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NORTHERN AIRBORNE TECHNOLOGY LTD.

Reducing the Cost of 406 MHz ELTs: An Investigation

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Reducing the Cost of 406 MHz ELTs: An Investigation

by
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Since some of the accepted measures in the industry are imperial, metric measures are not always used in this report.

Un sommaire en français se trouve avant la table des matières.

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16. Abstract

This report discusses ways to reduce the cost of a 406 MHz emergency locator transmitter (ELT), currently priced at approximately $3,000. The target price is between $1,000 and $1,500. The existing application specific integrated circuit (ASIC) and supporting circuitry used on the previous prototype are expensive. A new low-cost design must be completed, involving new electrical and mechanical components. The cost of a new reference oscillator design is a major consideration. The use of lithium sulphur dioxide ($LiSO_2$) cells in the battery pack should be allowed – although a current Airworthiness Directive prohibits its use for civil aviation. Studies should be initiated to determine the safety and reliability of the new generation of $LiSO_2$ technology. The 121.5 MHz radiated power requirement should be reduced to agree with the current EPIRB specification. The cost of product development, tooling, and approvals is extremely high for an ELT. Mandated carriage for general aviation would allow amortization of these high costs over a large number of units, as well as reduction of material costs because of volume purchasing. With these factors considered, it should be possible to arrive at a price of $1,500.

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16. Résumé

Ce rapport examine des moyens de réduire le coût des radiobalises de détresse (ELT) 406 MHz, lequel se situe présentement autour de 3 000 $ pièce. Le coût visé est de 1 000 $ à 1 500 $. Le circuit intégré spécifique (CIS) et l'ensemble des circuits connexes utilisés pour le prototype réalisé dans une phase antérieure s'avèrent coûteux.

Il y a donc lieu de réaliser un nouveau prototype moins coûteux, constitué de composants électriques et mécaniques. Le coût du nouvel oscillateur de référence contribue pour une grande part au coût global du dispositif. Le recours à des piles au lithium ($LiSO_2$) devrait être permis (une consigne de navigabilité en interdit présentement l'utilisation dans l'aviation civile). Des études devraient être entreprises pour déterminer la sûreté et la fiabilité des piles $LiSO_2$ de nouvelle génération. La norme actuelle concernant la puissance d'émission sur 121,5 MHz devrait être révisée pour être au diapason de la spécification concernant les balises marines (RLS). Les coûts associés au développement de produit, à l'outillage et au processus d'homologation sont extrêmement élevés pour une radiobalise de détresse. Le fait de rendre obligatoire une radiobalise 406 MHz dans les aéronefs de l'aviation générale permettrait de répartir ces coûts sur un grand nombre d'unités, sans compter les économies réalisées par l'achat en masse des matériaux. En conjuguant tous ces facteurs, il devrait être possible d'atteindre le coût cible de 1 500 $.

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EXECUTIVE SUMMARY

The aviation community has been slow to adopt the new 406 MHz beacon technology, mainly because of the large installed base and lower cost of the older 121.5 MHz units. This study examines ways to reduce the cost of the 406 MHz ELTs, which are selling for approximately $3,000. The target price is in the $1,000 to $1,500 range.

This cost study is based on the prototype ELT developed by Northern Airborne Technology Ltd.: the SATFIND-406 Model A-1000 ELT, developed under a previous National Search and Rescue Secretariat New Initiatives program. It investigates the possibility of modification of various standards, as well as the use of the latest technology.

An in-depth analysis was completed on the A-1000 ELT to determine how cost reductions could be realized. The A-1000 ELT uses an application specific integrated circuit (ASIC) developed in 1991. The use of this ASIC and the inherent design approach are expensive and the cost cannot be reduced further. A lower-cost electrical design must be implemented. Alternative design approaches such as an analogue phase modulator, a new lower-cost power amplifier, and a microprocessor-based controller would help to reduce overall costs. Low-cost design approaches such as eliminating tuning components where possible and designing for automated testing would also help to lower costs. A smaller, lower-cost housing must be designed to meet the stringent TSO-C126 specifications and to require a minimum amount of labour to assemble.

An Airworthiness Directive currently prohibits the use of lithium sulphur dioxide ($LiSO_2$) in ELTs. This directive should be reviewed in light of improvements in the safety and reliability of $LiSO_2$ cells made over the last few years. $LiSO_2$ chemistry has been used extensively in marine beacons, with excellent results. A significant cost saving could be realized if $LiSO_2$ chemistry was used in ELTs.

The reference oscillator is the single most expensive item in the beacon design, and perhaps it could be redesigned. A redesign would focus on low-cost manufacturing and low current consumption at low temperatures. This redesign could lower costs substantially.

Relaxation or elimination of any of the current ELT specifications would appear detrimental to ELT reliability. One exception is for the 121.5 MHz output power. This specification should be lowered, perhaps to align with what is currently used for the marine beacon, the EPIRB. Reducing this output power requirement, combined with using a lower current in the oscillator, may allow for a reduction in the number of cells used or for the use of smaller cells within the battery pack.

A major contributor to the high cost of the ELT is the high development cost required to comply with the stringent environmental requirements of RTCA DO-204 and the software requirements of D0-178B, coupled with the knowledge required and the high cost of completing the TSO-C126 approval process. If volumes were high enough, this high cost could be amortized over many units. Furthermore, if volumes increase, the material cost will be reduced. These high volumes will be achieved once the regulating bodies require the carriage of 406 MHz ELTs.

With the combination of new electrical and mechanical designs, the allowed use of $LiSO_2$ batteries, a new oscillator design, a relaxation of the 121.5 MHz output power requirement, and the high volumes guaranteed from the mandated carriage of 406 MHz ELTs, the anticipated goal of $1,500 should be attainable.

SOMMAIRE

Le milieu de l'aviation tarde à adopter les nouvelles radiobalises de détresse 406 MHz, en raison surtout du vaste parc de balises déjà installées et du coût moindre des anciennes balises utilisant la fréquence 121,5 MHz. La présente étude examine des moyens d'abaisser le coût des radiobalises de détresse 406 MHz, lequel se situe présentement autour de 3 000 $ pièce. Le prix visé est de 1 000 $ à 1 500 $.

Cette étude porte plus précisément sur le prototype de radiobalise mis au point par Northern Airborne Technology Ltd. (SATFIND-406, modèle A-1000), dans le cadre d'un programme antérieur réalisé au titre des Nouvelles initiatives du Secrétariat national Recherche et sauvetage. Elle examine en outre la possibilité de revoir diverses normes, y compris de normaliser l'utilisation des nouvelles radiobalises 406 MHz.

Les chercheurs ont analysé en profondeur la radiobalise A-1000 afin de déterminer les éléments de coût propices à une réduction. Cette radiobalise utilise un circuit intégré spécifique (CIS) développé en 1991. Or, l'utilisation de ce circuit et la démarche de conception connexe entraînent des coûts très élevés et incompressibles. D'où la nécessité de se tourner vers une conception fondée sur des composants électriques, moins coûteux. Des solutions de rechange faisant appel, par exemple, à un modulateur de phase analogique, à un nouvel amplificateur de puissance plus économique et à un contrôleur à micro-processeur, pourraient réduire le coût global de la radiobalise. Une conception moins coûteuse, comme l'élimination, lorsque c'est possible, des dispositifs de réglage et l'adjonction d'un système de vérification automatique, sont d'autres façons de réduire les coûts. Il y a lieu en outre de concevoir un boîtier plus petit et plus économique, qui respecterait la norme TSO-C126 et exigerait un minimum de travail d'assemblage.

Une consigne de navigabilité interdit présentement les radiobalises de détresse alimentées par des piles au lithium ($LiSO_2$). Il importe de revoir cette consigne à la lumière des améliorations apportées à la sûreté et à la fiabilité des nouvelles piles $LiSO_2$ produites depuis quelques années. Les piles $LiSO_2$ sont largement utilisées dans les radiophares maritimes, avec d'excellents résultats. Des économies importantes pourraient être réalisées si les piles au lithium étaient autorisées pour les radiobalises de détresse.

L'oscillateur de référence est le composant le plus cher de la radiobalise. Peut-être pourrait-on le repenser, en se fixant comme objectifs un faible coût de fabrication et une faible consommation d'énergie à basse température. Ces caractéristiques pourraient réduire considérablement les coûts.

L’abaissement ou l’élimination de l’une ou l’autre des exigences actuelles concernant les radiobalises de détresse pourraient compromettre la fiabilité de ces dispositifs. Il existe toutefois une exception, soit la puissance d’émission sur 121,5 MHz. Cette exigence devrait être abaissée de façon à être au diapason de celle qui vise les balises maritimes (RLS). L’abaissement des exigences en matière de puissance d’émission, conjugué à une consommation moindre d’énergie par l’oscillateur, peut allonger la période de remplacement des piles ou permettre l’utilisation de piles de moindre puissance.

Le coût élevé d’une radiobalise de détresse s’explique en grande partie par les fortes sommes consacrées aux travaux de développement nécessaires pour respecter les exigences élevées de la norme DO-204 de la RTCA en matière de protection de l’environnement et la norme DO-178B concernant le logiciel, ainsi que par les connaissances approfondies et les coûts élevés que supposent les règles d’homologation établies par le document TSO-C126. Il est donc avantageux de pouvoir répartir tous ces coûts sur un nombre élevé de dispositifs. Sans compter les économies réalisées par l’achat en masse des matériaux. Or, il sera possible d’atteindre ces forts volumes lorsque les organismes de réglementation exigeront que les aéronefs soient équipés de radiobalises 406 MHz.

La combinaison de tous ces facteurs – de nouveaux composants électriques et mécaniques, la permission d’utiliser des piles au lithium, un nouvel oscillateur, l’abaissement de l’exigence concernant la puissance d’émission sur 121,5 MHz, les forts volumes de production garantis par la prescription de radiobalises 406 MHz – devrait réduire le coût de la radiobalise au environ de 1 500 $, comme prévu.

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1 INTRODUCTION

This document is the final report for the project entitled “Investigation Study to Reduce the Cost of 406 MHz ELTs”, sponsored by the Transportation Development Centre (TDC).

1.1 Objectives

The objectives, as set out in the contract Statement of Work, are as follows:

1.1.1 Project Objective

To produce a study to determine ways to reduce the cost of 406 MHz ELTs.

1.1.2 R&D Objective

To develop expertise, techniques, and equipment to improve flight safety in the Canadian air transportation system.

1.1.3 R&D Sub-Objective

To conduct research and development techniques and equipment to improve accident survivability.

1.2 Background

This project represents the continuation of several previous initiatives sponsored by the National Search and Rescue Secretariat (NSS) New SAR Initiatives Program, including the design and development of a 406 MHz ELT (emergency locator transmitter) and a GPS (global positioning system) Interface ELT. These units are being developed with technologies first implemented in the marine sector and are now being implemented for the aviation sector. The aviation community has been slow to adopt the new 406 MHz beacon technology, mainly due to the large installed base and lower cost of the 121.5 MHz units. This study will look for ways to reduce the cost of new 406 MHz ELTs, which are selling for approximately $3000. The target price is $1000 to $1500.

1.3 Scope

The scope of this study is to outline various potential alternatives in order to reduce the cost of 406 MHz ELTs, using the prototype ELT design (SATFIND-406 Model A-1000) as a baseline.

2 DESIGN CONSIDERATIONS

To minimize the cost of an ELT, a low cost electrical and mechanical design must be developed. This new ELT must be a "bare-bones" unit, yet still meet the regulatory requirements. Characteristics of this low-cost ELT will be:

- dual frequency 406 MHz and 121.5 MHz
- no 243 MHz transmitter
- Automatic Fixed configuration only
- serialized protocol – factory programming only
- single antenna port output only
- no GPS receiver or GPS interface
- rugged, metal housing
- $LiSO_2$ (lithium sulphur dioxide) battery

This basic unit could possibly have options to allow for a higher 121.5 MHz output power and the addition of a 243 MHz transmitter. This would meet the European requirements. In addition, the inclusion of a GPS interface and different programming capabilities could be made available. These options would be incorporated at an appropriate additional cost to the user.

2.1 Current Design vs. New Design

The electrical design used in the A-1000 was based on a custom ASIC (application specific integrated circuit) developed in 1991. This ASIC-based design is a high-precision, digitally-based phase modulation design. The ASIC produces a 10 MHz phase modulated intermediate frequency, which is further upconverted to 406 MHz. This upconversion requires the use of a mixer, local oscillator, and a SAW filter. These components are expensive. This method is expensive in relation to lower cost, lower accuracy analogue methods.

By using analogue techniques for phase modulation of the 406 MHz signal, the expensive upconversion process can be eliminated, resulting in a significant cost saving.

2.2 Battery Technology

In the early 1970s, 121.5 MHz ELTs were mandated. Most were built with inferior technology utilizing early $LiSO_2$ battery designs. Problems were experienced and as a result an Airworthiness Directive was issued prohibiting the use of $LiSO_2$ chemistry in ELTs. This directive (CF-81-29R2) is included in Appendix A of this report.

The last decade has seen a tremendous improvement in $LiSO_2$ reliability and safety. EPIRBs (Emergency Position Indication Radio Beacons) are beacons used in marine applications. EPIRBs use this battery technology extensively and have had excellent results with no reported safety incidents in the field. The biggest concern is the fact that the $LiSO_2$ cell uses highly pressurized sulphur dioxide gas in their construction. In the event of a cell failure, the cell may vent releasing sulphur dioxide gas. This gas is very toxic and may be debilitating in a small enclosed environment such as a cockpit. Perhaps a properly designed enclosure could contain any explosive forces and vented components of the battery. This housing would likely be a cast metal housing.

With the excellent safety history that these cells have demonstrated, along with some special housing design techniques, the Airworthiness Directive CF-81-29R2 should be re-evaluated. At the least, an independent laboratory should complete a safety and reliability study into the newer $LiSO_2$ technology.

Lithium manganese dioxide ($LiMnO_2$) is currently used in most ELTs. This chemistry is a non-pressurized, solid cathode design. The compelling reason for wanting to use $LiSO_2$ technology instead of $LiMnO_2$ technology is the cost. A $LiSO_2$ cell is approximately 25% of the cost of a $LiMnO_2$ cell. Typically, four cells are used in a pack. Furthermore, if other design requirements are modified or changed, such as oscillator power and 121.5 MHz output requirements, there is a possibility that the battery pack could be composed of only three cells. This would further increase the savings with the overall cost savings being very significant.

2.3 Reference Oscillator

The ovenized reference oscillator is currently the single most expensive item in the beacon. Reducing this cost is essential to realizing a lower cost ELT. Manufacturers currently producing this part have lowered their prices as far as possible. Perhaps it is time for a beacon manufacturer to develop and produce an oscillator. Various technologies should be examined with the goal of achieving the required frequency stability and the minimum current consumption at the lower temperatures of operation. With sufficient funding for development, the oscillator cost could be reduced by 50%.

3 SPECIFICATION CONSIDERATIONS

3.1 TSO-C126

The Federal Aviation Administration's Technical Standard Order TSO-C126 addresses the requirements for 406 MHz ELTs. Other documents relating to the required parameters of an ELT include COSPAS-SARSAT T.001, which ensures that the signals transmitted by a beacon are fully compliant with the receivers on the satellites. Other documents include RTCA DO-204, which addresses all electrical and environmental parameters of a 406 MHz ELT, RTCA DO-183, which addresses the requirements for the 121.5 MHz transmitter, and RTCA DO-178B, which addresses all software related issues.

3.2 COSPAS-SARSAT T.001

3.2.1 406 MHz Output Power

The output power requirement is 5W +/- 2 dB at the input to the antenna. The antenna gain is –3 to +4 dBi. For the low earth orbiting satellites (LEOs), this output power appears to have plenty of margin, however, with the geostationary satellites (GEOs) now forming an important part of the COSPAS-SARSAT infrastructure, this output power is required. On location protocol beacons, the distress location can be determined almost instantaneously provided the signal reaches the GEO satellites with sufficient power levels. This near instantaneous alerting can allow SAR forces to be set in motion hours before the LEO satellites determine the Doppler location. These critical hours can mean the difference between life and death for crash victims. Hence, the 406 MHz 5W output power requirement should not be reduced. Any changes made to this specification would be detrimental to system performance.

3.2.2 Oscillator Stability

The heart of the beacon is a highly stable ovenized crystal oscillator (OCXO). This OCXO is the single most expensive item in the ELT. It must meet the demanding stability requirement of the COSPAS-SARSAT specifications. This highly stable signal is used by the LEOs to determine the location of the distress signal (using Doppler shift techniques). The more stable the signal, the more accurate the distress location.

A proposal from an Australian company has been presented to the COSPAS-SARSAT Joint Committee to relax the stringent frequency stability requirement of the 406 MHz transmitter. The intent of the proposal was to replace the OCXO with a temperature compensated crystal oscillator (TCXO) at a much lower cost, and add a GPS receiver which would be the position determining element. Along with cost savings, the use of the TCXO would save the battery current normally used for the OCXO oven. This would allow the use of a smaller battery, hence more cost savings. The location determined from the GPS receiver would be included on the transmitted 406 MHz message using the COSPAS-SARSAT location protocols.

If the frequency stabilities were relaxed, then the location accuracy determined from Doppler shift would be degraded. Table 1 shows the comparison of the current Cospas-Sarsat requirement and the proposed requirement and how it affects the location accuracy.

Table 1. Oscillator stability comparison

	COSPAS-SARSAT current requirement	**Proposed requirement**
Short term stability	2 X 10^{-9} in 100 ms	2 X 10^{-8} in 100 ms
Medium term stability:		
- Mean slope	1 X 10^{-9} /min	1 X 10^{-7} /min
- Residual frequency	3 X 10^{-9}	3 X 10^{-7}
Location accuracy	3 km	>100 km
Search area	28 km^2	31,416 km^2

The location accuracy would be severely degraded using these relaxed requirements. This means that if the GPS portion of the beacon did not acquire location data for any reason, the beacon would effectively not be locatable. COSPAS-SARSAT has relied successfully on the 406 MHz component as the backbone of its system for many years. The GPS system is not yet robust enough to replace the 406.

Furthermore, it is questionable whether cost savings would be achieved.
Many current beacon designs utilize a 3 or 4 D-cell battery pack. The reduction in current due to switching from an OCXO to a TCXO may allow battery designs to switch to a C cell or a 5/4 C cell. The cost savings between the D and C cells is only about $3 per cell or about $9 to $12 per pack, depending on the final pack arrangement. The estimated cost savings using the TCXO is $50. The estimated cost of an integrated GPS engine and antenna is $60. The estimated net cost savings is shown in Table 2.

Table 2. Cost saving using a relaxed frequency stability requirement

	Δ$
Replace OCXO with TCXO	-50
Replace D cells with C Cells	-10
Add GPS Engine	+60
NET SAVING	**$0**

As shown in Table 2, there is essentially no cost saving to this proposal. Thus, the proposed relaxation of the frequency stability requirement should not be adopted.

3.3 RTCA/DO-183

3.3.1 121.5 MHz Output Power

The requirement RTCA/DO-183 defines the minimum radiated output power of the 121.5 MHz and 243 MHz transmitters as 50 mW. This output power is double the minimum homing power required for marine beacons (EPIRBs). This level is considered to be excessive. By the year 2008, the 121.5 MHz processing may be eliminated from the satellites. This will mean that the 121.5 MHz signals on all beacons will be used solely by SAR forces to home in on the ELT for the last few kilometres. If the main purpose for the 121.5 MHz transmitter is for homing and not for satellite processing, then the output power requirement can be reduced. Experimentation has shown that SAR aircraft can home in on beacons from a range of 24 km (15 miles) while transmitting between 5 mW and 10 mW PERP. Theoretical ranges are determined using the formula:

$$d_{km} = \log^{-1}\left[\frac{-(P_r) + P_t + G_t - 32.5 - 20\log f}{20}\right]$$

where:
d_{km} = range in kilometres
P_r = effective homing receive threshold power in dBm
P_t = transmitter power in dBm
G_t = transmit antenna gain in dB
f = frequency in MHz

The typical receiver threshold is -110 dBm, the typical receiver antenna gain is 0 dBi, and the typical cable and antenna switching array losses are -8 dB. Thus, the effective receiver threshold power is: P_r = -110 -(0) -(-8)= -102 dBm

ELT transmitter antenna gain: G_t = -3 dB
ELT transmitter frequency: f = 121.5

Table 3. 121.5 MHz output power and homing range

PERP (mW)	Range (km)
100	174
50	123
25	87
10	62
5	44

The results shown in Table 3 indicate there is sufficient range when the transmitter is used solely as an auxiliary homer for the 406 MHz transmitter even when transmitting at levels as low as 5 mW.

As the 121.5 MHz transmitter and the oven oscillator are the largest current consumers in a beacon, reducing the 121.5 MHz transmitter power requirement would have a significant impact on the overall power consumption of the ELT. This may allow an ELT to use fewer cells or a smaller size cell. Both scenarios would reduce the ELT cost. At a minimum, the ELT specification should be changed to agree with the EPIRB specification where the minimum transmitted output power is 25 mW.

4 MANDATED CARRIAGE

Development costs are very high when it is necessary to comply with the stringent environmental requirements of RTCA DO-204 and the software requirements of D0-178B. Given the severe operating environment of an ELT and the need for a high quality product, it is not feasible to eliminate any of these requirements. Cost effective enclosures for the ELT that meet the environmental requirements usually require very high tooling costs. Also, the TSO-C126 approval process is rather convoluted. In order to get through all the approvals, a thorough knowledge of the process is required. This knowledge is expensive. All of these factors combined create very high development costs that must be amortized over the number of units sold. For instance, a $1M development cost amortized over 2000 units is $500 per unit, while amortized over 50,000 units is $20 per unit. This is very significant. Also, when volumes increase, the component volume will increase, further reducing costs. With higher volumes guaranteed, companies will be more likely to invest the necessary dollars required to develop better, lower-cost components such as the reference oscillator. These high volumes will be only be realized once the regulating bodies mandate carriage of 406 MHz ELTs.

Based on the recommendations of the Transport Canada (TDC) report TP12829E, “Design and Development of a Second Generation 406 MHz Emergency Locator Transmitter (ELT)”, TSO C126 should be adopted and mandated for general aviation. Major price reductions cannot be achieved until guaranteed volumes are scheduled.

5 CONCLUSIONS

Various means to reduce the cost of the 406 MHz ELT have been presented. If the following recommendations listed in section 5.1 are implemented, the cost of an ELT should be able to approach the goal of $1,500.

5.1 Recommendations

Based on the work completed for this study, the following recommendations are presented:

- An overall cost reduction for the ELT should be completed. The new cost-reduced ELT would consist of:
  - redesigned reference oscillator
  - lower-cost battery technology
  - a very low-cost metal housing. This housing would be a cast housing designed for the more demanding requirements such as the impact test and the flame test. This housing would withstand a high internal pressure and contain any vented components from the battery.
  - labour content would be minimized through effective mechanical and electrical design, extensive use of automated surface mount technology, and the use of automated testers.

  A bare-bones ELT-AF unit would not include a 243 MHz transmitter or any GPS functions. In comparison to the ASIC design used in the prototype units, newer design technology exists that is far less expensive in material and labour costs.

- Using lithium sulphur dioxide ($LiSO_2$) technology in the battery pack would provide a tremendous cost saving over the currently used lithium manganese dioxide (MnO_2) technology. Newer, more robust housing designs to contain any venting components may help promote the acceptable use of this technology. A current Airworthiness Directive (AD-CF-81-29R2) prohibits the use of $LiSO_2$ chemistry in ELTs. This directive should be reviewed and a study completed by an independent laboratory into the safety and reliability of the newer $LiSO_2$ technology available today.

- The reference oscillator should be redesigned with cost as the main consideration.

- The 121.5 MHz output power requirement is excessive and should be relaxed. The minimum output power level should be brought in line with the current EPIRB specification of 25 mW PERP.

- Based on the recommendations of the TDC report TP12829E, TSO-C126 should be adopted and mandated for all aircraft. Major price reductions cannot be achieved until volumes are assured in order to amortize the high cost of development, tooling, and approvals.

5.2 Follow-on Work

Possible areas of follow-on work include:

- Review Airworthiness Directive AD-CF-81-29R2 and complete a new independent study into the safety and reliability of current $LiSO_2$ battery technology.

- Provide funding for the development of a low-cost reference oscillator.

- Provide funding for a low-cost ELT development.

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10 FCC: Part 87 of Chapter 1 of Title 47 of the Code of Federal Regulations

11 RTCA/DO-204 Minimum Operational Performance Standards for 406 MHz Emergency Locator Transmitter (ELT). Sept. 29, 1989

12 RTCA/DO-183 Minimum Operational Performance Standards for Emergency Locator Transmitters Operating on 121.5 and 243 MHz. May 13, 1983

13 RTCA/DO-160C Environmental Conditions and Test Procedures for Airborne Equipment. Dec. 4, 1989

14 RSS-187 Emergency Indication Radio Beacons, Emergency Locator Transmitters and Personal Locator Beacons. Issue 3, Rev. 1, June 17, 1997, Industry Canada

15 MIL-HDBK-217E Reliability Production of Electronic Equipment. October 27, 1986

16 CJ-81-29R2 Transport Canada Airworthiness Directive

17 TP 12829E Design and Development of a Second Generation 406 MHz Emergency Locator Transmitter (ELT), Transportation Development Centre, Transport Canada

APPENDIX A: AIRWORTHINESS DIRECTIVE CF-81-29R2

CF-81-29R2 EMERGENCY LOCATOR TRANSMITTERS

Applies to all Canadian registered aircraft equipped with emergency locator transmitters (ELTs) containing, or which have at any time contained, lithium sulphur dioxide batteries.

Compliance is required on 28 October 1994, the effective date of Airworthiness Directive (AD) CF-81-29R1.

There have been instances of explosive failures of lithium sulphur dioxide batteries installed in ELTs, and a further incident involving the venting of noxious gas into the cabin area of an occupied aircraft. Subsequently, it was determined that there was a high potential for sulphurous acid corrosion to occur within an ELT which, at any time, contained lithium sulphur dioxide batteries. Such corrosion might occur even after the lithium sulphur dioxide batteries had been removed and replaced by another battery type. As a consequence, this directive was originally issued to require removal of all lithium batteries from ELTs and an annual inspection for sulphurous corrosion for any ELTs that had at any time contained lithium batteries.

AD CF-81-29R1 was issued to cover all ELTs that are presently eligible for installation on Canadian registered aircraft and to provide relief to the annual inspection required by the original issue of this directive. Additionally, it was subsequently recognized that when this AD was originally issued, lithium batteries were mainly of one type, namely sulphur dioxide ($LiSO_2$), whereas new technology type lithium batteries (e.g. $LiMnO_2$) can be installed in ELTs without causing any hazards, provided that those batteries are properly approved for airborne usage.

To preclude the hazards associated with explosion or venting of lithium sulphur dioxide cells installed in ELTs and to ensure that any ELTs, which are installed to meet the requirements of ANO II, No. 17, are serviceable, accomplish the following:

1. Remove any ELT that contains lithium sulphur dioxide batteries and replace with an eligible serviceable ELT.

Note: Eligible ELTs are listed in the current edition of the Industry Canada Radio Equipment List (PSP-100). Eligible ELT batteries are listed in the current edition of Airworthiness Notice No. B014.

2. ELTs that have at any time contained lithium sulphur dioxide batteries may be installed on the aircraft, provided that these ELTs are:

(a) Fitted with a non-lithium sulphur dioxide battery pack approved by the ELT manufacturer; and

(b) Inspected before installation, and annually thereafter, for sulphurous corrosion. Any ELT found corroded shall be removed from service.

The above inspection requirement may be discontinued for an ELT which is found to be free of sulphurous corrosion on at least three (3) consecutive annual inspections.

Alternative means of compliance with the requirements of this directive may be used only if approved by the Director, Airworthiness Branch, Transport Canada, Ottawa. Any application should be made to the appropriate regional office.

This revision supersedes Airworthiness Directive CF-81-29R1 issued 30 August 1994.

This directive becomes effective 10 April 1995.

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