat *Information on emergency beacons, and Canada's National Search and Rescue Program*
   www.nss-snrs.gc.ca

3) Canadian Forces
   Air search and rescue
   www.airforce.forces.gc.ca/v2/page-eng.asp?id=17

4) Transport Canada
   National Aircraft Certification — List of Approved Emergency Locator Transmitters
   www.tc.gc.ca/eng/civilaviation/certification/elt-65.htm

5) Transport Canada
   Regional Offices — Information and contacts
   www.tc.gc.ca/eng/regions.htm

6) RTCA, Inc. (Radio Technical Commission for Aeronautics)
   Standards for the design and installation of ELTs
   www.rtca.org

7) Manufacturers of COSPAS-SARSAT and Canadian-certified 406 MHz ELTs (as of March 10, 2011):

ACK Technologies Inc.	**www.ackavionics.com**
Air Precision (Cobham Avionics)	**www.cobham.com**
Ameri-King	**www.ameri-king.com**
Cobham Avionics/Artex	**www.cobham.com**
DME Corporation (Astronics)	**www.dmecorp.com**
ELTA	**www.elta.fr**
Emergency Beacon Corp.	**www.emergencybeaconcorp.com**
Honeywell ASCa Inc.	**www.honeywell.com**
H.R. Smith (Technical Developments)	**www.hr-smith.com**
Kannad	**www.kannad.com**

As this list is periodically updated, be sure to consult Transport Canada's National Aircraft Certification Web site (see #4 above) for the latest information on certified 406 MHz ELTs.

Questions, comments, and suggestions related to this document; or requests for printed or electronic copies may be sent to:

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