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Current Emergency Locator Transmitter (ELT) Deficiencies and Potential Improvements Utilizing TSO-C91a ELTs

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LIST OF ATTACHMENTS

1. Excerpt from the House of Representatives, 1st Session, Report 99-212. Department of Housing and Urban Development Independent Agencies Appropriation Bill, 1986, Page 44.

2. NTSB form 6120.4, Sup. A, Page 1, Block 56, ELT Reason for Noneffectiveness/Failure.

3. FAA ELT Field Test Procedure/Data Sheet.

4. Alaskan ELT Survey, Letter from Alaskan Region FAA Office to HQ ARRS, Scott AFB, Illinois, dated December 30, 1987.

Current Emergency Locator Transmitter (ELT) Deficiencies and Potential Improvements Utilizing TSO-C91a ELTs

I. INTRODUCTION

- ***The Interagency Committee for Search and Rescue (ICSAR) and the Search and Rescue (SAR) community has long been aware of the current Emergency Locator Transmitter (ELT) problems.***

- ***In a letter to the Federal Aviation Administration (FAA), ICSAR stated the problem as a 2/3 failure rate and 97% false alarm rate.***

The Emergency Locator Transmitter (ELT) has proven to be an effective life saving device for the aviation community; however, two problems have plagued its operational effectiveness since its inception. First, ELTs often fail to operate when involved in an aircraft accident and second, they often operate when they are not supposed to, creating false alarms. The impact of these two problems is far reaching. Its failure to operate when it should causes lives to be lost unnecessarily which in turn erodes public confidence in the system as a life saving device. Its tendency to transmit false alarms has also created a "cry wolf" syndrome. Aircraft owners resent having to install and maintain a device which is not reliable and the rescue community is forced to deal with hundreds of false alarms annually.

- ***Congress, in a 1986 appropriations bill, requested the National Aeronautics and Space Administration (NASA) to assist the FAA in the implementation of a second generation ELT.***

Recognizing the need to improve ELT performance, Congress in 1986 (Department of Housing and Urban Development-Independent Agencies Appropriation Bill) urged that improvements be addressed (Attachment 1). The bill stated, "It is not satisfactory that units with a false alarm rate of over 97% and a non-activation rate of 70% continue to be mandated by the federal government when an improved technical standard has been developed and can be provided for effective satellite monitoring. It is recognized that NASA cannot initiate the necessary administrative action to mandate improved transmitters, but as the developer of the satellite system, NASA should urge the FAA to proceed and should make available technical expertise to support any FAA initiative in this area."

- ***Objectives of NASA Analysis:***
  - ***Validate the problem***
  - ***Document the specific causes of the problem***
  - ***Estimate improvements from C91a***
  - ***Estimate the benefits***
  - ***Determine the need for and benefits from an improved inspection and maintenance program.***

NASA, in response to the Congressional report, offered assistance to the FAA, which was in the process of developing a Notice of Proposed Rule Making (NPRM) concerning ELT improvements. Although everyone recognized that problems existed with the current ELTs in the field, quantification of the problems was lacking. Recognizing that specific data would be necessary to support their rule making effort, the FAA, in response to the NASA offer of assistance, asked that NASA conduct an analysis of ELT problems. The scope of the analysis included validation of the problem, quantification of the specific causes of the ELT's failure to operate when it should, causes of false alarms, an estimate of the improvement in performance to be expected from implementation of TSO-C91a (DO-183) and the benefits to be derived as well as the need for an improved inspection and maintenance program. The data used in the analysis is contained in Appendix A.

II. VALIDATION OF FAILURE RATES AND IDENTIFICATION OF SPECIFIC CAUSES

A. Validation of Failure Rate from NTSB Data Analysis

- ***Both the National Transportation Safety Board (NTSB) Annual Reviews of Aircraft Accident Data for General Aviation and the Air Force Rescue Coordination Center (AFRCC) Annual Reports substantiate, what was generally believed, that approximately 75% of all ELTs involved in general aviation accidents do not operate.***

Data from the NTSB data base that originated from the "Factual Report Aviation Accident/Incident" (NTSB Form 6120.4) for calendar years 1983 through 1987 were analyzed. Of the 12,744 accident reports during this period, only 3270 contained information concerning the ELT. In these 3,270 accident reports that included ELT data, the ELTs operated 819 (25%) times and did not operate 2,451 (75%) times. (See Table 1).

Table 1
NTSB Data from 1983 through 1987 Showing the Number and Percentage of ELTs That Did Not Operate During Crashes Involving General Aviation Aircraft

	# OF ACCIDENT REPORTS * 1983-1987	PERCENT
OPERATED	819	25%
DID NOT OPERATE	2451	75%
TOTAL REPORTS	3270	100%

* Accident reports where reasons for ELT Noneffectiveness/Failure were available (Item 56 in Supplement A)

B. Validation of Failure Rate from AFRCC Data Analysis

Further validation of the ELTs failure to operate when in aircraft accidents was obtained from the AFRCC Annual Reports for 1984 through 1987. On 544 aircraft search missions the ELT worked 120 times or 22.1% of the time and did not work on 424 missions or 77.9% of the time. (See Table 2).

Table 2
AFRCC Data from 1984 Through 1987 Showing the Number and Percent of ELTs That Did Not Operate in Crashes when Search Missions Were Required

	# OF SEARCH MISSIONS				TOTALS	PERCENT
	1984	1985	1986	1987		
OPERATED	31	39	35	15	120	22.1%
DID NOT OPERATE	108	93	118	105	424	77.9%
TOTAL	139	132	153	120	544	100%

C. NTSB Data on Specific Causes of Failure

- ***88% of the failures are crash related***
- ***12% are preventable with an inspection and maintenance program***

The NTSB "Factual Report Aviation Accident /Incident" lists 19 specific reasons for ELT non-effectiveness/failure (Attachment 2). Two of the "reasons" (Operated Effectively and Test Satisfactorily after Accident) listed in the NTSB accident report form were dropped from the analysis as they could not be evaluated as "reasons for non-effectiveness." Table 3 below lists the remaining 17 reasons and the number of ELTs that failed in each category during the four year period, 1983 - 1987, as extracted from the NTSB data. It is interesting to note that 88% of the failures are crash related, i.e., "G" switch, fire damage, impact damage and antenna broken or disconnected, which reflects a requirement for ELTs and antennas which are more crash damage resistant. Twelve percent of the failures are attributed to defects which, in most cases, probably existed prior to the accident and consequently prevented the ELT from operating in an emergency situation.

Under a direct contract from the FAA the information derived from the NTSB data base was validated by a detailed review of a sample of 119 case files. This study is contained in Appendix C.

Table 3
ELT Failures from NTSB Factual Report Accident/Incident
(NTSB Form 6120.4) 1983 - 1987

REASONS FOR ELT FAILURE	# OF ELT FAILURES
1. Insufficient G's	245
* 2. Improper installation	12
* 3. Battery dead	42
* 4. Battery corroded	2
* 5. Battery installation incorrect	3
* 6. Incorrect battery	4
7. Fire damage	280
8. Impact damage	356
9. Antenna broken/disconnected	180
10. Water submersion	62
*11. Unit not armed	70
12. Shielded by wreckage	17
13. Shielded by terrain	9
14. Internal failure	14
15. Signal direction altered by terrain	4
*16. Packing device still installed	3
*17. Remote switch off	16
Total:	1319

* NOTE: Preventable with Mandatory Maintenace/Inspection Program

D. Other Substantiating Data

- ***Although other data sources could not be directly correlated with the NTSB data, they supported the finding of the NTSB data analysis.***

Table 4 adds the data collected from other reports that also addresses the ELT non-effectiveness/failure problem. The data listed under the FAA Service Difficulty Reports

(SDR), NTSB Special Study and the FAA Directed Safety Inspection, 1976 (DSI) columns could not be directly correlated to all of the specific reasons for failure listed under the NTSB 1983-1987 column; however, general support does exist. As an example, the NTSB data attributes 245 failures to the "G" switch. The FAA SDR report lists four (4) failures, the NTSB Special Study lists 2,228, and the DSI report lists 109. The small number under SDR (4) does not correlate because SDRs are usually submitted by maintenance technicians who discover defects during normal inspection and maintenance while the 245 "G" switch failures were documented during the process of accident investigation by the NTSB. In addition, the small number of "G" switch problems submitted through the SDR program may be attributed to a lack of information and equipment in the field to determine whether or not a "G" switch is functioning according to specification.

Table 4

Reasons for ELT Non-Effectiveness/Failure Based on Various Sources

	NTSB 1983-1987	SDR	NTSB SPECIAL STUDY	DSI
1. Insufficient G's	245	4	2228	109
2. Improper installation	12	40		6
3. Battery dead	42	47	53	15
4. Battery corroded	2	75		7
5. Battery installation incorrect	3	27		4
6. Incorrect battery	4	67		
7. Fire damage	280	1	} 266*	5
8. Impact damage	356			23
9. Antenna broken/disconnected	180	8	84	10
10. Water submersion	62	3		3
11. Unit not armed	70	3	205	6
12. Shielded by wreckage	17			
13. Shielded by terrain	9			
14. Internal failure	14	102	219	13
15. Signal direction altered by terrain	4			
16. Packing device still installed	3			5
17. Remote switch off	16			20
Totals:	1319	377	3115	226

* Fire and Impact Damage Combined in NTSB Special Study

<u>*SDR*</u> – *FAA Service Difficulty Reports*

<u>*NTSB Special Study*</u> -- *Special Study - Emergency Locator Transmitters: An Overview, 1978*

<u>*DSI*</u> -- *FAA Directed Safety Investigation, 1976*

III. VALIDATION OF FALSE ALARM RATE & CAUSES OF FALSE ALARMS

- ***While the percentage of false alarms is well documented, the specific causes are not easily quantified.***

The number of false alarms that are generated on an annual basis is well documented; however, details which identify the cause of each one is seldom obtained (nor recorded). This is the result of not having a workable follow-up system which would document false alarm cause factors. The Rescue Coordination Centers (RCC) do record reasons, although they are limited by what is forwarded to them by the personnel in the field who locate the ELT transmitting the false alarm. Furthermore, the search personnel (often Civil Air Patrol volunteers) do not have the technical expertise or the test equipment available on the spot to "trouble shoot" a defective ELT and determine what caused the false transmission. Their task, when they locate the transmitting ELT is to simply turn it off. Sometimes the cause is obvious to them, from external examination; i.e., switch turned on, dropped on floor of hangar, case corroded, etc. In this case the information is usually included in the after action mission report which they submit to the AFRCC. However, when a defective ELT is taken by the owner to a shop for repair, the reason for the false transmission is lost in the process. There is no requirement for the owner or the repair shop to report why the ELT malfunctioned nor is there a central data collection point for this information. Consequently, the AFRCC at Scott AFB, Il has the most current and complete documentation available concerning the causes of ELT False alarms.

- ***97% of the ELT signals reported to the AFRCC at Scott Air Force Base are false alarms.***

From 1984 through 1987 the RCC at Scott AFB opened 6,626 rescue missions to locate transmitting ELTs. The results revealed that 6,421(97%) were non-distress or false signals generated by defective ELTs or operator mishandling. A random sample of 265 AFRCC ELT false mission reports yielded 9 reasons for false alarms with the major problems being the "G" switch, corrosion and mishandling. Of the 265 false alarm reports analyzed from the AFRCC, 45 (17%) were EPIRBs, 32 (12%) were military ELTs and 188 (71%) were civilian. It should be noted that in 58% of the cases investigated the cause of the false alarm was unknown or undetermined by the person in the field who located the ELT and filed the mission report with the AFRCC.

The other studies and reports reviewed for false alarm data generally support the information collected at the AFRCC (Table 5).

Table 5
Combined Reasons for False Alarms Based on Current and Post Studies

CAUSE	AFRCC	ARINC FIRs & SDRs	CRI #1	CRI #2	TOTAL
1. G-Switch	17	403	25	9	454
2. Corrosion	4	212	4		220
3. Human Failure	8	62	1	2	73
4. Misc. (heat, water or radiated interference)		70			70
5. G-Switch or Corrosion out of Aircraft	48				48
6. Incorrect Installation of ELT		45			45
7. Mishandling in Aircraft	26				26
8. Accidental Operation of Control			20		20
9. Accidental Operation of Remote Switch			6		6
10. Internal Failure	2		4		6
11. Vibration			4	1	5
12. Repeat Offender	5				5
13. Incorrect Battery	1				1
14. Unknown (no other info given)	154	900	35	4	1,093
TOTALS	265	1,692	99	16	2,072

<u>*AFRCC*</u> -- *Air Force Rescue Coordination Center*

<u>*ARINC*</u> -- *ARINC Research Corporation*

<u>*FIRs*</u> -- *Frequency Interference Reports from the Airways Facilities Division of the FAA*

<u>*SDRs*</u> -- *FAA Service Difficulty Reports*

<u>*CRI*</u> -- *Crash Research Institute*

IV. ESTIMATION OF IMPROVEMENTS TO BE EXPECTED FROM IMPLEMENTING TSO-C91a

As a first step in estimating the improvements that can be expected by implementing TSO-C91a[1], a detailed paragraph by paragraph comparison was made with the requirements of the TSO-C91[2]. RTCA Document DO-147, dated November 1970, established the requirements for the current generation of ELTs that are in the field today. This comparison of performance requirements is contained in the table in Appendix B.

The next step involved a paragraph by paragraph analysis of identified improvements against the reasons for failure (derived from the NTSB data base) and the causes of false alarms (derived from AFRCC data). This resulted in an estimated percent of expected performance improvement. A team of experts consisting of former members of the RTCA ELT committee and an experienced Search and Rescue Operations Officer was assembled to perform the detailed analysis. The team of experts also included a crash investigator who has also been active in ELT research and development.

A. Comparison of Old and New Specifications

To assist in the evaluation of the DO-147 and DO-183 requirements, the pertinent specifications from each document were summarized and placed side by side in a table grouped into five categories:

1. Performance Requirements
2. Crashworthiness
3. Electromagnetic Environment Requirements
4. Environmental Requirements
5. Installed Equipment Performance and Operational Tests

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[1]Details of C91a requirements are contained in RTCA Document DO-183 entitled "Minimum Operational Performance Standards for Emergency Locator Transmitters."

[2]Details of C91 requirements are contained in RTCA Document DO-147 entitled "Minimum Performance Standards for Emergency Locator Transmitters"

"Performance Requirements" was subdivided into ten areas, "Crashworthiness" into five areas, "Electromagnetic Environment" into eight areas, "Environmental Requirements" into fifteen areas and "Installed Equipment Performance and Operational Tests" into six areas. The applicable paragraph from the RTCA documents was then placed in each area for the detailed comparison analysis. (In many cases the DO-147 specifications did not address areas addressed by DO-183.) The team of experts then analyzed the differences between the two documents in each area and summarized the improvements to be expected in the last column of the Appendix B table.

B. Estimate of Improvements in Reliability of the ELT During Crashes

- ***25% of ELTs currently activate in a crash situation; an increase to 73% is expected.***

The NTSB data discussed in Chapter 2 on the specific causes of ELT failure in 1,319 crashes was examined in the light of the improvements summarized in the Appendix B table. For each of the 17 failures documented, the entire set of specifications and the expected improvements was estimated by the team of experts. This improvement, expressed in percentage, along with the applicable areas from the Appendix B table, are shown in Table 6. The percentage of "Expected Improvement" was then used to derive the remaining number of failures that could be expected after TSO-C91a is implemented. The "Expected Improvement" and the remaining number of failures to be expected, is shown in Table 7.

Table 6
Expected Improvements from Implementation of DO-183

REASONS FOR ELT FAILURE	EXPECTED IMPROVEMENT %	APPLICABLE IMPROVEMENTS*
1. Insufficient G's	95%	A.7, A.9, B.2, D.8, E.1, E.4
2. Improper installation	95%	E.1, E.3, E.4, E.5
3. Battery dead	95%	A.9, E.5, E.6
4. Battery corroded	50%	A.10, E.5
5. Battery installation incorrect	45%	A.9, E.2, E.3, E.4, E.5
6. Incorrect battery	75%	E.3, E.4, E.5
7. Fire damage	10%	B.3, B.4, D.14, D.15
8. Impact damage	75%	B.1, B.2, B.3, B.4
9. Antenna broken/disconnected	85%	B.2, B.5
10. Water submersion	0	
11. Unit not armed	98%	A.9, E.1, E.2, E.4, E.5
12. Shielded by wreckage	10%	A.3
13. Shielded by terrain	10%	A.3
14. Internal failure	75%	B.2, B.3, B.4, C.2, D.1, D.9, D.10, D.11, D.12
15. Signal direction altered by terrain	10%	A.3
16. Packing device still installed	98%	E.1, E.3, E.4, E.5
17. Remote switch off	100%	E.1, E.2, E.4, E.5

* *The paragraph numbers listed in the Applicable Improvements column above refer to the ELT Performance Specifications Comparison chart in Appendix B of this document. The paragraphs identified provide the basis for predicting the expected percent improvement for each reason of ELT failure.*

Table 7

Analysis of 1319 ELT Failures (where data was available) 1983-1987 and Expected Improvement from TSO-C91a and Expanded Inspection/Maintenance Program

REASONS	# OF ELT FAILURES	EXPECTED IMPROVEMENT %	EXPECTED # OF ELT FAILURES
1. Insufficient G's	245	95%	12
* 2. Improper installation	12	95%	1
* 3. Battery dead	42	95%	2
* 4. Battery corroded	2	50%	1
* 5. Battery installation incorrect	3	45%	2
* 6. Incorrect battery	4	75%	1
7. Fire damage	280	10%	252
8. Impact damage	356	75%	89
9. Antenna broken/disconnected	180	85%	27
10. Water submersion	62	0	62
*11. Unit not armed	70	98%	1
12. Shielded by wreckage	17	10%	15
13. Shielded by terrain	9	10%	8
14. Internal failure	14	75%	4
15. Signal direction altered by terrain	4	10%	4
*16. Packing device still installed	3	98%	0
*17. Remote switch off	16	100%	0
Current Total of ELTs not Activated	1,319		
Expected Total of ELTs not Activated			481

* Preventable with an Expanded Maintenance/Inspection Program

Summary:

Current Success Rate: 25%   Expected Success Rate: 73%
The Expected Success Rate is Approximately Three Times the Current Success Rate.

Implementation of TSO-C91a and a more stringent inspection and maintenance program would drastically reduce the number of failures. TSO-C91a would vastly improve "G" switch performance, slightly improve fire resistance, reduce failures due to impact damage (primarily due to a better mount and case construction in relation to the mount) and significantly reduce antenna broken/disconnected incidents. A more stringent inspection and maintenance program would reduce the number of battery problems, the number of improper installations, the number of units not armed, the number of incorrect batteries installed and should preclude installation of ELTs with packing devices still installed as well as remote switches turned off.

The summary of the expected improvements is shown at the bottom of Table 7. The current failure rate of 75% (found from review of NTSB Factual Report Accident/Incident Form 6120.4 entries) should be reduced to 27% resulting in an improvement in ELT performance from 25% currently experienced to an expected 73%.

C. Estimate of the Reduction in False Alarms to be Expected From Implementation of TSO-C91a and an Improved Inspection and Maintenance Program

- ***The current number of false alarms can be expected to be reduced by 75% with implementation of TSO-C91a and a mandatory inspection and maintenance program.***

The data on false alarm causes obtained from AFRCC records and other data sources (discussed in Chapter 2) were used to assess the potential benefit to be derived in reducing the false alarms due to the improved performance of TSO-C91a ELTs. Each cause of false alarms was examined in the light of improvements indicated in the Appendix B table and an assessment made by the team of experts of the percentage of improvement to be expected. This improvement was then applied to the number of false alarms by cause to derive the remaining number of false alarms expected after implementing TSO-C91a. The expected improvement for each cause of false alarm (due to the improved specification and an improved inspection and maintenance program) and the remaining false alarms is shown in Table 8.(Note that false alarms for unknown causes were removed from the data.)

It is obvious that implementation of TSO-C91a and a comprehensive mandatory inspection and maintenance program would have positive effects in most cause categories. Implementation of TSO-C91a would result in improvements in the "G" switch; built in resistance to internal failure primarily through corrosion control (positive separation of the battery and electronic sections); problems with heat, water and radiated interference; and the ability to withstand higher levels of vibration without activation of the ELT. False alarms due to corrosion, incorrect installation and incorrect batteries could be reduced through a more stringent mandatory inspection and maintenance program. A strong education program coupled with fines or license suspension for repeated offenders would have a positive effect on the mishandling/ human failures which are causing a high percentage of the false alarms.

In summary, the current number of false alarms is projected to be reduced by 75% with implementation of TSO-C91a and an improved inspection and maintenance program.

Table 8
Summary of Causes of False Alarms & Expected
Improvement From TSO C-91a and
a Mandatory Inspection and Maintenance Program

CAUSE OF FALSE ALARM	# OF FALSE ALARMS BY CAUSE	EXPECTED IMPROVEMENT %	EXPECTED # OF FALSE ALARMS	APPLICABLE IMPROVEMENTS
1. G-Switch	454	90%	45	A.7, A.9, E.1, E.4, E.5
2. Corrosion	220	80%	44	A.9, A.10, D.9, D.10, D.11, E.5
3. Human Failure	73	20%	58	A.9, E.1, E.5
4. Miscellaneous (heat, water or radiated interference)	70	65%	25	A.9, C.2, D.1, D.9, E.2, E.3
5. G-Switch or Corrosion out of Aircraft	48	40%	29	A.7, A.10, D.9, D.10
6. Incorrect Installation of ELT	45	90%	5	E.1, E.2, E.3, E.4, E.5
7. Mishandling in Aircraft	26	20%	21	A.9, E.1, E.5
8. Accidental Operation of Control	20	60%	2	A.9, E.1, E.5
9. Accidental Operation of Remote Switch	6	60%	2	A.9, E.1
10. Internal Failure	6	80%	1	A.10, B.1, B.2, B.3, B.4, D.1, D.9, D.12
11. Vibration	5	95%	1	A.9
12. Repeat Offender	5	50%	3	A.9
13. Incorrect Battery	1	0	1	
TOTAL	979		237	

Summary:
Current False Alarms = 979
Expected False Alarms = 237

Expected False Alarms = 25% of the TSO C-91 ELTs

V. INSPECTION AND MAINTENANCE

- ***The effectiveness of implementing TSO-C91a will be limited unless improved inspection and maintenance criteria are established.***

To validate the conclusion in Chapter II that 12% of the ELT failures were preventable by an effective inspection and maintenance program, three sources of information were reviewed to determine the condition (status) of ELTs installed in general aviation aircraft. The information was collected in 1987, 1988, and 1989 from two U.S. and one Canadian report. All three of the reports revealed that an unacceptable number of discrepancies existed in the installed ELTs. Some of the discrepancies could cause ELTs not to operate when involved in an aircraft accident and others could contribute to the false alarm problem. A 1976 Directed Safety Inspection was reviewed to compare current findings with early ELT defect documentation.

A. 1989 FAA ELT Maintenance Survey

In 1989, the Federal Aviation Administration conducted a special survey with six Fixed Base Operators (FBOs) participating at five different locations in the United States. The FAA provided the FBO repair facilities with an ELT field test procedure/data collection sheet which included inspection instructions (see attachment 2). A "G" switch go/no go test fixture was used at two of the survey locations on some of the ELTs inspected.

- ***107 ELTs inspected****
- ***69 (64%) were discrepancy free***
- ***39 (36%) had a total of 52 discrepancies***

This analysis reviewed 107 of the survey forms (Attachment 3) that were completed by the FBO repair facilities. Sixty-nine or 64% were discrepancy free while 39 or 36% had a total of 52 discrepancies some of which could have caused the ELTs to fail in an accident or could eventually cause false alarms (See Table 9).

* *Note: 53 (49.5%) of the ELTs inspected by the FAA Special Survey were installed in twin engine aircraft.*

Table 9

ELT Discrepancies Found in the 1989 FAA Survey (107 ELTs)

DISCREPANCY	# OF DISCREPANCIES
1. "G" Switch Inoperative	1
2. "G" Switch Limits Exceeded	16
3. Low Power Output	6
4. On/Off Switch in Off Position	5
5. Battery Overdue	6
6. Corrosion	3
7. Antenna Discrepancies	11
8. Defective On/Off Switch	1
9. Portable Antenna Missing	1
10. Battery Leaking	1
11. Remote Switch Inoperative	1
TOTAL	52

- ***24 "G" switches tested***
- ***16 (67%) failed***
- ***8 (33%) passed***

The FAA-furnished "G" switch go/no go test fixture was used on 24 of the ELTs surveyed. Significantly, only eight or 33% passed the "G" switch operational test and sixteen or 67% failed. This finding supports NTSB accident report data that documents the "G" switch as a major cause of ELT failures when involved in accidents. The test also correlates with reports that identify the "G" switch as a major contributor to the high number of ELT false alarms. Obviously, if the "G" switch mechanism is not within specification limits prior to an accident the possibility of it operating is reduced. Conversely, if the switch is over sensitive, it can be activated by a hard landing or towing operations thereby generating a false alarm.

B. 1987 Alaskan ELT Maintenance Survey

The Alaskan survey (Attachment 4) was conducted in 1987 by Northern Lights Avionics in Anchorage. The results were forwarded by the Alaskan Region FAA Office to Headquarters, Airspace Rescue and Recovery Service at Scott Air Force Base in Illinois and to the FAA-DOT, AWS-120, 800 Independence Avenue, S.W., Washington, D.C. 20591.

- ***119 ELTs inspected***
- ***22 (18%) were discrepancy free***
- ***97 (82%) had a total of 119 discrepancies***

The Alaskan survey inspected 119 ELTs and only 22 or 18% of the units were free of discrepancies (See Table 10). Ninety-seven or 82% of the units had a total of 119 discrepancies. The high number of discrepancies may be attributed to the harsh Alaskan climate, a lack of adequate test facilities (avionics shops), aircraft storage at remote locations and perhaps a lack of owner interest. Unfortunately, the Alaskan climate is unforgiving to those who encounter its harshness in a survival situation and search forces are faced with vast remote areas that are difficult, if not dangerous, to search. The Alaskan survey, at least in 1987, indicates that in a location where ELTs would be most beneficial, they were in the worst condition.

Table 10
ELT Discrepancies Found in the 1987 Alaskan Survey

DISCREPANCY	# OF DISCREPANCIES
1. Battery	49
2. "G" Switch	8
3. Circuit/Circuit Board	28
4. On/Off Switch	6
5. Corrosion/Rust	6
6. Antenna	5
7. Modulation Problems	2
8. Unknown Causes	15
TOTAL	119

C. 1988 Transport Canada ELT Maintenance Survey

- ***306 discrepancies in 1,684 ELTs***

The Transport Canada report that was prepared by Leigh Instruments Limited of Ontario, Canada in 1988 revealed 306 discrepancies (18%) in 1,684 ELTs inspected.

Table 11
Results of Transport Canada's Defective ELT Survey

TYPE OF DEFECT	# OF DEFECTS
1. Circuit Board Failure	59
2. Battery Replacement Overdue	58
3. Crash Activated Switch ("G" Switch) Malfuction	46
4. Corrosion	43
5. Battery Failure	37
6. Antenna and/or RF Connector Failure	34
7. Miscellaneous Defects	29
TOTAL	306

D. 1976 Directed Safety Investigation

The Directed Safety Investigation (DSI) [RIS: FS-8330-9], Emergency Locator Transmitter Activations, prepared by the Flight Standards Technical Division (Maintenance Analysis Center), dated March 1976, also identified a high number of similar ELT maintenance discrepancies. This verifies that the same basic ELT problems exist today that were present in 1976. The applicable parts of the DSI Executive Briefing follow:

Part I.* Unwanted ELT Activations. The purpose of this portion of the survey was to determine any causal factors for the occurrences of unwanted activations.

Total number of reports	417
Total number of manufacturers reported	12
Number of ELT **units found with switch "on"**	**99**
Number of ELT **units found with "corrosion"**	**64**
Number of activated units **"cause" not reported**	**254**

Part III.* Accident Survey - ELT Performance. The purpose of this portion of the survey was to determine what factors or conditions are preventing the ELT from functioning when exposed to conditions that should cause it to activate.

The analysis of this study considered the fact that ELT integrity should remain intact, only in survivable accidents. The unit is not designed to withstand or operate under conditions exceeding 50g.

Total number of reports	358
Number of reports citing **function switch in the "off" position**	**27**
Number of reports citing **battery condition to be "discrepant"**	**78**
Number of reports citing **"insufficient impact or direction wrong ("G" switch problem)"**	**112**

Part V.* Manufacturers Warranty/Repair History. The purpose of this portion of the survey was to determine what defects were being found when units were returned on warranty or for repair. Although there are 18 manufacturers of ELTs, reports were only received on eight.

Total number of units reported on	366
Number of reports citing **defective transistors and printed circuit boards**	**84**
Number of reports citing **defective function of switches**	**70**
Number of reports citing **defective "G" switches**	**32**
Number of reports citing **defective crystals**	**30**
Number of reports citing multiple defects	28
Number of reports citing **defective batteries**	**18**

*Direct quote from the FAA DSI

E. Summary

There was no attempt made to correlate the foregoing surveys. Each survey stands alone and each verifies that an unacceptable high number of TSO-C91 ELTs installed in general aviation aircraft are defective. Some of the discrepancies could cause the ELTs not to operate when involved in an aircraft accident and some, over a period of time, could generate false alarms. Some lives will be lost because of ELTs that are inoperative before a crash occurs. Also, national resources will be unnecessarily expended responding to false alarms caused by ELT discrepancies that go undetected until a false alarm is generated.

In assessing the percentage of failures that could be prevented by an effective inspection and maintenance program it was decided that a conservative estimate would be between 12% (Based on the NTSB data base) and 18% (Based on the Canadian study). The FAA survey and the Alaskan surveys were considered too small of a sample and could contain biases, although they decidedly support the need for an effective inspection and maintenance program.

The FAA 1976 DSI also supports the above conclusions, however it was felt that this data was not necessarily valid due its much earlier time frame.

F. Conclusions

- ***12-18% of the ELT failures in aircraft accidents could be prevented with an effective inspection and maintenance program.***

- ***Current ELT inspection and maintenance methods and procedures are inadequate.***

- ***The effectiveness of any ELTs, including TSO-C91a ELTs, can only be realized if backed by an effective ELT inspection and maintenance program.***

- ***The NASA developed and FAA tested ELT inspection procedure should be refined, if necessary, and established as an FAA requirement.***

- ***ELT inspection and maintenance must be coupled with rule making to ensure the potential effectiveness of the C91a ELTs.***

VI. HUMAN SURVIVABILITY IN CRASHES WITH AND WITHOUT AN ELT

A large percentage of general aviation accidents result in some survivors. Review of the data from Block 213 of the NTSB accident records revealed that 85% of general aviation accidents result in some survivors categorized as : Seriously Injured; Minor Injuries or No Injuries. The time between a serious aircraft accident and when potential survivors can be found by rescue forces can have a dramatic impact on the probability of accident victims surviving the accident. This general time/survivability relationship is shown in Figure 1 developed by DOT, Mundo, et al. This time factor is particularly crucial when a search is required to locate the crash site.

The importance of having an operational ELT is supported by the statistics gathered through a review of the Aircraft Accident Investigative Report data provided by the NTSB and search missions coordinated by the AFRCC.

A. Elapsed Search Time With and Without an Operational ELT

From NTSB Data:

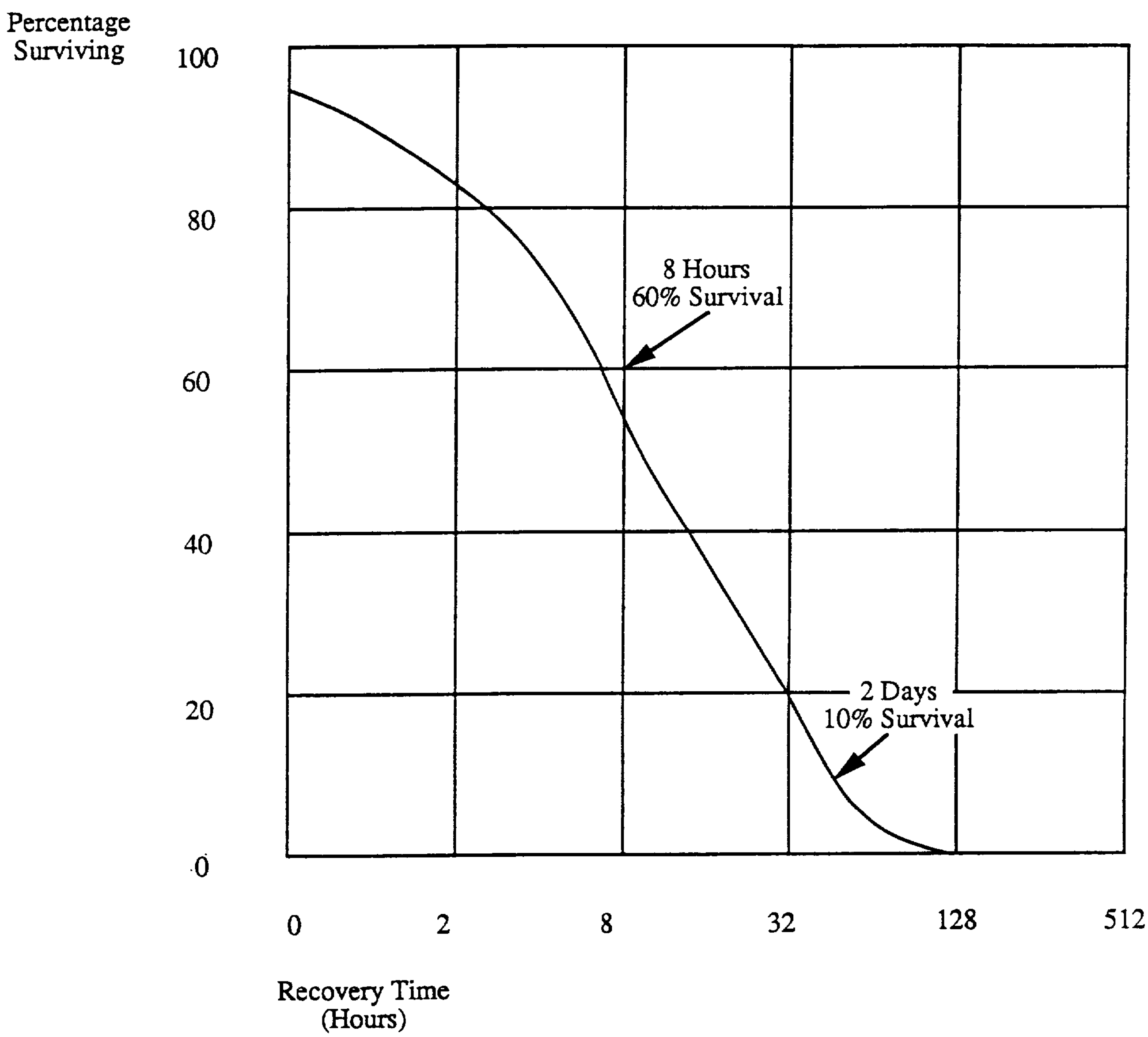
- ***12.4 hours to locate a crash with an operable ELT***
- ***103.0 hours to locate a crash without an operable ELT***

For the time period 1984 - 1987, NTSB accident reports document (Table 12) that it takes 12.4 hours to locate an aircraft crash with an ELT operating when a search is involved while it takes an average of 103.0 hours when ELTs are not operating.

Table 12
Data From NTSB Factual Report Aviation Accident/Incident
(NTSB Form 6120.4) 1984 through 1987

WAS ELT WORKING?	TIME FROM SAR NOTIFICATION TO LOCATION OF DISTRESS (IN HOURS)				AVERAGE TIME FOR 1984 THROUGH 1987 (IN HOURS)
	1984	1985	1986	1987	
WORKING	8.7	9.2	7.9	23.8	12.4
NOT WORKING	67.4	138.3	160.7	45.7	103.0

Figure 1
SURVIVAL AS A FUNCTION OF RECOVERY TIME



REF: Final Report ICSAR Ad Hoc Working Group Report on Satellites for Distress Alerting and Locating, Oct. 1976, pg. 6-15.

DOD & NSC data given in C. Mundo, L. Tami & G. Larson, Final Report Program Plan for Search & Rescue Electronics Alerting and Locating System, DOT-TSC-OST-73-42, February 1974.

From AFRCC Data:

- ***12.3 hours to locate a crash with an operable ELT***
- ***50.0 hours to locate a crash without an operable ELT***

Time saved in locating an aircraft crash with and without an operable ELT is the dominant factor in improving the survivability from serious aircraft accidents where a search is involved. The AFRCC Annual Reports for the years 1984 through 1987 (Table 13) documents that it takes an average of 12.3 hours to locate a crash from the time of RCC notification with an ELT operating and an average of 50.0 hours when no ELT is operating.

Table 13
Data from USAF AFRCC Annual Reports for 1984 through 1987

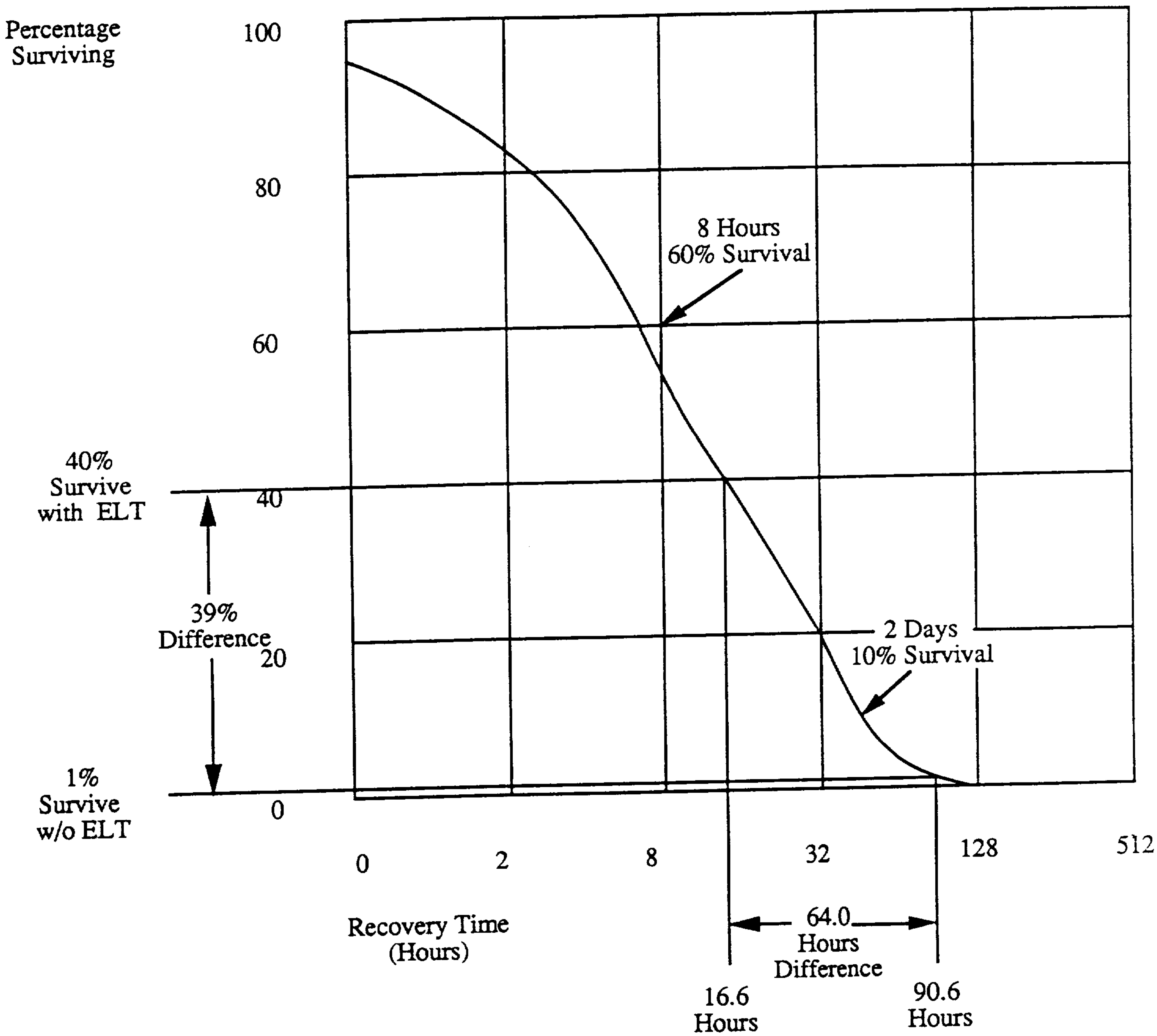
WAS ELT WORKING?	TIME FROM SAR NOTIFICATION TO LOCATION OF DISTRESS (IN HOURS)				AVERAGE TIME FOR 1984 THROUGH 1987 (IN HOURS)
	1984	1985	1986	1987	
WORKING	14.3	16.1	9.5	9.2	12.3
NOT WORKING	33.6	119.2	18.1	29.4	50.0

In The General Case of All Accidents

The above data can be used to project the expected improvement in survivability when an ELT is used during a search for a missing aircraft. If we average the difference in time from the two data sources (NTSB and AFRCC records) a projection of improved survivability can be derived from the DOT survival curve as shown in Figure 2.

In cases where searches were not required to locate the accident it is generally accepted that the ELT often acts as the first alert that a crash has occurred, although there is no data source to quantify this time advantage. To attempt to quantify the survivability advantage of a working ELT the entire NTSB Data Base period 1 January 1983 through 17 October 1988 was analyzed.

Figure 2
SURVIVAL AS A FUNCTION OF RECOVERY TIME



From NTSB Form 6120.4, Factual Report Aviation Accident/Incident, Supplement M, Search/Rescue/Firefighting/Medical Treatment Section and AFRCC data (See Tables 9 and 10).

REF: Final Report ICSAR Ad Hoc Working Group Report on Satellites for Distress Alerting and Locating, Oct. 1976, pg. 6-15.

DOD & NSC data given in C. Mundo, L. Tami & G. Larson, Final Report Program Plan for Search & Rescue Electronics Alerting and Locating System, DOT-TSC-OST-73-42, February 1974.

B . Survivability With and Without an Operational ELT

To establish a basis for projecting the number of lives that could be saved using the improved C91a ELTs and a mandatory inspection and maintenance program, two approaches were used. In the first approach the NTSB data base was examined for cases with and without an ELT operating where a search was involved. A survivability rate was calculated for both cases (i.e. Working ELT and Non-Working ELT). Survivability was defined as the number of survivors divided by the total number of people involved in the accident. In the second approach the total population of 12,744 general aviation accidents during the period of 1983 through October 1988 was evaluated. (The premise of this later approach was that the sheer number of accidents would randomize the other variables of survivability.)

From the NTSB Data Base Where a Search Was Required

- ***NTSB records from 1 January 1983 through 17 October 1988 where a search was involved indicate that an additional 23 lives per year could have been saved had the ELT operated.***

Of the 662 accident records from 1 January 1983 through 17 October 1988 where a search was required, the ELT operated 255 times and failed to operate 407 times. (See Table 14) When the ELT operated 222 occupants survived for a 34% survivability rate. When the ELT did not operate 179 occupants survived for a 19% survivability rate.

Subtracting the 19% from 34% results in a 15% survivability advantage when the ELT operates. If the 15% advantage is multiplied by the 928 people involved where the ELT did not work the potential for additional survivors is 139 people. Dividing the 139 people over the six years equals an additional 23 lives per year that potentially could have been saved had the ELT worked in all of these accidents.

Table 14
NTSB Survivor Data Where a Search was Required
(1 January 1983 through 17 October 1988)

	# of Accidents	# People Involved	# of Survivors	Survival Rate
A. Accidents where ELT was operating	255	648	222	34%
B. Accidents where ELT was not operating	407	928	179	19%

Survivability Advantage When ELT is Operating
34%-19%=
15%

Lives lost from 1983 through 17 October 1988 due to ELT not operating
15% x 928 people involved =
139 LIVES

Number of lives lost per year due to ELT failure
139 / 6 years =
23 LIVES / YEAR

From the Total NTSB Data Base:

- ***NTSB records from 1 January 1983 through 17 October 1988 indicate that an additional 58 lives per year could have been saved had the ELT operated.***

Of 12,744 accident reports that were filed between 1 January 1983 and 17 October 1988, the ELT operated 4102 times and failed to operate 8642 times. When the ELT operated, 7077 aircraft occupants survived for an 85% survivability rate. When the ELT did not operate, 13,843 occupants survived for an 83% survivability rate.

Subtracting the 83% from 85% equals a 2% survivability advantage when the ELT operates. If the 2% advantage is multiplied by the 16,607 people involved where the ELT did not work, the product is 332 lives. Dividing the 332 lives over 5.8 years (1 January 1983 to 17 October 1988) equals an additional 58 lives per year that could be saved with operating ELTs.

Table 15
NTSB Survivor Data From Total NTSB Data Base
(1 January 1983 Through 17 October 1988)

	# of Accidents	**# People Involved**	**# of Survivors**	**Survival Rate**
A. Accidents where ELT was operating	4102	8369	7077	85%
B. Accidents where ELT was not operating	8642	16,607	13,843	83%

Survivability Advantage When ELT is Operating
85% - 83% =
2%

Lives lost from 1983 through 17 October 1988 due to ELT not operating
2% x 16,607 people involved =
332 LIVES

Number of lives lost per year due to ELT failure
332 / 5.8 years =
58 LIVES / YEAR

VII. PROJECTED BENEFITS FROM TSO-C91a ELTs COUPLED WITH AN EFFECTIVE INSPECTION AND MAINTENANCE PROGRAM

A. Review of Lives Lost Per Year due to ELT Failures

Chapter VI examined the survivability of occupants in aircraft accidents for the six-year period 1983 through 1988. The examination of the overall data base of 12,744 general aviation accidents concluded that **58 lives per year were lost** (Table 15, page 27) in accidents where the ELT failed to operate that otherwise should have survived if the ELT had operated.

With the assumption that the operation of the ELT is a more dominant factor in the saving of lives where a search is required, the NTSB data base was examined for those cases where the accident investigator had filled out Supplement M of the Accident Investigation Report. Review of these 662 accident records revealed that **23 lives per year were lost** (Table 14, page 26) in accidents where the ELT did not operate and a search was required.

To evaluate the above results and project the potential life saving benefits the following factors must be considered:

- ***The effectiveness of an ELT as an alerting device even when a search is not required.***

- ***The 662 accident records where search information was available is probably somewhat lower than the actual number of cases and does not represent a complete set of data for the six-year period. In many cases the accident investigator may not have this information available at the time of his investigation.***

- ***Because one cannot be sure that other factors may have biased the overall results of survivability when considering the entire data base, these results are subject to challenge. However, the large number of people involved (24,976) as well as the number of accidents (12,744) over the six-year time frame should tend to randomize the other variables which could affect survivability.***

- ***The potential benefits in lives saved by a dramatic reduction in the number of false alarms (75% reduction) cannot be quantified, however, it is apparent that this reduction will improve the pre-rescue time and therefore save additional lives.***

Taking the above factors into consideration it is concluded that the potential for lives to be saved is bounded by the results from the two data bases and an average of these bounds appears to be a conservative estimate of the lives lost each year due to ELT failure. Based upon this assumption it is concluded that **41 lives are lost each year** due to the failure of the ELT to operate.

B. Projected Benefits of Lives Saved Each Year

Based upon the analysis and projected improvements derived in Chapter IV, a performance improvement of 48% (73%-25%) is projected. This translates into **approximately 25 lives per year that will be saved** due to the improved C91a ELT and an effective inspection and maintenance program.

Although the projection in lives saved is based upon the C91a specification ELTs versus the C91 ELTs, the inspection and maintenance program is necessary to ensure that ELTs are properly installed and in working order. From the results of the maintenance studies given in Chapter V, lack of an effective inspection program will result in 12 to 18% of failures prior to the aircraft accidents resulting in **a loss of approximately 6 lives per year** (e.g., a reduction in the projected 25 lives per year saved).

VIII. SUMMARY AND CONCLUSIONS

Analysis of the NTSB accident investigation data (1983-1987) and the AFRCC annual reports (1984-1987) confirmed the previously reported failure rate of ELTs in aircraft accidents (75%) and the high incidence of false alarms (97%) being experienced with the TSO-C91 ELTs currently in the field. A detailed comparison of the specification required by TSO-C91a versus TSO-C91 was made to assess the improvements that could be expected for each type of crash failure and each false alarm cause. The projected improvement for each type of failure and each cause of false alarms concluded that the success rate of the ELT operation in a crash could be improved by 3 times the current success rate and the number of false alarms could be reduced to 1/4 of the number from C91 ELTs. By examining the survivability factor of aircraft accidents, with and without a transmitting ELT, it was projected that approximately 25 lives per year could be saved by implementing the TSO-C91a ELTs along with an effective inspection and maintenance program. Lack of an effective inspection and maintenance program would reduce this projection of lives saved by approximately 6 lives per year.

APPENDIX A

Sources of Data Gathered for Analysis

APPENDIX A

Sources of Data Gathered for Analysis

Numerous studies, reports and analyses have been published concerning ELT performance. Fifty such reports were reviewed as source material for the NASA analysis. The following list of reports highlight the type of information that was available:

- DSI Study by the FAA
- CRI Reports
- ARINC False Alarm Study
- AFRCC Annual Reports
- NTSB Annual Reports

Unfortunately, very few of the 50 published documents could be used in the NASA analysis because each of them had their own purpose or goal. Although these documents substantiated most of the problem areas there was insufficient data to provide meaningful correlation with the NTSB data and the AFRCC records.

In addition to the reports that were reviewed, a study of the various relevant data bases was conducted to quantify the ELT performance and characterize the problems. The data bases studied were:

- NTSB Accident Investigations Data Base (NTSB Form 6120.4) (1983 - 1988)
- FAA Service Difficulty Reports
- AFRCC False Alarm Mission Reports (Selected 1988 Files)
- Alaskan Maintenance Survey
- FAA Maintenance Survey

A detailed review of the above data bases resulted in the following conclusions:

- The FAA Service Difficulty Reports did not correlate with other data bases, although they did substantiate the need for a better and more frequent inspection program; however, the type of problems reported do reinforce the data from other sources.

- The maintenance surveys conducted in Alaska and in the CONUS by the FAA also reinforce the need for a more frequent and more comprehensive inspection program.

- The AFRCC False Alarm Mission Reports proved to be the only current data available to characterize the false alarm; however, past reports were reviewed and the data combined with the results of our study of the AFRCC data.

Consequently, after review of the available documentation, it was determined that NTSB and AFRCC data would be used as the cornerstones of the NASA analysis. Support of the NTSB and AFRCC data was provided by other documentation that could be correlated.

A. NTSB Data:

NTSB data was obtained from the NTSB Factual Report Aviation/Accident Report (NTSB Form 6120.4) which in completed by NTSB aircraft accident investigators. The following sections were used:

1. Basic Report, Blocks 67, 68 and 69 (Attachment 3): Blocks 67,68 and 69 of the basic report asked the NTSB accident investigator if an ELT was installed (yes or no), if an ELT was required (yes or no) and if the ELT operated (yes or no). This information was used to determine the percentage of ELTs that operated when involved in a crash and was compared to survivor data collected from the search and rescue section of the report.

2. Basic Report, Block 216 (Attachment 4): Block 216 of the basic report asked the accident investigator to classify the injuries sustained by the aircraft crash victims. Four classifications were available; A-Fatal, B-Serious, C-Minor and D-None. This information was used to determine fatality rates for aircraft accidents with and without the ELT operating.

3. <u>Supplement A, Block 56 (Attachment 5)</u>: Supplement A, Block 56 of the report provides nineteen (19) reasons for ELT noneffectiveness/failure from which the accident investigator could select one or more (multiple entry) reasons. The number 1 block, if selected, indicated that the ELT operated effectively and an "A" selection is available to signify reasons "other" than the 19 listed. The number 1 block and the "A" selection were not considered in the analysis for obvious reasons; i.e., even if the ELT operated effectively, it could have still had some type of superficial damage. The "A-Other" block was not used because it was not specific. Supplement A. Block 56 data was used to identify the specific reasons why ELTs do not work in accidents and then used as a basis for determining improvements that could be realized through implementation of RTCA DO-183.

4. <u>Supplement M, Blocks 1 though 12 (Attachment 6)</u>: Blocks 1 through 12 identified; (1) Whether or not a search was required; (2) The type of search conducted; (4) When the search agency was notified; (5) When the aircraft occupants were located; (7) Whether or not the Civil Air Patrol was involved; (8) Whether military or Coast Guard personnel were involved; (9) Whether a distress call was transmitted; (10) Whether a distress call was received; (11) The method of locating the accident site; and (12) The condition of the aircraft occupants at rescue. (Note: Blocks 3 and 6 were not used on the NTSB accident report form.) The Search and Rescue Section of Supplement "M" was used to identify aircraft accidents involving search operations in other NTSB data runs and to determine the time factors involved in reaching occupants of crashed aircraft with and without operating ELTs.

B. Air Force Rescue Coordination Center Data

AFRCC Annual Reports were used to:

1. Determine the time lapse from SAR notification to location of the distress. This data was compared with the time lapse data extracted from Supplement M-Search/Rescue/Firefighting/Medical Treatment, Blocks 1-12, of the NTSB Factual Report Aviation Accident/Incident.

2. Determine, on aircraft search missions coordinated by the AFRCC (Years 1984 through 1987), the number of ELTs that worked as opposed to ELTs that did not work in aircraft crashes. This data was compared with Block 69 (Operated, yes or no) of the Basic Section, NTSB Factual Report Aviation Accident/Incident.

AFRCC False Mission Records were used to (hands on review):

Identify the causes of ELT false Alarms. This information was used to compare cause of false activations in Federal Aviation Administration (FAA) Service Difficulty Reports and other independent reports containing data which could be correlated.

C. Other Substantiating Reports

1. Federal Aviation Administration Service Difficulty Reports (SDR), in computer format, were obtained from the Aviation Standards National Field Office in Oklahoma City. These reports identify defects discovered during the process of performing aircraft maintenance. They are forwarded to the FAA, on a voluntary basis, by private industry aircraft mechanics/avionics personnel who discover abnormal or repeat defects which they believe need corrective action and desimination to the aviation public. The data was compared to the AFRCC causes of false alarms, the Alaskan Survey and the NTSB Reasons for Non-Effectiveness in aircraft accidents.

2. The Canadian Feasibility Study of Potential Approaches to Upgrade Existing Emergency Locator Transmitters was reviewed. The study contained a section (Section 3) which identified ELT defects discovered by Canadian avionics maintenance shops. This information was compared, by defect category, to the U.S. FAA SDRs.

3. The ARINC Research Corporation, Final Report, Control of False Alarms, October 1979, and the Crash Research Institute Study by David S. Hall concerning false alarms, were compared to 1988 false alarm data obtained from the AFRCC to determine whether or not the causes of false alarms had varied since the late 1970's to 1988.

4. In 1989 the FAA conducted an ELT maintenance survey which field tested a new method of determining whether or not an installed ELT was functioning in accordance with published specifications. This determined the number of ELTs that would not have operated in an accident because of an existing defect and evaluated the effectiveness of new check-out procedures when accomplished by private industry representatives.

APPENDIX B

ELT Performance Specifications

ELT PERFORMANCE SPECIFICATIONS

(RTCA/DO-183, RTCA/DO-147 COMPARISON)

A. PERFORMANCE REQUIREMENTS

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
1. Operating Life	Paragraph 2.2.1 Reference 2.2.2.5, 2.3.1 The power supply capacity is to provide continuous operation between the temperatures of -20° and 55°C. It should operated for a 50-hr period with a minimum PERP of 50 mW (17 dBm) or operate for a 100-hr period with a minimum PERP of 25 mW (14 dBm). Additionally, the ELT may be qualified to operate throughout a 50-hr period at -40°C with a minimum PERP of 5 mW (7 dBm).	Paragraph 2.1 Reference 2.2.5 The power supply capacity is to provide continous operation for 48 hours under maximum power consumption. The PERP shall be at least 75 mW during this operation.	
2. Transmitter Operating Frequencies	Paragraph 2.2.2.1 The transmitter shall operate simultaneously on 121.5 and 243.0 MHz ±.005% under all environmental operating conditions.	Paragraph 2.2.1 The transmitter shall operate simultaneously on 121.5 and 243.0 MHz ±.005%.	
3. Transmitter Modulation Characteristics	Paragraph 2.2.2.2 The type of emission shall be A9 and shall have a distinct audio characteristic achieved by amplitude-modulating the carrier with an audio frequency sweeping downward over a range of not less than 700 Hz, within the range 1,600 to 300 Hz, and with a sweep repetition rate between 2 and 4 Hz. The modulation factor shall be at least .85. The following are optional characteristics to improve SAR capabilities: (a) SAR Detection and Homing Capabilities - a burst of unmodulated CW power for a duration of 2.0±.25 seconds and repeat this burst every 8.0±.25 seconds. (b) SAR Satellite Detection - provide clearly defined carrier with at least 30% of power within ±30 Hz of the carrier at 121.5 MHz and ±60 Hz at 243.0 MHz. (c) Voice Modulation (A3) - it shall consume energy from the power supply at a rate greater than normal ELT swept tone modulation (A9).	Paragraph 2.2.2 The type of emission shall be A9 and shall have a distinctive audio characteristic achieved by amplitude-modulating the carrier with an audio frequency sweeping downward over a range of not less than 700 Hz, within the range 1,600 to 300 Hz, and with a sweep repetition rate between 2 and 4 Hz. The modulation factor shall be at least .85. Modulation may be essentially or entirely negative going, and the modulation envelope may be essentially rectangular.	New optional transmitter requirements to improve SAR capabilities have been added: (a) Burst of unmodulated carrier for 2 seconds every 8 seconds to aid SAR system detection and homing. It could be used to distinguish between maritime and aeronautical users. (b) Provide clearly defined carrier that is distinct from the sideband components to aid SAR satellite detection system. (c) Voice modulation (A3) is permissible provided that it is consistent with ELT's primary function.

A. PERFORMANCE REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
4. Modulation Duty Cycle	Paragraph 2.2.2.3 Modulation applied to carriers shall have a minimum duty cycle of 33% and a maximum duty cycle of 55%.	Paragraph 2.2.3 Same	
5. Transmitter Duty Cycle	Paragraph 2.2.2.4 Reference 2.2.2.2 The transmission shall not be interrupted, except as specified in 2.2.2.2.	Paragraph 2.2.4 Reference 2.2.3 The carrier shall not be interrupted except as allowed in 2.2.3	Same as A3
6. Peak Effective Radiated Power	Paragraph 2.2.2.5 Reference 2.3.1.1, 2.3.1.2 The ELT shall meet one of the following power/time combinations: (a) at least 50 mW (17 dBm) over a 50-hr period (b) at least 25 mW (14 dBm) over a 100-hr period (c) not less than any linearly extrapolated power level vs. time period between (a) and (b) above. In addition to (a), (b), or (c), the ELT may operate over a 50-hr period at -40°C with a PERP of at least 5mW (7 dBm).	Paragraph 2.2.5 The PERP shall be at least 75 mW on each frequency.	
	Paragraph 2.2.9 Transmitter Turn-On Reference 2.2.2.5 Within 5 minutes of activation (auto or manual), the PERP shall be at least 50 mW (17 dBm) or that selected by the manufacturer.	None	The PERP minimum level shall be reached within 5 minutes of manual or automatic activation. This increases the probability of the unit functioning in extreme environments.

A. PERFORMANCE REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
7. Automatic Crash Activation of Sensor	Paragraph 2.2.3 Reference 2.4.2.3, Figure 2-1 The crash activation sensor will activate with a threshold force level of 2.0±.3 G's and a minimum velocity change of 3.5±.5 ft/sec (but not under less severe conditions) and when simultaneously subjected to 30 G's of cross-axis acceleration.	Paragraph 2.3.1 The transmitter shall be automatically activated when the crash force sensor is subjected to a force of 5.0±.2 G's and greater in the direction of the longitidinal axis of the aircraft, but it shall not activate under any less severe conditions. After automatic activation, the transmitter shall remain activated when subsequently subjected to shock forces in any direction of up to 50 G's and having durations of up to 11 milliseconds.	The crash sensor must activate is accordance with a new de-acceleration response curve and it shall function properly when simultaneously subjected to 30 G's of cross-axis acceleration. The result of this improvement is to provide a significant increase in the number of crashes detected and a decrease in the number of false alarms caused by factors such as hard landings or mis-handling.
	Paragraph 2.2.3 c. Sensor Packaging Reference 2.2.1 If the crash sensor is packaged as a separate unit, no combination of short circuits and/or open circuits in the interconnecting wiring shall result in a reduction of operating life or in deactivation of the transmitter after it has been activated.	None	
	Paragraph 2.2.3 d. Crash Sensor/ELT Interface Also if a separate unit is used, the interface wiring is not required to survive the crash after it transmits the activation signal. Disconnecting the interface for maintenance shall not cause a false activation.	None	Potential improvement available from a remote crash sensor.
	Paragraph 2.2.3 e. Optional Sensors Reference 2.2.3 b., 2.2.1 Alternate crash sensors are optional. Switches must be mounted in sufficient numbers and locations to detect a crash as described in 2.2.3b. Using operational parameters, such as engine pressure or engine vacuum, to indicate crash situations is another acceptable method. ELT activation shall not occur during normal operational procedures and special action on the part of the pilot to disarm the device at the end of the flight shall not be required.	Paragraph 2.3.1 Note Alternate sensors may be used provided that they may be shown to be substantially equivalent to sensors responsive to the crash forces as described above.	

A. PERFORMANCE REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
8. Antenna Radiation Characteristics	Paragraph 2.2.4 Both the fixed antenna and the auxiliary antenna (if provided) shall radiate on 121.5 and 243.0 MHz. Radiation shall be vertically polarized and omnidirectional in the horizontal plane, but only when the antenna is in its normal orientation.	Paragraph 1.10 a-c The antenna shall provide optimum performance at 121.5 and 243.0 MHz and its radiation pattern in the horizontal plane shall be essentially omnidirectional.	
9. Activation Monitor and Remote Control	Paragraph 2.2.6 a-e An aural and/or visual monitor (integral or separate from the ELT unit) is required to alert the pilot as to when the ELT has been activated and is transmitting. The aural monitor must be integral to the ELT or installed in the aircraft and must have a signal minimum intensity level of 90 dBm measured 1 meter from the source. The visual monitor must be in view of the pilot's position, and it shall be visible under normal daytime ambient light conditions at 1 meter. Remote controls shall be provided if the local controls are not accessible from the pilot's position. For both monitors, the remote control modes will be Manual On, Armed, and Reset. Off will not be available. The power supply, either a dedicated or alternate power supply, may not detract from the ELT operating life. For fault tolerance, no combination of short circuits between the remote control, monitor(s), associated wiring and the airframe shall either inhibit the equipment from being automatically activated or deactivate the ELT after it has been activated or cause a power drain.	None	The ability of the pilot to determine whether the ELT is armed and/or when it is activated will result in a twofold benefit: (1) A significant decrease in the number of crashes where the ELT was found unarmed. (2) A mitigation of the false alarm problem by making the pilot aware when the transmitter has been inadvertantly turned on. This will provide a greater probability of proper operation in a crash when a remote control/monitor is used.
10. Power Supply	Paragraph 2.1.1.1 Requires that gas or liquid seepage from power supply shall not effect internal ELT components (separation of battery compartment from electronics)	None	Major improvement to prevent corrosion of electronics from battery leakage will: (1) Reduce false alarms (2) Improve reliability in a crash situation

B. CRASHWORTHINESS

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
1. Shock Impulse Survival Level	Paragraph 2.3.4.1 The ELT must survive 1 shock impulse of 500 G's (4±1 ms duration) in each of six directions. This impulse is based on aircraft impact velocities of 190 mph.	None	The chances of survival of the ELT in a crash will be greatly improved.
2. System Integrity Associated with Crashworthiness	Paragraph 2.2.5 Reference 2.4.2.4 The attachment/mounting normally used to mount the ELT in the aircraft shall withstand a shock test of 100 G's in all directions in the non-operating mode without the ELT breaking loose, damaging the equipment, or otherwise resulting in the ELT not being able to activate.	Paragraph 3.3 Survive one shock impulse of 50 G's (11±2 ms duration) in each of six directions. The crash sensor is exempted from this requirement.	The survival of the ELT in its mount will be greatly improved. In the current system many ELTs separate from their mounts.
3. Crash Protruding Survivability	Paragraph 2.3.4.2 The ELT must withstand a drop of 25 kg (55lb) mass with a penetrator of .64 cm (.25 in) x 2.5 cm (1 in) from a height of 15 cm (6 in) on the most vulnerable area of three or four required areas of the ELT.	None	This new requirement is based on studies of real and controlled crashes and will result in a higher degree of survivability against impact damage.
4. Crash Pressure Survivability	Paragraph 2.3.4.3 The ELT must withstand a crushing pressure of 6.9 x 10^5 newtons per m^2 (100 psi) not to exceed 450 kg (1000 lb) successively over three or four required surface areas of the ELT.	None	A significant improvement in the ability of the ELT to survive impact damage in a crash.
5. Antenna and Coaxial Cable	Paragraph 3.1.10, 3.1.11 Specific requirements for proximity of antenna to ELT (3.1.10.2); static load test of 100 x weight (3.1.10.3); cable installation requirements (3.1.11).	None	Significant improvement in crash survivability of antenna and interconnecting cable.

C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
1. Radio Frequency Intermodulation	Paragraph 2.2.7 a-b Reference 2.4.2.7, Figure 2-2, 2-3 Table 2-1, 2-2 When the ELT unit is in the Armed mode, the application of any two frequencies in the 54-108 MHz band at +10 to +14 dBm to the ELT shall not result in reradiation of a third frequency in the 108-137 MHz band exceeding the levels specified below: (a) direct coupling to the RF output terminal - the third frequency shall not exceed -83 dBm (b) radiation coupling to external surface of the aircraft test configuration - it shall not result in a third field with an intensity greater than 7 microvolts/meter at an appropriate receiving antenna 2 meters from the ELT antenna.	None	Reduces the potential for the ELT to interfere with other avionics systems in the aircraft and in other nearby aircraft.
2. Radio Frequency Susceptibility (not applicable to ELTs)	Paragraph 2.2.8 When the ELT unit is in the Armed position, it shall not be activated or damaged when a signal in the 108-137 MHz band at a +23 dBm level is directly coupled to the ELT antenna terminal or for ELTs that employ internally mounted antennas, when a vertically polarized electromagnetic field of 9.6 volt/meter is applied to the external surface of the aircraft test configuration.	None	Reduces the potential for internal failures to the ELT and false activations due to high power external transmissions.
3. Normal Variations of the Electrical Power Supply Inputs	Paragraph 2.3.12.1 Reference 2.2.6 Reference DO-160B, 16.5.1 and/or 16.5.2 If applicable, the ELT Remote Monitor shall operate and meet "Activation Monitor" requirements (Paragraph 2.2.6) under normal variation (surges, peaks or ripple voltage variations, interruptions, etc.) of the aircraft electrical system, as specified in 16.5.1 and/or 16.5.2.	None	When a remote monitor/control is provided the requrement reduces the potential for electrical power variations to cause inadvertent activation.
4. Abnormal Conditions of the Electrical Power Supply Inputs	Paragraph 2.3.12.2 Reference 2.2.6 Reference DO-160B, 16.5.3 and/or 16.5.4 If applicable, the ELT Remote Monitor shall withstand abnormal conditions of the aircraft electrical system, as specified in 16.5.3 an/or 16.5.4.	None	Same as above.

C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
5. Voltage Spike Protection	Paragraph 2.3.13 Reference 2.2.6 Reference DO-160B, 17.3 (Category A) or 17.4 (Category B) If applicable, the ELT Remote Monitor shall withstand the effects of voltage spikes arriving on its power leads as specified in 17.3 (Category A) or 17.4 (Category B). The ELT shall not activate under conditions less severe than this.	None	When a remote monitor/control is provided the requirement reduces the potential for electrical power variations to cause inadvertant activation.
6. Conducted Audio-Harmonics Susceptibility	Paragraph 2.3.14 Reference 2.2.6 Reference DO-160B, Section 18 The ELT Remote Monitor shall operate and meet "Activation Monitor" requirements when subjected to audio frequency components that are harmonically related to the power supply fundamental frequency, as specified in Section 18. The ELT shall not activate under these conditions.	None	When a remote monitor/control is installed, this requirement will reduce the probability of inadvertant activation due to improper design of the equipment.
7. Induced Audio-Signal Susceptibility	Paragraph 2.3.15 Reference 2.2.6 Reference DO-160B, Section 19 The ELT monitor shall operate and meet "Activation Monitor" requirements when its interconnecting wire bundle is subject to induced audio spikes, and electric and magnetic fields, as specified in Section 19. The ELT shall not activate under these conditions.	None	When a remote monitor/control is used, this requirement will reduce the probability of inadvertant activation due to induced voltages in the wiring.
8. Radio Frequency Energy Emission	Paragraph 2.3.16 Reference DO-160B, Section 21 The equipment shall operate within the RF conducted and radiated permissible levels specified in Section 21.	None	Reduces the potential for the ELT to interfere with other avionics systems in the aircraft and in other nearby aircraft.

D. ENVIRONMENTAL REQUIREMENTS

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
1. Ground Survival (Non-Operating) Temperature	Paragraph 2.3.1.1 Low -55° (±3°) C Paragraph 2.3.1.2 High +85° (±3°) C	Paragraph 3.1 Low -65°C High +71°C	The higher temperature limit will reduce the number of internal failures.
2. Operational Temperature	Paragraph 2.3.1.1 a Low -20° (±3°) C with full PERP Paragraph 2.3.1.1 b Low -40° C with a reduced PERP of 5mW (±7dBm) during a 50-hour operating period. Paragraph 2.3.1.2 High +55° (±3°) C	Paragraph 3.1 Low -20° C High +55° C	Provides operation under environmental conditions not currently available with existing specifications. In particular, areas like Alaska and the northern states will benefit significantly in the winter months.
3. Operational Temperature Variation	Paragraph 2.3.2 Reference DO-160B, Section 5 The ELT must operate at maximum duty cycle during temperature variations of 2-5° C minimum per minute between high (55°C) and low (-20° C) operating temperature extremes.	Paragraph 3.5 The ELT must operate at maximum power consumption during temperature variations not exceeding 1 ° C per minute between +55° C and -40° C.	Improves the capability of the ELT to operate under rapid temperature changes.
4. Humidity	Paragraph 2.3.3 Reference DO-160B, 6.3.1, Category A The ELT must withstand 48 hours (two cycles) of exposure in a standard humidity environment. A cycle is defined as follows: (a) 8 hours exposure to and atmosphere of 50°C and a relative humidity of at least 95%, and (b) 16 hours exposure to an atmosphere at 38°C or lower and a relative humidity of at least 85%.	Paragraph 3.2 SAME.	

D. ENVIRONMENTAL REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
5. High-Altitude Survival Pressure for Installations in Non-Pressurized Compartments	Paragraph 2.3.1.3 Reference DO-160B, Table 4-1, 4-2 The ELT equipment shall withstand a low-pressure equivalent to the maximum operational altitude for the aircraft on which the ELT will be installed.	Paragraph 3.1.3 50,000 ft. (15,240 m) or 116 mbars	
6. Decompression Survival Requirement	Paragraph 2.3.1.4 Reference DO-160B, 4.6.2 The ELT shall withstand an absolute pressure reduction from 8,000 ft. (752.6 mbars) to the equivalent of the maximum operational altitude for the aircraft on which the ELT will be installed.	Paragraph 3.1.4 The ELT must withstand a reduction in pressure from 8,200 ft. altitude to the atmospheric pressure of 40,000 ft. altitude.	
7. Overpressure Survival for Installations in Pressurized Compartments	Paragraph 2.3.1.5 Reference DO-160B, 4.6.3 The ELT must withstand an absolute pressure of 1697.3 mbars (-15,000 ft equivalent).	Paragraph 3.1.5 It specifies overpressure requirements, but it does not list pressure value.	
8. Vibration Endurance	Paragraph 2.3.5 There will be no activation during exposure to a vibratory motion (varying at a rate not to exceed 1.0 octaves/minute) in all three major orthogonal ELT axes.	Paragraph 3.4 SAME	
9. Waterproofness	Paragraph 2.3.7.2 Spray Proof Paragraph 2.3.7.1 Drip Proof (When Required) Reference DO-160B, 10.3.1, 10.3.2 The ELT in operating mode shall withstand 15 minutes of spray water in all six sides and, if required, falling drip water as specified in 10.3.1 and 10.3.2. Also compliance is tested after the 15 minute water spray.	Paragraph 3.7 Same except that compliance with standards is only determined while being subhected to the spray or falling (drip) water and not after the 15-minute period.	More effective test of ability of ELT to withstand water penetration.

D. ENVIRONMENTAL REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
10. Salt Water Resistance	Paragraph 2.3.11 Salt Water Spray (Optional for AF) Reference DO-160B, Section 14, Category S The ELT must withstand a salt fog atmosphere at 35° C for a 48-hour period and a 48-hour drying period at ambient temperature.	None	Improved reliability of ELTs operability near salt water environment.
	Paragraph 2.3.8.2 Salt Water Immersion (Optional for AF) Reference DO-160B, 11.4.2, 14.3.4, 14.3.4.1, Category S The ELT must withstand a 24-hour immersion period in salt water at 30°C to 40°C and a 160-hour drying period at 65°C.	Paragraph 3.6 The ELT must withstand a 15-hour immersion period in salt water.	Improved reliability of ELTs operating near a salt water environment.
11. Fluids Susceptibility	Paragraph 2.3.8.1 Fluid Spray (When Required) Reference DO-160B, 11.4.1 The ELT must withstand a 24-hour fine mist wetted condition and a 160-hour drying period at 65°C.	None	Improved performance for ELT installations in areas where fluid contamination could be commonly encountered.
	Paragraph 2.3.8.3 Fluid Immersion (When Required) Reference DO-160B, 11.4.2 The ELT must withstand a 24-hour immersion period and a 160-hour drying period at 65°C.	None	
12. Blowing Sand and Dust Resistance	Paragraph 2.3.9 Reference DO-160B, Section 12 When required, the ELT must withstand a dust and sand jet between .5 and 2.5 m/sec during a 1-hour period at 25°C and 30% relative humidity and a 1-hour period at 55°C and 30% relative humidity along each major orthogonal axis.	None	Improved reliability of ELT, particularly under environmental conditions where blowing sand and dust are prevalent.
13. Fungus Resistance	Paragraph 2.3.10 Reference DO-160B, Section 13 When required, the ELT must withstand a 28-day fungus growth period at 30°C and 97% relative humidity followed by a 48-hour drying period at room temperature.		

D. ENVIRONMENTAL REQUIREMENTS (cont.)

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
14. Explosion Proofness	Paragraph 2.3.6 Reference DO-160B, Section 9 There will be no detonation of the explosive mixture (when required).	None	Improved crash reliability regarding potential for causing fire.
15. Fire Resistance	Paragraph 2.1.5 Except for small parts (such as knobs, seals, etc.) that would not contribute significantly to the propagation of a fire, all ELT materials used shall be self-extinguishing. A means of showing compliance is contained in Federal Aviation Regulation (FAR), Part 25, Appendix F.	None	Significant improvement in reliability during crashes where fire is a factor.

E. INSTALLED EQUIPMENT PERFORMANCE & OPERATIONAL TESTS

ELT SPECIFICATION REQUIREMENTS	RTCA/DO-183 (MAY 1983)	RTCA/DO-147 (NOV 1970)	IMPROVEMENTS
1. Equipment Installation	Paragraph 3.1 Provides specific requirements for installation of ELT in aircraft which take in account accessibility, aircraft environment, display visibility, dynamic response, failure protection, inadvertant turn-off, ELT location, crash sensor orientation, antenna installation and location, and coaxial cable installation and integrity.	None	Major improvement in survivability and performance of ELT mounted in aircraft.
2. Installed Equipment	Paragraph 3.2 Suppliments Paragraph 2.1 and 2.2 by adding installed equipment requirements of dynamic response and interference effects.	None	Improves performance of installed ELT system.
3. Condition of Test	Paragraph 3.3 Requires testing with other avionics equipment operating.	None	Improves compatibility with the equipment in aircraft.
4. Test Procedures for Installed Equipment Performance	Paragraph 3.4 Requires inspection of installed equipment to meet requirements of Section 2 with specific requirements to test remote monitor/control, accessibility and interference effects.	None	Improved performance of installed equipment.
5. Operational Tests	Paragraph 4.0 Provides preflight procedures, post-flight procedures, operational checks and inspection requirements.	None	Improves overall reliability by providing confidence checks of ELT system on a regular basis.
6. Power Supply	Paragraph 2.1.11 Specifies shelf life not greater than one half the cell shelf lifeand that the expiration date be clearly marked externally.	None	
	Paragraph 2.1.11 Provides for use of aircraft battery or other supplemental power supply for remote monitor/control and/or charging.	None	Remote monitor/control does not drain ELT battery; allows design of a more effective and reliable system.

APPENDIX C

Federal Aviation Administration ELT Performance Validation Study

U.S. Department
of Transportation

Federal Aviation
Administration

Federal Aviation Administration ELT Performance Validation Study

U.S. Department of Transportation
Federal Aviation Administration (AIR-120)
800 Independence Ave., S.W.
Washington, D.C. 20591

This study has been prepared to validate the data base information used in the NASA study titled "Current Emergency Locator Transmitter (ELT) Difficiencies and Potential Improvements Utilizing TSO-C91a ELTs" dated 2 July 1990.

It was prepared by ARC Professional Services Group (Mr. Bernard J. Trudell and Mr. Ryland R. Dreibelbis) under Order Number DFTA03-90-00800.

FEDERAL AVIATION ADMINISTRATION
ELT PERFORMANCE VALIDATION
STUDY
15 MAY 1990

I. PURPOSE

The purpose of this study was to validate the National Aeronautics and Space Administration (NASA) analysis of Emergency Locator Beacon (ELT) performance in aircraft accidents. The NASA analysis was derived from National Transportation Safety Board (NTSB) computerized data files that contained information extracted from accident reports completed by NTSB accident investigators. In order to insure that the computerized data did not result in misleading information, the FAA requested a review of at least 100 NTSB Form 6120.4, Aircraft Accident/Incident Reports, to compare the information found in the full report with the data contained in the computer data base.

II. APPROACH

The validation study was initiated with the review and analysis of ten (10) NTSB Form 6120.4 reports that contained a variety of ELT failure causes and crash outcomes related to the occupants of the aircraft involved. These ten reports were used to verify the planned approach that would be used for the validation study.

The selection of individual accident reports reviewed in each failure category was determined by its percentage of the total number of failures in each category of the data base examined. A minimum of two reports was selected for each category.

The examination of the NTSB Aviation Accident/Incident Report was accomplished by a detailed review of blocks 16, (Narrative Statement of Facts, Conditions and Circumstances Pertinent to the Accident/Incident), Blocks 67,68, 69 and 70 (Emergency Locator Transmitter) and Block 213 (Injury Summary) of the basic document. Also, Block 56, (ELT - Reason for Noneffectiveness/Failure) of Supplement A, Supplement I, (Crash Kinematics and Photo documentation) and Supplement M (Condition of Aircraft Occupants at Rescue) were reviewed. In addition, the individual reports were scanned for special entries concerning ELT performance.

An examination of the 19 reasons for ELT Noneffectiveness listed in Block 56 of Supplement A, revealed that the reasons could be distributed to four general cause categories that identify failure origins. The categories are Poor Design, Lack of

Maintenance and Inspection, Beyond Specification and Undetermined. The categories are defined as follows:

a. Poor Design: Poor design is defined as a failure due to inadequate design specifications of the ELT or its installation.

b. Maintenance and Inspection: A maintenance and inspection failure is defined as one in which the problem could have been identified and corrected with an effective inspection and maintenance program.

c. Beyond Specification: A failure attributed to "beyond specification" is one in which the TSO-C91 ELT's operational capability was exceeded.

d. Undetermined: This category was used whenever the information examined was not specific enough to allow placement of the reason for failure into categories a, b, or c above.

The injury summary (Block 213 of the basic report) was reviewed to identify survivable accidents and to validate the information contained in the NTSB computer data runs that were used as source material for the NASA ELT analysis.

III. FINDINGS:

One hundred sixty-five reasons for ELT failure (some were double entry in the same report) were identified in the 119 NTSB Aircraft Accident/Incident reports examined.The primary reason for failure was selected for each case and distributed as shown in Table 1.

In 12 of the 19 reason categories minor differences existed between the computerized NTSB data base and the information entered in the docket (NTSB Accident Report).

The most significant error in data entry was in number 10, Antenna Broken/Disconnected. In this category the dockets reflected 10 more failures than the NTSB data base. If this error rate exists throughout the entire data base then it is in error by 53 percent, indicating a more serious problem than reflected in the data base.

The validation also disclosed that 26 (22%) of the 119 dockets revealed failures that could have been detected by an effective inspection and maintenance program as opposed to the 12 to 18% identified in the NASA study.

The other differences were considered minor, i.e., not more than three in each reason category. It was interesting to note, however, that in reason number 1, Operated Effectively, the data base had three entries while the docket had no entries in this category. These errors are probably due to data entry clerical errors.

The number of data entry errors detected in this study appears to be approximately 10 percent, which seems higher than would normally be expected.

TABLE 1

56. ELT - Reason (s) for Noneffectiveness/Failure	Number of Primary Reasons for Failure from Docket
1. Operated Effectively	0
2. Insufficient "G"	15
3. Improper Installation	3
4. Battery Dead	5
5. Battery Corroded	1
6. Battery Installation Incorrect	2
7. Incorrect Battery	2
8 Fire Damage	22
9. Impact Damage	27
10. Antenna Broken/Disconnected	15
11. Water Submersion	7
12. Unit Not Armed	9
13. Shielded by Wreckage	1
14. Shielded by Terrain	2
15. Internal Failure	3
16. Test Satisfactory after Accident	1
17. Signal Direction Altered by Terrain	1
18. Packing Device Still Installed	1
19. Remote Switch Off	2
Total:	119

The second step of the validation process categorized each primary reason for noneffectiveness/failure into one of four groups, e.g., Poor Design, Maintenance and Inspection Deficiencies, Beyond Specification and Undetermined. The 119 primary reasons for noneffectiveness were distributed within these four groups or categories as shown in Table 2.

TABLE 2

Cause Category	Number of Reasons	Percentage
Poor Design	29	24%
Maintenance & Inspection	26	22%
Beyond Specification	51	43%
Undetermined	13	11%
Totals	119	100%

Note: The definitions listed in paragraphs II a, b, c and d of this report were used to determine the cause category distribution of each reason for noneffectiveness.

IV. OBSERVATIONS and CONCLUSIONS:

The following observations were derived from examination of 120 NTSB Form 6120.4, Aircraft Accident/Incident Reports:

1. Although differences exist between the NTSB data base information and the dockets in 12 of the 19 reasons for ELT noneffectiveness, the variations are minor with the exception of one category. In the Antenna Broken/Disconnected reason, (Number 10) the examination of the dockets revealed that there were 10 more entries than in the data base. This difference of 53 percent, if applied to the NASA predicted improvements (Table 7 contained in the NASA Analysis of ELT Problems report), would increase the overall expected improvement from 73 to 74 percent.

2. An improved FAA maintenance and inspection program may be more effective in lowering the ELT failure rate than projected by the NASA study. This validation discovered that 22 percent of the ELTs failed to operate due to pre-crash defects (discrepancies) while the NASA study reflects a 12 to 18 percent rate.

3. The docket study results were not significantly different to support alteration of the TSO-C91a ELT benefits prediction.

List of Attachments:

1. ELT Performance Validation Charts (24 pages)
2. NTSB Form 6120.4, Page 1, Block 16, Narrative Statement of Facts, Conditions and Circumstances Pertinent to the Accident/Incident
3. NTSB Form 6120.4, Page 4, Blocks 67, 68, 69, and 70, Emergency Locator Transmitter (ELT)
4. NTSB Form 6120.4, Page 9, Block 213, Injury Summary
5. NTSB Form 6120.4, Sup. A, Page 2, Block 56, ELT-Reason for Noneffectiveness/Failure
6. NTSB Form 6120.4, Sup. M, Page 1, Block 12, Condition of Aircraft Occupants at Rescue
7. NTSB Form 6120.4, Sup. I, Page 1, Crash Kinematics
8. NTSB Form 6120.4, Sup. S, Page 1, Aircraft Occupant and Injured Ground Personnel

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

Parts of Docket Examined (NTSB Form 6120.4):
BASIC: Block 16 (Narrative), Blocks 67, 68, 69, 70 (ELT)
BASIC: Block 213 (Injury Summary)
SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
(⊗) Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: No	Category for Noneffectiveness: Poor Design	Category for Noneffectiveness: Maintenance/Inspection	Category for Noneffectiveness: Beyond Specs	Category for Noneffectiveness: Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
001	11	(11)	X				(⊗)		1 5	2F 2S	2F 2S	Water Submersion: Aircraft was involved in a mid-air collision with a helicopter, made an uncontrolled descent and crashed into the East River in N.Y.C.. The aircraft sank in 40 feet of water. Two passengers escaped. The pilot and another passenger were killed.
002	9	(9)	X		(⊗)				2 3	3F	3F	Impact Damage: Aircraft crashed during the evening of 12 October killing the pilot and his wife. The pilot's son survived the crash and was located alive the next morning; however, he died after arriving at the hospital.
003	9	(9)	X		(⊗)				2 3 6 7	4F	4F	Impact Damage: Aircraft crashed killing the pilot and two passengers on impact. A third passenger, who was badly burned, died the next day. The report indicated that the fire consumed the aircraft from the firewall to the aft fuselage separation point.
004	8	(8)	X				(⊗)		1 2 4	2F	2F	Fire Damage: Aircraft crashed into rising terrain. The pilot was killed on impact. The one passenger was able to walk down the mountainside to obtain help, but later died of injuries.
005	9 10 11	9 10 (11)	X		X		(⊗)		1 2 4	3F 1S	3F 1S	Impact Damage, Water Submersion and Antenna Broken/Disconnected: Pilot was demonstrating how fast the aircraft was flying at low level over the Niagara River when the aircraft came into contact with the water. The pilot and two rear seat passengers were killed. The right front seat passenger survived.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*
1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*
1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive - died later
4 ☐ Died awaiting rescue
5 ☐ Located alive - trapped
6 ☐ Able to assist with locating
7 ☐ Left scene - successfully located
8 ☐ Left scene - unsuccessful in finding aid
9 ☐ Left scene - unsuccessful in finding aid - died later
A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

Parts of Docket Examined (NTSB Form 6120.4):
BASIC: Block 16 (Narrative), Blocks 67, 68, 69, 70 (ELT)
BASIC: Block 213 (Injury Summary)
SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
006	9 15	9 ⑮	X		X	⊗			1 2 5	2F 2S	2F 2S	Impact Damage and Internal Failure: Black wire to battery was disconnected at the solder joint. Aircraft crashed on takeoff from a busy airport; however, no one saw impact. The pilot and one passenger were killed on impact. Two other passengers survived, but waited several hours while dozens of aircraft departed over them. The survivors could see control tower.
007	4	④	X			⊗			2 4	2F 2S	2F 2S	Battery Dead: measured 0.2 volts. Aircraft was flown into trees. The pilot and right front seat passenger received fatal injuries. The two rear seat passengers survived. The empennage remained intact.
008	11	⑪	X				⊗		2 4	2F	2F	Water Submersion: Aircraft sank in 21 feet of water. The pilot of the aircraft died of drowning while a second pilot on board survived the crash. However, he later died of exposure while trying to walk for help in 23 degree weather.
009	10 12 16	10 ⑫ 16	X		X	⊗			1 2	1F 1S	1F 1S	Antenna Broken/Disconnected and Unit Not Armed: It did test satisfactorily after the crash. The pilot survived the accident; however, his passenger was killed. The pilot was 80 years old and his passenger was 87.
010	8	⑧	X				⊗			2F	2F	Fire Damage: Aircraft was totally burned. Both the pilot and the passenger were killed on impact.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
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Reasons for Failure
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SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Docket	Remarks
011	1 2	⑫		X		⊗				1S	1S	Unit Not Armed: Reasons in NTSB data base were 1 and 2. Reason in docket was Unit Not Armed (12). Aircraft crashed into a plowed field and the pilot was seriously injured. The difference between the data base entry and the docket is apparently the result of a data entry error.
012	2	②	X				⊗			2N	2N	Insufficient "G": Two aircraft involved, one landing on top of the other at touchdown point on same runway. Both aircraft recovered and landed safely - minor damage.
013	2	②	X		⊗					1M	1M	Insufficient "G": Aircraft flipped on its back after landing in a plowed field in a stall condition.
014	1 2 6	② 16		X	⊗					2N	2N	Insufficient "G": Aircraft rolled into a hangar wall after leaving the runway on landing. It penetrated the hangar wall and the aircraft was destroyed. "G" forces may have been sufficient although the pilot and passenger were uninjured. Another data entry error may be involved.
015	2	②	X				⊗			4N	4N	Insufficient "G": Pilot made a good forced landing. Minor damage to aircraft.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

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2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

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3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

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BASIC: Block 213 (Injury Summary)
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SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
Ⓜ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/ Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/ Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
016	2	②	X				⊗			2N	2N	Insufficient "G": Aircraft was involved in a minor mid-air. Both aircraft landed safely. No "G" forces were involved that would activate the ELT.
017	2 8 9	2 ⑧ 9 10		X	X		⊗			3S 5M	3S 5M	Insufficient "G", Fire and Impact Damage: Aircraft crashed into trees on final approach and was totally destroyed by crash and post crash fire. The docket included antenna broken/disconnected (10) as a reason for noneffectiveness. "G" forces should have been sufficient to activate the ELT.
018	2 12	2 ⑫	X		X	⊗				3N	3N	Insufficient "G"and Unit Not Armed: Aircraft made a hard forced landing shearing one gear and flipping on its back. It hit ground 20 degrees nose down, slid 50 feet and hit a gully, then nosed over. The aircraft occupants were not injured.
019	2	②	X		⊗					2N	2N	Insufficient "G": Aircraft crashed after takeoff into trees. It ended up nose down on the ground. The aircraft was substantially damaged; however, the two occupants were uninjured.
020	2	②	X		⊗					1F	1F	Insufficient "G": Aircraft crashed into hard ground 40 degrees nose down. Pilot was killed. Accident report estimated aircraft hit ground between 60 to 75 MPH. This does not concur with Insufficient "G" as reason for ELT not operating.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
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3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT Reasons for Failure Analysis Report

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BASIC: Block 213 (Injury Summary)
SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Docket	Remarks
021	1 2	⑫		X		⊗				1S 1M 1N	1S 1M 1N	Unit Not Armed: Impact in this crash was severe. NTSB data showed causes for noneffectiveness as 1, operated effectively, and 2, insufficient "G". Docket listed reason for noneffectiveness as 12 (unit not armed). This is apparently an entry error.
022	2 16	② 16	X		⊗					2S 1M	2S 1M	Insufficient "G": Aircraft hit fence, then wall and bounced back 7 feet. Both front seat occupants were seriously injured. Rear seat passenger was not injured. The ELT tested satisfactorily after the accident.
023	2	②	X					⊗		1S 2M	1S 2M	Insufficient "G": Aircraft bellied in on instrument approach. Minor injuries involved.
024	3 16	③ 16	X			⊗			2	2F	2F	Improper Installation: Tested satisfactorily after accident. Body length of beacon was parallel to aircraft's longitudinal axis. It should have been mounted perpendicular. The aircraft was flying magnetometer survey flights at low altitude (300 to 400 feet) in strong winds and turbulence. It may have stalled, hitting ground in 78 degree nose down attitude. Both occupants were killed.
025	3	③	X		X	⊗			1 2	U N K	2F	Improper Installation: ELT apparently broke loose from mount. It did emit a signal on test after the accident. The battery was leaking and was overdue replacement by 3 years and 9 months. The aircraft crashed during climb out after takeoff. Both occupants were killed on impact.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
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12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

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SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):

F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:

⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Docket	Remarks
026	5	⑤ 15		X	X	⊗				2F	2F	NTSB data had Battery Corroded (5), docket had Internal Failure (15) and Battery Corroded: AFRCC report, which was included in docket, had antenna broken, armed but not transmitting. The aircraft collided with mountainous terrain during marginal VFR conditions, killing both aircraft occupants.
027	5	⑩		X	⊗					1F	1F	NTSB data had Battery Corroded (5) but docket had Antenna Broken/Disconnected (10): The aircraft encountered low ceilings while enroute and collided with the terrain. The pilot was killed on impact.
028	6	⑥ 10		X	X	⊗				2F	2F	NTSB data had Battery Installation Incorrect (6). Docket had (6) and Antenna Broken/Disconnected (10): Docket narrative also stated that one pole of the connector was found loose on the circuit board. The aircraft crashed on approach to Talladega Airport on 01/03/86. The aircraft was not located until 01/10/86.
029	6	⑥	X			⊗				2F	2F	Battery Installation Incorrect: No explanation in narrative of report. The aircraft was apparently flown into an area of 3 to 4 level thunderstorms. The left wing was lost in flight. The aircraft crashed on 23 July and was not located until 25 July.
030	2	②	X				⊗			6N	6N	Insufficient "G": This was a helicopter that was in a high hover when the engine failed. A hover type autorotation was made. Landing was cushioned with collective pitch application. Very little "G" force involved.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
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19 ☐ Remote switch off
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1 ☐ Located alive
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7 ☐ Left scene - successfully located
8 ☐ Left scene - unsuccessful in finding aid
9 ☐ Left scene - unsuccessful in finding aid - died later
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031	2	②	X					⊗		1N	1N	Insufficient "G": Aircraft was involved in a forced landing. The gear was down but it sheared off during the landing. No injuries to the pilot.
032	2	②	X					⊗	2	3F	3F	Insufficient "G": Aircraft disintegrated in the air. Possibly flew into a thunderstorm or associated turbulence. All occupants of the aircraft were killed. Level three thunderstorms were in the area. "G" force when wreckage hit ground should have been sufficient to activate ELT. Possibly, direction of impact was off.
033	2	②	X				⊗			2N	2N	Insufficient "G": Aircraft made a forced landing on an unused runway. It did hit some barrells and posts which marked the unused runway.
034	2	②	X		⊗					1N	1N	Insufficient "G": Pilot error accident during landing. The nose gear was torn off the aircraft and the aircraft flipped on its back.
035	2	②	X					⊗		2N	2N	Insufficient "G": Pilot lost directional control on take off roll and ran off the runway. Wing was damaged, prop bent and strut broken.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*
1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
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1 ☐ Located alive
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036	7	⑦ 9		X	X	⊗			2	1F	1F	NTSB data entered as Incorrect Battery (7). Docket included Impact Damage (9): Aircraft was flown into the side of a mountain. ELT was examined and battery box contined 6 "D" cells wired in series which was not authorized for this ELT.
037	7 9	⑦ 9	X		X	⊗				1S	1S	Incorrect Battery (7), and Impact Damage (9): Aircraft spun into trees from 500 feet above ground level. The pilot was injured.
038	7 12	7 ⑫	X			⊗			2	4F	4F	Incorrect Battery and Unit Not Armed: The arming switch was found in the off position and the ELT battery had been removed and replaced by 6 "D" cell flashlight batteries (1.5 V each) wired and soledered in series. The aircraft log indicated that the aircraft owner pilot had replaced the battery March 16, 1982. The crash was on July 27, 1983.
039	8	⑧	X				⊗		1 6 7	2S 2M	2S 2M	Fire damage: The aircraft burned from the firewall aft to the beginning of the dorsal fin -- completely destroyed by fire. The ELT was located in the empennage.
040	8	⑧	X				⊗			2F	2F	Fire Damage: Aircraft was instructed to abort landing on short final and reenter downwind. Aircraft made right turn at low altitude and hit power pole. Crashed and burned. No further information on ELT in report.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
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Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
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041	8	(8)	X				⊗		2	2F	2F	Fire Damage: Instructor pilot requested a flight reversal after take off so he could do a simulated engine out at 700 feet and return downwind to departure end of runway. Aircraft stalled, crashed and burned. No other ELT data in report.
042	8	(8)					⊗			1S	1S	Fire Damage: Engine failed on takeoff. Pilot tried to return to runway. Aircraft was consumed in flames -- pilot was seriously injured. The ELT was consumed by the post-crash fire.
043	8	(8)	X				⊗			3F	3F	Fire Damage: Super Cub hit a tree while buzzing. Wing was torn off in tree and aircraft crashed approximately 100 feet from the tree and was completely burned.
044	8	(8)	X				⊗			2F	2F	Fire Damage: Aircraft hit power line during traffic survey flight for New Mexico State Police. The aircraft was consumed by post-crash fire. Both occupants were deceased.
045	8	(8)	X				⊗			2S 2M	2S 2M	Fire Damage: Aircraft lost right engine shortly after lift-off and crashed. The aircraft was destroyed by impact and post-crash fire.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

Parts of Docket Examined (NTSB Form 6120.4):
BASIC: Block 16 (Narrative), Blocks 67, 68, 69, 70 (ELT)
BASIC: Block 213 (Injury Summary)
SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/ Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/ Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent ...: No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
046	8	(8)	X					⊗		4F	4F	Fire Damage: Aircraft crashed into trees shortly after takeoff. The aircraft was demolished by impact and post crash fire. Docket indicated two survivors and two fatal. NTSB data indicated four fatalities. The ELT was not found.
047	8	(8)	X				⊗			1F	1F	Fire Damage: Aircraft flew into ground at night during a cross country flight from El Monte, CA to Santa Ynez. Aircraft was destroyed by impact and post crash fire. No other ELT information in report. The pilot was killed.
048	8	(8) 9 10		X	X		⊗			1F	1F	NTSB data entered as Fire Damage. Docket indicated in 56A Fire Damage (8), Impact Damage (9), and Antenna Broken/Disconnected (10): Aircraft crashed into ground during instrument approach procedure. The pilot was killed and the aircraft destroyed by fire and impact.
049	8	(8)	X				⊗			1F	1F	Fire Damage: The aircraft crashed while attempting an instrument approach procedure. The aircraft was destroyed by crash impact and post crash fire. The pilot was killed. The ELT was so badly burned that the position of the switch could not be determined.
050	8	(8)	X		X		⊗			2F	2F	Fire Damage: Aircraft crashed into trees while on a sight seeing flight. Aircraft was destroyed by impact and post crash fire. Both occupants were killed. No additional information on the ELT was included in the report.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*
1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*
1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive - died later
4 ☐ Died awaiting rescue
5 ☐ Located alive - trapped
6 ☐ Able to assist with locating
7 ☐ Left scene - successfully located
8 ☐ Left scene - unsuccessful in finding aid
9 ☐ Left scene - unsuccessful in finding aid - died later
A ☐ Other

Federal Aviation Administration
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SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal   M - Minor
S - Serious   N - None

Noneffectiveness Reasons and Category:
⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Nonffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12) / Injury Summary (Block 213): Data Base	Docket	Remarks
051	8	⑧	X				⊗		1F	1F	Fire Damage: The aircraft was stolen by a non-pilot. He got the aircraft airborne at night, but crashed apparently trying to return to the airport. The aircraft was destroyed by impact and post crash fire. The pilot received fatal injuries. No additional information on the ELT was included in the report.
052	8	⑧	X				⊗		1F	1F	Fire Damage: Aircraft crashed into trees and high terrain in a slightly left wing - low nose attitude. Fire was apparently present as aircraft crashed through trees. Severe impact damage was also involved. Pilot was killed on impact.
053	8	⑧	X				⊗		3F	3F	Fire Damage: Aircraft crashed on a road while making an approach to an airport. This fabric aircraft was totally burned. Both occupants were killed by impact and fire. The ELT was located in the cabin which was totally involved in the fire.
054	8	⑧	X				⊗		2F	2F	Fire Damage: Aircraft experienced an engine failure after airport departure and crashed into a power line during the forced landing. The aircraft was consumed by fire. Both occupants were killed by impact.
055	8 9	⑧ 9	X				⊗		2F	2F	Fire and Impact Damage: Aircraft was towing a banner at low altitude when banner caught an electric power line. The aircraft appeared to stall, then landed on a highway, crashing into a truck. Both occupants of the aircraft were killed by impact and fire.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
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SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal   M - Minor
S - Serious   N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/ Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/ Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
056	8, 9	(8), 9	X				⊗		2	1F	1F	Fire and Impact Damage: Aircraft crashed into terrain and burned. The pilot was killed on impact.
057	8, 9	(8), 9	X				⊗			1F	1F	Fire and Impact Damage: Aircraft crashed into houses while on approach to Logan International Airport in Boston. The aircraft was destroyed and the houses burned. The pilot was killed.
058	8, 9, 10	8, (9), 10	X		X		⊗		2	1F	1F	Fire Damage, Impact Damage, and Antenna Broken/Disconnected: Aircraft descended below minimum obstruction clearance altitude in icing conditions and crashed into the terrain. The pilot was killed. The ELT was destroyed with the battery found separated.
059	8, 9, 10	8, (9), 10	X				⊗		2	4F	4F	Fire Damage, Impact Damage and Antenna Broken/Disconnected indicated by Sup. A 56. However, narrative does not indicate fire existed. Aircraft was destroyed by impact forces and all four occupants were killed.
060	9	(9), 10, 13, 14		X			⊗		2	1F	1F	Data base indicated Impact Damage only but docket Sup. A Block 56 also included Antenna Broken/Disconnected (10), Shielded by Wreckage (13), and Internal Failure (15): The aircraft crashed into a gravel pit 90 degrees nose down, killing the pilot.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive - died later
4 ☐ Died awaiting rescue
5 ☐ Located alive - trapped
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7 ☐ Left scene - successfully located
8 ☐ Left scene - unsuccessful in finding aid
9 ☐ Left scene - unsuccessful in finding aid - died later
A ☐ Other

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SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
061	9	(9) 10		X	X		⊗			2F	2F	Data base indicated Impact Damage only but docket Sup. A Block 56 also included Antenna Broken/Disconnected (10): Aircraft was flown into a 1/2 inch steel ground line of an electric power line. Pilot and passenger were killed on impact.
062	9	(9)	X					⊗		2F	2F	Impact Damage: Aircraft was flown into terrain while approaching airport. The aircraft did burn; however, the docket did not indicate that the ELT burned. Both occupants of the aircraft were killed on impact.
063	9	(9) 10		X	⊗				1 2	1F 1S	1F 1S	Data base indicated Impact Damage only but docket Sup. A Block 56 also included Antenna Broken/Disconnected (10): Aircraft was flown into ground in 45 degree nose down attitude by pilot who had been drinking. The pilot survived, the passenger was killed.
064	9	(9)	X		⊗					1F 1S	1F 1S	Impact Damage: The aircraft hit the trees in a nose low, left wing low attitude then crashed into the ground. There was no fire. The pilot was killed and his son survived. Photo evidence indicates that this ELT should have operated. There was little damage to the aircraft tailcone where the ELT was located.
065	9	(9)	X		⊗					2F	2F	Impact Damage: The aircraft hit a television tower wire. The plane cartwheeled into the ground. There was no post crash fire. Both occupants of the aircraft were killed. The empennage/tail cone where the ELT was located was not disintigrated. The ELT could have survived.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
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12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

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5 ☐ Located alive - trapped	A ☐ Other

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Injury Summary Key (Block 213):

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Noneffectiveness Reasons and Category:

(6) Primary Reason for Noneffectiveness
(X) Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/ Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/ Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: No	Category for Noneffectiveness: Poor Design	Category for Noneffectiveness: Maintenance/Inspection	Category for Noneffectiveness: Beyond Specs	Category for Noneffectiveness: Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
066	9	(9)	X		(X)					2F 1M	2F 1M	Impact Damage: The aircraft was flown into the ground while attempting to land during a heavy rainstorm. Impact damage was severe, however, the tail cone and empennage were relatively intact. The ELT should have survived the impact. Two of three occupants were killed.
067	9	(9)	X		(X)				2	1F	1F	Impact Damage: Aircraft crashed into trees and terrain in an uncontrolled descent. The student pilot was fatally injured. The investigator could not determine the pre-crash location of the ELT.
068	9	(9)	X		X		(X)		2	3F	3F	Impact Damage: Aircraft crashed into trees and terrain during inclement weather conditions. The pilot and two passengers were killed on impact. The investigator indicated that the aircraft was too badly damaged to determine the pre-crash position of the ELT.
069	9	(9)	X				(X)			1F	1F	Impact Damage: Aircraft came out of clouds in 45 degree nose down attitude and was flown into ground at high power setting. Aircraft was totally destroyed and the pilot was killed on impact. Pilot may have been drunk.
070	9	(9) 10		X			(X)			4F	4F	Data base had Impact Damage. Docket added Antenna Broken/Disconnected: Pilot reported oil on his windshield and requested immediate landing. The aircraft crashed on the airport killing all four occupants.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

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4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

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Injury Summary Key (Block 213):
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Noneffectiveness Reasons and Category:
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Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
071	3	③ 16		X		⊗				2F	1F	Improper Installation: No other information in docket. The aircraft crashed during an attempted go-around attempt. The pilot, who was still a student, had approximately 30 hours of dual. He died of crash injuries.
072	4 8 9	④ 8 9 13 14		X		⊗	X			4F	4F	Battery Dead, Fire Damage, Impact Damage, Shielded by Wreckage, Shielded by Terrain: Aircraft crashed into a mountainside after departing Aspen, CO. Report does not indicate how Dead Battery (4) was determined when (8), (9), (13), and (14) were also selected.
073	4	④ 14	X			⊗	X			1F	1F	Battery Dead and Shielded by Terrain: No explanations on how dead battery was determined. The aircraft was flown into terrain at night and possibly in IFR conditions. The pilot died of crash injuries.
074	4 10 16	④ 10 16	X		X	⊗				6F	6F	Battery Dead, Antenna Broken/Disconnected, Test Satisfactorily After Accident: The ELT was found separated from the aircraft. Another battery and antenna were connected to the ELT after the accident and the ELT tested satisfactorily. The aircraft had collided with the terrain while on a medical transport flight. The pilot and 5 passengers were killed.
075	4	④	X			⊗				2S	2S	Battery Dead: No explanation included in report. The aircraft apparently had an engine failure after takeoff. The pilot returned to the airport but overshot the runway and crashed, seriously injuring himself and his wife.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

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12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

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5 ☐ Located alive - trapped	A ☐ Other

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Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: No	Category for Noneffectiveness: Poor Design	Category for Noneffectiveness: Maintenance/Inspection	Category for Noneffectiveness: Beyond Specs	Category for Noneffectiveness: Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
076	9	⑨	X					⊗		3F	3F	Impact Damage: Pilot departed airport at night with low ceilings and after heavy drinking. He was not instrument rated. The aircraft crashed in a 45 degree nose down attitude killing the pilot and two female occupants.
077	9	⑨	X		⊗				1 2 7	2F 1S 1M	2F 1S 1M	Impact Damage: Aircraft crashed into high terrain and trees while trying to follow a road through a mountain pass at night. Weather was also a factor. The pilot and one passenger were killed. Two passengers survived.
078	9	⑨	X					⊗	2	5F	5F	Impact Damage: The pilot was trying to fly through mountainous terrain VFR when IFR conditions prevailed. The aircraft hit a 3600 ft. mountain at the 3200 ft. level killing all five occupants. The CAP located the aircraft 6 days after the crash.
079	9	⑨	X		⊗					1F 1S	1F 1S	Impact Damage: The pilot reported engine problems and declared an emergency. The aircraft crashed 45 degrees nose down at 75 to 90 mph near the airport. The pilot was killed and the passenger suffered serious injuries. The tail cone and empennage were basically intact.
080	9	⑨	X				⊗			3F	3F	Impact Damage: Aircraft was flown into an area of thunderstorms and severe turbulence. The resultant crash demolished the aircraft and the passengers died of crash injuries.

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11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive - died later
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5 ☐ Located alive - trapped
6 ☐ Able to assist with locating
7 ☐ Left scene - successfully located
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⑥ Primary Reason for Noneffectiveness
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Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent ...: No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
081	9	⑨ 10		X	X		⊗		2	2F	2F	The data base and Block 56 of Sup. A indicated Impact Damage as the cause for failure to operate, but the Inspection and Surveillance Record included Antenna Broken/Disconnected: Both occupants were killed. A seven day search was involved.
082	9	⑨	X				⊗			2F	2F	Impact Damage: Aircraft was a World War II P-51. The pilot attempted a roll at low altitude and never recovered. The aircraft struck the ground in excess of 200 mph. Both occupants were killed on impact.
083	9	⑨	X					⊗		4F	4F	Impact Damage: Aircraft crashed into tall trees in a mountainous area. All four occupants died of impact injuries.
084	9	⑨	X		⊗					1S	1S	Impact Damage: Aircraft pitched up after takeoff for unexplained reasons and then stalled. The aircraft contacted the ground in a flat attitude. The empennage and tail cone of the aircraft remained basically intact. The ELT should have functioned.
085	9	⑨	X				⊗		2	2F	2F	Impact Damage: Aircraft was performing a loop when the left wing failed. The aircraft struck the ground in a nose down vertical descent. The aircraft was totally destroyed by impact forces.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Federal Aviation Administration
Order No. DTFA03-90-P-00800
REQ/REF No. 9092A025

Validation of NASA ELT
Reasons for Failure
Analysis Report

Parts of Docket Examined (NTSB Form 6120.4):
BASIC: Block 16 (Narrative), Blocks 67, 68, 69, 70 (ELT)
BASIC: Block 213 (Injury Summary)
SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
⑥ Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent…: No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
086	9	⑨	X		⊗					1F 1S	1F 1S	Impact Damage: The pilot was practicing slow flight when he raised the nose too high. A spin resulted and the other pilot was unable to totally recover before the aircraft crashed into trees. The pilot originally flying the aircraft was killed. The other pilot survived.
087	9 10	⑨ 10	X					⊗		4F	4F	Impact Damage: The aircraft crashed at night while attempting to stay under a low overcast. The aircraft was destroyed on impact and all four occupants were killed.
088	10	⑩	X		⊗		X			1F	1F	Antenna Broken/Disconnected: Aircraft crashed inbound to the destination airport inside the VOR station. The non-instument rated pilot was trying to reach the airport in IMC conditions. He was killed on impact. No other information on the ELT.
089	10	⑩	X		⊗		X			1F	1F	Antenna Broken/Disconnected: Aircraft crashed into the terrain in marginal VFR conditions. The pilot was fatally injured. The pilot was flying on a revoked student permit. The ELT was found separated from its antenna. The ELT did not activate.
090	10	⑩	X		⊗		X			2S	2S	Antenna Broken/Disconnected: Aircraft crashed on takeoff during high density altitude conditions. The aircraft ended up 1380 ft. down the runway, 230 ft. to the left, nose down and inverted. The pilot and passenger were seriously injured. They were not discovered in the wreckage for 45 minutes after the crash.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

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SUP. A: Block 56 (ELT - Reasons for Noneffectiveness)
SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
091	10	(10)	X		X		⊗			2F	2F	Antenna Broken/Disconnected: Aircraft crashed on a go-around caused by failure to lower the gear for landing. The engine and cockpit burned. Both aircraft occupants were killed. The ELT was located in the cabin.
092	10	(10)	X		⊗					2F	2F	Antenna Broken/Disconnected: Aircraft crashed after pilot died in the air and his wife, who was not rated, tried to fly the aircraft. She was killed on impact. A picture of the ELT was in the report. It was not visibly damaged.
093	10	(10)	X		⊗					2S	2S	Antenna Broken/Disconnected: Aircraft had an engine failure after takeoff. A left turn to an open field was made but aircraft hit a telephone line and crash landed into a ditch. The pilot and passenger survived. The ELT should have worked. The tail cone had little damage.
094	10	(10)	X		⊗					1F	1F	Antenna Broken/Disconnected: Aircraft crashed during initial climb after takeoff. The aircraft initially struck trees and then the ground. The pilot died of crash injuries. The ELT was armed, but not coupled to the antenna. It tested functional.
095	10	(10)	X		X		⊗			1F	1F	Antenna Broken/Disconnected: Aircraft crashed after making a missed approach in instrument meteorological conditions. The aircraft struck the ground very hard in a 45 degree nose down attitude killing the pilot.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

Parts of Docket Examined (NTSB Form 6120.4):
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SUP. I: Crash Kinematics and Photo Documentation
SUP. M: Block 12 (Condition of Aircraft Occupants at Rescue)

Injury Summary Key (Block 213):
F - Fatal M - Minor
S - Serious N - None

Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: No	Category for Noneffectiveness: Poor Design	Category for Noneffectiveness: Maintenance/Inspection	Category for Noneffectiveness: Beyond Specs	Category for Noneffectiveness: Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
096	10	(10)	X		⊗					1S 1M	1S 2M	Antenna Broken/Disconnected: Aircraft crashed one mile short of the landing runway after engine failure. The pilot was seriously injured and his two passengers received minor injuries. The ELT should have survived the crash.
097	10	(10)	X		X		⊗			2F	2F	Antenna Broken/Disconnected: Aircraft crashed into terrain killing both the pilot and his passenger. The aircraft was totally destroyed.
098	10	(10)	X		⊗					1S 2M	1S 2M	Antenna Broken/Disconnected: Aircraft crashed into trees after running out of fuel on approach to airport. The two pilots in the front two seats received minor injuries. A rear seat passenger received serious injuries. The aircraft was destroyed. No fire. The empennage separated from the aircraft.
099	10	(10)	X		X		⊗			2F	2F	Antenna Broken/Disconnected: Aircraft crashed into trees near a private airstrip. Both occupants were killed on impact. There was no crash fire. The aircraft was inverted and totally destroyed.
100	10	(10)	X		⊗		X			2F 1S	2F 1S	Antenna Broken/Disconnected: Aircraft crashed on takeoff. The pilot and one passenger were killed. A second passenger survived. The aircraft was destroyed on impact with trees and terrain.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive - died later
4 ☐ Died awaiting rescue
5 ☐ Located alive - trapped
6 ☐ Able to assist with locating
7 ☐ Left scene - successfully located
8 ☐ Left scene - unsuccessful in finding aid
9 ☐ Left scene - unsuccessful in finding aid - died later
A ☐ Other

Federal Aviation Administration
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Noneffectiveness Reasons and Category:
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⊗ Category for Primary Reason for Noneffectiveness

Case	Reason(s) for Noneffectiveness/Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
101	11	⑪	X					⊗		1M	1M	Water Submersion: Aircraft ran off runway, through overrun and into bay. Pilot had minor injuries. Unable to determine from accident report if aircraft was totally submerged.
102	11	⑪	X				⊗			2F	2F	Water Submersion: Aircraft crashed into a lake at night. A witness said the aircraft suddenly went straight down into the lake. The aircraft was destroyed and both occupants were killed.
103	11	⑪	X				⊗			1S 2M 5N	1S 2M 5N	Water Submersion: Aircraft went off the end of the runway on an attempted takeoff, hit an embankment, and then ended up inverted in shallow water (i.e. waist deep). All eight passengers survived.
104	11	⑪	X					⊗		2S	2S	Water Submersion: Aircraft lost power over Florida Bay and was ditched in shallow water (4 feet). Aircraft remained upright. Both occupants were seriously injured. Docket said aircraft was not submerged and that the ELT had been turned off. Accident was reported to U.S. Customs.
105	12	⑫	X			⊗				1S	1S	Unit Not Armed: The aircraft lost 6 3/4 inches of one prop blade after takeoff. The pilot tried to return to the departure airport but crashed into trees short of the runway. The pilot was seriously injured but the tail cone and empennage were basically intact.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain
3 ☐ Improper installation	8 ☐ Fire damage	13 ☐ Shielded by wreckage	18 ☐ Packing device still installed
4 ☐ Battery dead	9 ☐ Impact damage	14 ☐ Shielded by terrain	19 ☐ Remote switch off
5 ☐ Battery corroded	10 ☐ Antenna broken/disconnected	15 ☐ Internal failure	A ☐ Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐ Located alive	6 ☐ Able to assist with locating
2 ☐ Located deceased	7 ☐ Left scene - successfully located
3 ☐ Located alive - died later	8 ☐ Left scene - unsuccessful in finding aid
4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

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Injury Summary Key (Block 213):
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Noneffectiveness Reasons and Category:
(6) Primary Reason for Noneffectiveness
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Case	Reason(s) for Noneffectiveness/ Failure (Block A-56): Data Base	Reason(s) for Noneffectiveness/ Failure (Block A-56): Docket	Was Docket Consistent with NTSB Data Base Entry in A-56, "Reasons for Noneffectiveness"?: Yes	No	Category for Noneffectiveness: Poor Design	Maintenance/Inspection	Beyond Specs	Undetermined	Condition of Occupants at Rescue (Sup. M, Block 12)	Injury Summary (Block 213): Data Base	Injury Summary (Block 213): Docket	Remarks
106	12	(12)	X			⊗				1F	1F	Unit Not Armed: The pilot accidently stalled the aircraft while chasing a wolverine at low altitude (Alaska) and crashed from a height of approximately 150 ft. The pilot was killed on impact.
107	12	(12)	X			⊗			2	2F	2F	Unit Not Armed: The aircraft crashed into a mountainside, fatally injuring both occupants. The ELT was newly installed but the owner said when he installed it, the ELT began to transmit so he turned it off. This was caused by the "G" switch not being reset prior to arming. This was a four day search.
108	12	(12)	X			⊗				2F	2F	Unit Not Armed: Aircraft crashed shortly after departure, fatally injuring both occupants. The aircraft may have stalled and spun in. The aircraft was enroute to Alaska and was 80 lbs over max gross. There was no additional ELT data in the report.
109	13	(10) 13		X	X		⊗			1F 3N	1F 3N	Shielded by Wreckage (13) however the docket added Antenna Broken/Disconnect (10): The aircraft collided with trees and terrain causing extensive damage. The survivors were not located until the day after the crash. The pilot walked 7 miles for help.
110	13 14	(13) 14	X				⊗			1F	1F	Shielded by Wreckage and Shielded by Terrain: Aircraft crashed into trees on takeoff killing the student pilot. This was an early morning takeoff with possible 800 ft. ceiling.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐ Operated effectively	6 ☐ Battery installation incorrect	11 ☐ Water submersion	16 ☐ Test satisfactorily after accident				
2 ☐ Insufficient G's	7 ☐ Incorrect battery	12 ☐ Unit not armed	17 ☐ Signal direction altered by terrain				
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12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

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4 ☐ Died awaiting rescue	9 ☐ Left scene - unsuccessful in finding aid - died later
5 ☐ Located alive - trapped	A ☐ Other

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111	14 16	(14) 16	X		X		⊗			2F 1S	2F 1S	Shielded by Terrain and Test Satisfactorily After Accident: The aircraft crashed on an instrument approach in low ceilings. The pilot was not instrument rated. The pilot survived and his two passengers died. The tail cone was not extensively damaged.
112	15	(15)	X		⊗					1F 1N	1F 1N	Internal Failure: Aircraft struck power line and trees on go-around. The pilot died of crash injuries. The ELT stayed in its mount in the tail cone. The investigator could not determine why it did not operate. It did radiate in the on position when tested after the accident.
113	15	(15)	X		⊗					1S	1S	Internal Failure: Aircraft collided with trees while making an instrument approach. The aircraft was destroyed and the pilot was seriously injured. The tail cone of this aircraft, where the ELT was mounted, was basically intact. The ELT should have operated.
114	17	(16)		X				⊗		2S	2S	Test Satisfactorily After Accident: The engine stopped running at low altitude and right wing caught a tree apparently while the pilot was trying to land in a pasture. The aircraft was destroyed. Both occupants survived. No other ELT information in report.
115	14 17	(14) 17	X				⊗			U N K	1F	Shielded by Wreckage and Signal Altered by Terrain: Aircraft experienced a structural failure in flight. The pilot was killed. The ELT operated but did not aid in the air search.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1	Operated effectively	6	Battery installation incorrect	11	Water submersion	16	Test satisfactorily after accident
2	Insufficient G's	7	Incorrect battery	12	Unit not armed	17	Signal direction altered by terrain
3	Improper installation	8	Fire damage	13	Shielded by wreckage	18	Packing device still installed
4	Battery dead	9	Impact damage	14	Shielded by terrain	19	Remote switch off
5	Battery corroded	10	Antenna broken/disconnected	15	Internal failure	A	Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1	Located alive	6	Able to assist with locating
2	Located deceased	7	Left scene - successfully located
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4	Died awaiting rescue	9	Left scene - unsuccessful in finding aid - died later
5	Located alive - trapped	A	Other

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116	18	⑱	X			⊗				2F	2F	Packing Device Still Installed: Aircraft spun in from approximately 2000 ft. Both occupants died of crash injuries.
117	18	⑰		X			⊗			UNK	5F	Data base indicated Packing Device Still Installed (18) but docket indicated Signal Altered by Terrain (17). The docket indicated that the ELT operated. The aircraft developed a severe vibration in flight. The pilot was unable to arrest the descent prior to crash.
118	19	⑲	X			⊗				2F	2F	Remote Switch Off: Aircraft was making touch and go landings when it was apparently stalled in the pattern. Both occupants received fatal injuries from the resulting crash.
119	19	⑲	X			⊗				2F	2F	Remote Switch Off: 'Aircraft was making touch and go landings. It stalled at approximately a 200 ft. altitude after takeoff and spun in. Both occupants were killed on impact.

56. ELT - Reason(s) for Noneffectiveness/Failure *(Multiple Entry)*

1 ☐	Operated effectively	6 ☐	Battery installation incorrect	11 ☐	Water submersion	16 ☐	Test satisfactorily after accident
2 ☐	Insufficient G's	7 ☐	Incorrect battery	12 ☐	Unit not armed	17 ☐	Signal direction altered by terrain
3 ☐	Improper installation	8 ☐	Fire damage	13 ☐	Shielded by wreckage	18 ☐	Packing device still installed
4 ☐	Battery dead	9 ☐	Impact damage	14 ☐	Shielded by terrain	19 ☐	Remote switch off
5 ☐	Battery corroded	10 ☐	Antenna broken/disconnected	15 ☐	Internal failure	A ☐	Other

12. Condition of Aircraft Occupants at Rescue *(Multiple Entry)*

1 ☐	Located alive	6 ☐	Able to assist with locating
2 ☐	Located deceased	7 ☐	Left scene - successfully located
3 ☐	Located alive - died later	8 ☐	Left scene - unsuccessful in finding aid
4 ☐	Died awaiting rescue	9 ☐	Left scene - unsuccessful in finding aid - died later
5 ☐	Located alive - trapped	A ☐	Other

Attachment
DOT Report

National Transportation Safety Board

FACTUAL REPORT
AVIATION

1 NTSB Accident/Incident Number

2
1 ☐ Accident
2 ☐ Incident

3 Investigation
1 ☐ NTSB
2 ☐ FAA Delegated

4 Aircraft Registration Number	5 Flight Number A Other	*For collision between aircraft, enter reg. no. and flt. no. for other aircraft*	6 Aircraft Registration Number	7 Flight Number A Other

8 Nearest City/Place	9 State	10 Zip Code *(First 5 numbers only)*	11 Accident Site Elevation
			________ Feet MSL

12 Date of Accident *(Nos. for M, D, Y)*	13 Day of Week *(First 2 letters)*	14 Local Time *(24 hour clock)*	15 Time Zone

16 Narrative Statement of Facts, Conditions and Circumstances Pertinent to the Accident/Incident

Additional Persons Participating in this Accident/Incident Investigation *(Name, address, affiliation, Continue on page 2 if necessary)*

Investigated By

17 Date *(Nos. for M, D, Y)*	18 Agency	19 Name/Signature

NTSB Form 6120.4 (Rev. 1-84)

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Aircraft Information (continued)

46 Landing Gear *(Multiple entry)*
1 ☐ Tricycle—fixed
2 ☐ Tricycle—retractable
3 ☐ Tailwheel—all fixed
4 ☐ Tailwheel—all retractable
5 ☐ Tailwheel—retractable mains
6 ☐ Amphibian
7 ☐ Hull
8 ☐ Float
9 ☐ Emerg. float
10 ☐ Ski
11 ☐ Ski/wheel
12 ☐ Skid
13 ☐ High Skid
A Other

48 No. of Seats
____
A Other

49 Stall Warning System Installed
1 ☐ Yes
2 ☐ No
A Other

50 IFR Equipped
1 ☐ Yes
2 ☐ No
A Other

51 Icing Certification/Equipped
(Multiple entry)
1 ☐ Certified
2 ☐ Not Certified
3 ☐ Equipped
4 ☐ Not Equipped
A Other

52 Engine Type
1 ☐ Reciprocating—carburetor
2 ☐ Reciprocating—fuel injected
3 ☐ Turbo prop
4 ☐ Turbo jet
5 ☐ Turbo fan
6 ☐ Turbo shaft
A Other

If not Engine powered, go to block 59

53 Engine Manufacturer

54 Engine Model and Series

55 Engine Rated Power
A _______ Horsepower
B _______ Lbs. Thrust
C Other

56 Number of Engines
____
A Other

If 3 or more engines enter times in Supp. C

Engine Time (Hours)	A Total Time	B Time Since Inspection	C Time Since Major Overhaul	D Other
57 Engine No. 1				
58 Engine No. 2				

59 Type Maintenance Program
1 ☐ Annual
2 ☐ Manufacturer's Inspection Program
3 ☐ Other approved inspection program (AAIP)
4 ☐ Continuous airworthiness
A Other

60 Type of Last Inspection
1 ☐ Annual
2 ☐ 100 hour
3 ☐ AAIP
4 ☐ Continuous airworthiness
A Other

61 Date Last Inspection Performed
(Nos. for M, D, Y)
____
A Other

62 Time Since Inspection
_______ Hours
A Other

63 Airframe Total Time
_______ Hours
A Other

64 Source of Maintenance Information
1 ☐ Tach
2 ☐ Flight
3 ☐ Hobbs
4 ☐ Logbooks Records
5 ☐ Estimate
6 ☐ Pilot/Operator Report
A Other

65 Hazardous Materials on Aircraft
1 ☐ No
A *(Type)* _______
B Other

Emergency Locator Transmitter (ELT)	1 Yes	2 No	A Other
67 Installed			
68 Required			
69 Operated			
70 Aided in location of accident site			

66 Hazardous Material Spill/Factor
1 ☐ Yes
2 ☐ No
A Other

Owner/Operator Information

71 Registered Aircraft Owner
Name

72 Address

73 Operator of Aircraft 1 ☐ Same as registered owner
A Name:
B dba
C Other

74 Address 1 ☐ Same as registered owner
A _______
____
B Other

75 Operator Certificate No.
____
A Other

76 Operator Designator Code

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Attachment 4

DOT Report

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB Accident/Incident Number

Accident Information

200 Aircraft Damage
1 None
2 Minor
3 Substantial
4 Destroyed

201 Aircraft Fire
1 None
2 In-flight
3 On ground
A Other

202 Explosion
1 None
2 In-flight
3 On ground
A Other

203 Damage to Property
1 None
2 Residence
3 Residential area
4 Commercial bldg.
5 Vehicle(s)
6 Airport facility
7 Trees
8 Crops
9 Fence
10 Wires/poles
11 Other property

204 Injury Index *(Most critical injury)*
1 None 2 Minor 3 Serious 4 Fatal

Injury Summary *Enter only one digit per block)*	A Fatal	B Serious	C Minor	D None	E Total
205 First Pilot					
206 Co-pilot					
207 Dual Student					
208 Check Pilot					
209 Flight Engineer					
210 Cabin Attendants					
211 Other Crew					
212 Passengers					
213 TOTAL ABOARD					
214 Other Aircraft					
215 Other Ground					
216 GRAND TOTAL					

217 Classification
1 U.S. Registered Aircraft on U.S. Soil, Territories and Possessions, or International Waters
2 U.S. Registered Aircraft on Foreign Soil
3 U.S. Registered Aircraft operated by a Foreign Operator
4 Foreign Registered Aircraft on U.S. Soil, Territories or Possessions
5 Military Aircraft
6 Aircraft not Registered

Part Failure/[illegible]

220 Part Failure/Malfunction *(Multiple entry)*
1 None
2 Part/component #1
3 Part/component #2
4 Part/component #3
A Other ______

221 Incorrect Part *(Multiple entry)*
1 None
2 Part/component #1
3 Part/component #2
4 Part/component #3
A Other ______

	A Part/Component #1	B Part/Component #2	C Part/Component #3
222 Part Name			
223 ATA Code			
224 Manufacturer			
225 Mfg. Part #			
226 Mfg. Model #			
227 Serial #			
228 Part Condition			
229 Total Time			
230 TSO			
231 TSI			
232 Cycles Total			
233 Cycles Since Overhaul			
234 Cycles Since Inspection			
235 Service Difficulty Report or Malfunction/Defect Report Submitted	1 Yes 2 No	1 Yes 2 No	1 Yes 2 No
236 Bogus Part	1 Yes 2 No	1 Yes 2 No	1 Yes 2 No

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National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Supplement A—Wreckage Documentation, Single and Twin Reciprocating Engine and Unpowered Aircraft (continued)

Fuel Tanks	Fuel on Board at Accident			D Tank Construction				F Spillsafe Fittings			H Fuel Leakage/Rupture				
	A Gallons Estimated	B Gallons Verified	C Other	1 Wet Wing	2 Bladder	3 Metal	E Other	1 Yes	2 No	G Other	1 None	2 Line	3 Fitting	4 Tank	I Other
33 Left Wing															
34 Right Wing															
35 Left Tip															
36 Right Tip															
37 Fuselage															
38 *(Specify)*															

41 Fuel Found In #1 Engine *(Multiple entry)*
1 ☐ None
2 ☐ Lines
3 ☐ Gascolator/strainer
4 ☐ Carburetor/fuel injector
5 ☐ Engine driven pump
6 ☐ Auxiliary fuel pump
7 ☐ Filter(s)
8 ☐ Selector valve
9 ☐ Fuel manifold/spider
10 ☐ Accumulator tank
A Other

42 Fuel Found In #2 Engine *(Multiple entry)*
1 ☐ None
2 ☐ Lines
3 ☐ Gascolator/strainer
4 ☐ Carburetor/fuel injector
5 ☐ Engine driven pump
6 ☐ Auxiliary fuel pump
7 ☐ Filter(s)
8 ☐ Selector valve
9 ☐ Fuel manifold/spider
10 ☐ Accumulator tank
A Other

43 Flight Controls, Evidence or Operational Failure or Malfunction *(Multiple entry)*
1 ☐ None
2 ☐ Pitch control
3 ☐ Roll control
4 ☐ Yaw control
A Other

44 Airframe/Structure, Evidence of In-Flight Separation/Failure *(Multiple entry)*
1 ☐ None
2 ☐ Helicopter *(Complete Supp. G)*
3 ☐ General disintegration
4 ☐ Left wing
5 ☐ Right wing
6 ☐ Left stab/elevator
7 ☐ Right stab/elevator
8 ☐ Vertical fin/rudder
9 ☐ Canard
10 ☐ Powerplant
11 ☐ Cabin/cargo door
A Other

45 Propeller, Evidence of In-Flight Separation/Failure
1 ☐ Yes
2 ☐ No
A Other

46 Powerplant, Evidence of In-Flight Mechanical Malfunction
1 ☐ Yes
2 ☐ No
A Other

47 Fuel, Evidence of Improper Grade or Contamination *(Multiple entry)*
1 ☐ None
2 ☐ Improper grade
3 ☐ Contamination
A Other

48 Oil, Evidence of Improper Grade or Contamination *(Multiple entry)*
1 ☐ None
2 ☐ Improper grade
3 ☐ Contamination
A Other

Emergency Locator Transmitter (ELT) Information

51 ELT Manufacturer
A Other

52 ELT Model No.
A Other

53 ELT Battery Type
1 ☐ Alkaline
2 ☐ Cadmium
3 ☐ Nicad
4 ☐ Nickel
5 ☐ Lithium
A Other

54 ELT Battery Expiration Date *(Nos. for M, D, Y)*
A Other

55 Preimpact ELT Location(s) *(Multiple entry)*
1 ☐ Cockpit
2 ☐ Cabin
3 ☐ Tailcone
4 ☐ Empennage
5 ☐ Raft
6 ☐ Survival Kit
A Other

56 ELT-Reason for Noneffectiveness/Failure *(Multiple entry)*
1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A Other

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Supplement I—Crash Kinematics

1 Accident Site Geographic Coordinates—Latitude *(Multiple entry)*

1 ☐ North
2 ☐ South
A ______ deg. ______ minutes
B Other

2 Accident Site Geographic Coordinates—Longitude *(Multiple entry)*

1 ☐ East
2 ☐ West
A ______ deg. ______ minutes
B Other

3 Impact Sequence—*(Number in sequence. Multiple entry.)*

1 ☐ None	7 ☐ Ground	13 ☐ Trees/limbs 12" diam. and up	19 ☐ Runway light
2 ☐ Rock face	8 ☐ Dirt bank	14 ☐ Frangible approach aid	20 ☐ Water
3 ☐ Rigid structure	9 ☐ Scrub tree	15 ☐ Non-frangible approach aid	21 ☐ Wire
4 ☐ Rocks to 1' diam.	10 ☐ Trees/limbs to 6" diam.	16 ☐ Submerged obstacle	22 ☐ Pole
5 ☐ Rocks 1'-2' diam.	11 ☐ Trees/limbs 6"-9" diam.	17 ☐ Vehicle	23 ☐ Snow bank
6 ☐ Rocks > 2' diam.	12 ☐ Trees/limbs 9"-12" diam.	18 ☐ Aircraft	A Other

4 Terrain at Principal Impact Point *(Multiple entry)*

1 ☐ None	6 ☐ Packed snow	11 ☐ Dry sod	16 ☐ Rock
2 ☐ Wet cultivated soil	7 ☐ Loose snow	12 ☐ Wet sod	17 ☐ Ice
3 ☐ Dry cultivated soil	8 ☐ Concrete	13 ☐ Water	18 ☐ Mud
4 ☐ Dry packed clay	9 ☐ Asphalt	14 ☐ Tundra	19 ☐ Sand
5 ☐ Boggy swampy	10 ☐ Loose rock	15 ☐ Dirt	A Other

Principal Impact Kinematics

5 Airspeed At Impact *(Enter direct or mark estimated range)*

1 ☐ 0-15	6 ☐ 75-90	11 ☐ 210 plus knots
2 ☐ 15-30	7 ☐ 90-120	A ______ Knots
3 ☐ 30-45	8 ☐ 120-150	B Other
4 ☐ 45-60	9 ☐ 150-180	
5 ☐ 60-75	10 ☐ 180-210	

6 Flight Path Angle *(Enter direct or mark estimated range)*

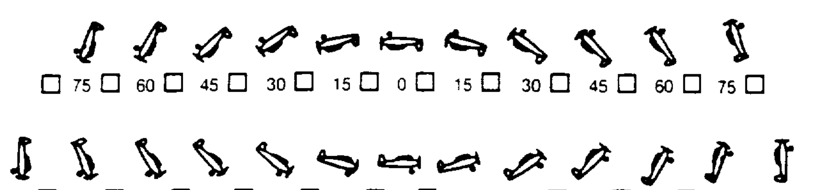
1 ☐ Up	6 ☐ 15-20	11 ☐ 60-90
2 ☐ Down	7 ☐ 20-25	A ______ Degrees
3 ☐ 0-5	8 ☐ 25-30	B Other
4 ☐ 5-10	9 ☐ 30-45	
5 ☐ 10-15	10 ☐ 45-60	

7 Pitch Attitude At Impact *(Enter direct or mark estimated range.)*

Pitch Attitude

1 ☐ Down
2 ☐ Up
A ______ Deg.

Nose Down Angle With Horizon — Nose Up Angle With Horizon



☐ 75 ☐ 60 ☐ 45 ☐ 30 ☐ 15 ☐ 0 ☐ 15 ☐ 30 ☐ 45 ☐ 60 ☐ 75 ☐

90 ☐ 75 ☐ 60 ☐ 45 ☐ 30 ☐ 15 ☐ 0 ☐ 15 ☐ 30 ☐ 45 ☐ 60 ☐ 75 ☐ 90 ☐

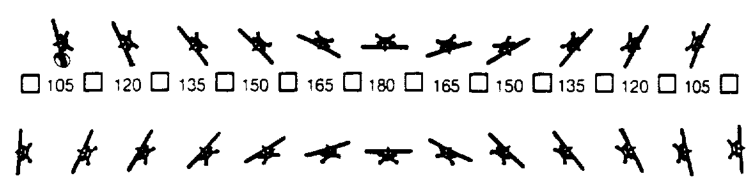
B or Other

8 Roll Attitude At Impact *(Enter direct or mark estimated range.)*

Roll

1 ☐ Left
2 ☐ Right
A ______ Deg.

Aircraft Rolled Left — Aircraft Rolled Right



☐ 105 ☐ 120 ☐ 135 ☐ 150 ☐ 165 ☐ 180 ☐ 165 ☐ 150 ☐ 135 ☐ 120 ☐ 105 ☐

90 ☐ 75 ☐ 60 ☐ 45 ☐ 30 ☐ 15 ☐ 0 ☐ 15 ☐ 30 ☐ 45 ☐ 60 ☐ 75 ☐ 90 ☐

B or Other

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Page 1

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Attachment 6 (Continued)
DOT Report

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Supplement I—Crash Kinematics (continued)

9 Yaw Attitude at Impact *(Enter direct or mark estimated range.)*

1 ☐ Nose left
2 ☐ Nose right
A _______ Deg.

Aircraft Yawed Left — Aircraft Yawed Right

90 ☐ 75 ☐ 60 ☐ 45 ☐ 30 ☐ 15 ☐ 0 ☐ 15 ☐ 30 ☐ 45 ☐ 60 ☐ 75 ☐ 90 ☐

or

B Other

10 Terrain Angle

1 ☐ Level
A Up _______ deg.
B Down _______ deg.
C Other

11 Principal Impact Ground Scar Length

1 ☐ None
A _______ feet
B Other

12 Principal Impact Ground Scar Depth

1 ☐ None
A _______ inches
B Other

13 Fuselage Totally Destroyed

1 ☐ Yes *(Go to block 36)*
2 ☐ No
A Other

14 Cockpit Damage *(Multiple entry)*

1 ☐ Destroyed
2 ☐ Collapsed
3 ☐ Part collapsed
4 ☐ Distorted
5 ☐ Burnt
6 ☐ Intact
7 ☐ None
A Other

15 FWD Cabin Damage *(Multiple entry)*

1 ☐ Destroyed
2 ☐ Collapsed
3 ☐ Part collapsed
4 ☐ Distorted
5 ☐ Burnt
6 ☐ Intact
7 ☐ None
A Other

16 AFT Cabin Damage *(Multiple entry)*

1 ☐ Destroyed
2 ☐ Collapsed
3 ☐ Part collapsed
4 ☐ Distorted
5 ☐ Burnt
6 ☐ Intact
7 ☐ None
A Other

17 Fuselage Split

1 ☐ No *(Go to block 19)*
2 ☐ Longitudinal
3 ☐ Circumferential
A Other

18 Fuselage Split Behind Seat #

____
A Other

19 Fuselage Collapse *(Estimated)*

1 ☐ None
A Horizontal _______ inches
B Vertical _______ inches
C Other

20 Fuselage Crush

1 ☐ None
A Horizontal _______ inches
B Vertical _______ inches
C Other

Approved Exits

Exit Location	A Type of Exit: 1 Door	2 Window	3 Hatch	B Other	C Operable: 1 Yes	2 No	D Other	E Fire Damage: 1 Yes	2 No	F Other	G Impact Damage: 1 Yes	2 No	H Other
21 Cockpit-Left													
22 Cockpit Right													
23 1L													
24 1R													
25 2L													
26 2R													
27 3L													
28 3R													
29 4L													
30 4R													
31 5L													
32 5R													
33 6L													
34 6R													

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Supplement M—Search/Rescue/Firefighting/Medical Treatment

Search and Rescue

1 ☐ **None Conducted** *(Go to block 16)*

2 Type of Search Conducted *(Multiple entry)*
1 ☐ Air
2 ☐ Ground
3 ☐ Sea
4 ☐ Informal
A Other

4 Search Agency Notified
A ________ *(Nos. for M. D. Y)*
B ________ Local time
C Other

5 Aircraft/Occupants Located
A ________ *(Nos. for M. D. Y)*
B ________ Local time
C Other

7 Civil Air Patrol Involved in Search
1 ☐ Yes
2 ☐ No
A Other

8 Military or Coast Guard Personnel Involved
1 ☐ Yes
2 ☐ No
A Other

9 Distress Call Transmitted *(Multiple entry)*
1 ☐ None transmitted
2 ☐ Prior to accident
3 ☐ After impact/accident
A Other

10 Distress Call Received *(Multiple entry)*
1 ☐ None received
2 ☐ Prior to accident
3 ☐ After impact/accident
A Other

11 Method of Locating Accident Site *(Multiple entry)*
1 ☐ ELT
2 ☐ HF radio
3 ☐ VHF radio
4 ☐ UHF radio
5 ☐ Visual sighting of wreckage
6 ☐ Visual sighting of occupants
7 ☐ Visual sighting of signal/smoke/fire
8 ☐ SAR satellite
9 ☐ ATC computer generated
A Other

12 Condition of Aircraft Occupants at Rescue *(Multiple entry)*
1 ☐ Located alive
2 ☐ Located deceased
3 ☐ Located alive-died later
4 ☐ Died awaiting rescue
5 ☐ Located alive-trapped
6 ☐ Able to assist with locating
7 ☐ Left scene-successfully located
8 ☐ Left scene-unsuccessful in finding aid
9 ☐ Left scene-unsuccessful in finding aid—died later
A Other

13 Weather Conditions—Indicate Most Severe Temperature/Wind Chill Condition During Search
A Temperature ____ °F
B Wind/chill factor ____ °F
C Other

Fire Fighting

16 ☐ **None Conducted** *(Go to block 31)*

17 Firefighting Unit Notified *(Nos. for M. D. Y)*
A ________
B ________ Local time
C Other

18 First Firefighting Unit Arrived
________ Local time
A Other

19 Firefighting Units Responding *(Multiple entry)*
1 ☐ Airport
2 ☐ Municipal
3 ☐ Military
A Other

20 Firefighting Units Assisted Evacuation
1 ☐ Yes
2 ☐ No
A Other

21 Fire Extinguished
________ Local time
A Other

Firefighting Agents	A Available		B Other	C Used		D Other
	1 Yes	2 No		1 Yes	2 No	
22 Protein Foam						
23 Dry Chemical						
24 Carbon Dioxide						
25 AFFF (Lite Water)						
26 Water						
26 *(Specify)* ________						

NTSB Form 6120.4 Supplement M (1-84)

National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB Accident/Incident Number

Supplement S—Aircraft Occupant and Injured Ground Personnel

[illegible] A Name	B Seat No.	C Address *(City & State)*	D Crew	E Passenger	F Non-Occupant	G FAA	H Degree of Injury 4 Fatal	 3 Serious	 2 Minor	 1 None
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
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21										
22										
23										

Page 1

NTSB Form 6120.4 Supplement S (1-84)

ATTACHMENTS

1. Excerpt from the House of Representatives, 1st Session, Report 99-212. Department of Housing and Urban Development Independent Agencies Appropriation Bill, 1986, Page 44.

2. NTSB form 6120.4, Sup. A, Page 1, Block 56, ELT Reason for Noneffectiveness/Failure.

3. FAA ELT Field Test Procedure/Data Sheet.

4. Alaskan ELT Survey, Letter from Alaskan Region FAA Office to HQ ARRS, Scott AFB, Illinois, dated December 30, 1987.

REPORT
1st Session | HOUSE OF REPRESENTATIVES | 99-212

Attachment 1

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT-INDEPENDENT AGENCIES APPROPRIATION BILL, 1986

JULY 18, 1985.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. BOLAND, from the Committee on Appropriations, submitted the following

REPORT

[To accompany H.R. 3038]

The Committee on Appropriations submits the following report in explanation of the accompanying bill making appropriations for the Department of Housing and Urban Development, and for sundry independent agencies, boards, commissions, corporations, and offices for the fiscal year ending September 30, 1986, and for other purposes.

INDEX TO BILL AND REPORT

	Page number Bill	Page number Report
Title I—Department of Housing and Urban Development	2	4
Title II—Independent Agencies:		
American Battle Monuments Commission	13	19
Consumer Product Safety Commission	14	19
Cemeterial Expenses, Army	15	21
Environmental Protection Agency	15	21
Council on Environmental Quality	17	29
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Selective Service System	31	51
Department of the Treasury	32	52
Veterans Administration	32	53

50-177 O

In connection with the ongoing search and rescue program, the Committee is pleased that NASA has progressed to an operational status and supports the continued carriage of search and rescue instruments on National Oceanographic and Atmospheric Administration polar orbiting weather satellites. The Committee also strongly supports the NASA concept of a backup satellite carrying search and rescue instruments which was described in hearings on the 1986 appropriation. This satellite would ensure that the United States' commitments to the international search and rescue program could be met even if an early failure of the NOAA satellite or a search and rescue instrument occurred. It is understood that a study is underway to examine the feasibility and cost of a backup satellite, and the Committee requests that NASA provide a copy of the study when it is completed. Further, the Agency is urged to proceed with the development of this satellite as soon as possible so that United States' international commitments can be met.

The Committee also recognizes and supports the continuing NASA effort to provide for system improvements such as the development of new distress transmitters, specifically designed for satellite detection, global coverage, and the possibility of instantaneous detection using geosyncronous satellites. It is hoped that this work will proceed as rapidly as technology will permit.

Finally, the Committee strongly urges that some improvements to the presently deployed emergency locator transmitters should be addressed. It is not satisfactory that units with a false alarm rate of over 97 percent and a non-activation rate of 70 percent continue to be mandated by the Federal government when an improved technical standard has been developed and can be provided for respective satellite monitoring. It is recognized that NASA cannot initiate the necessary administrative action to mandate improved transmitters, but as the developer of the satellite system, NASA should urge the Federal Aviation Administration to proceed and should make available technical expertise to support any FAA initiative in this area.

SPACE FLIGHT CONTROL AND DATA COMMUNICATIONS

1985 appropriation	$3,601,800,000
Estimate, 1986	3,509,900,000
Recommended in bill	3,402,900,000
Decrease below estimate	−107,000,000

The space flight control and data communications account includes the program elements that provide for the national fleet of space shuttle orbiters, including main engines, launch site and mission operations, control requirements, initial spares, production tooling, and related supporting activities. This account also provides the standard operational support services for the space shuttle and the expendable launch vehicles, and includes tracking, telemetry, command, and data acquisition support required to meet all NASA flight projects.

The Committee recommends a total of $3,402,900,000 for this activity in fiscal year 1986. This is a decrease of $107,000,000 below the budget request and is $198,900,000 below the 1985 appropria-

COMMITMENT	TITLE	ASSIGNED TO	DUE DATE	COMPLETED
86-A1	NASA/FAA Research Work	EC/Frouse	07/15/85	N

SOURCE: Required by House Appropriations 99-212, dated 8/28/85, p. 44

DESCRIPTION: Congress requested that NASA and the FAA work together on developing standards for emergency beacons. This problem is one of a high false alarm rate with the EPRBS and both a standards and technical problem. There has been numerous correspondence between Dr. Edelson and Admiral Engen of the FAA.

STATUS: As of 12/5/86, the request to assist the FAA in taking action to improve the false alarm rate of 121.5 MHz emergency beacons is in progress. NASA has officially proposed a technical program with the FAA to accomplish this. As a first step, NASA will furnish technical support in identifying the advantages and disadvantages of alternative approaches to the problem; develop recommendations, including cost considerations and milestones to address the problem. FAA has informally indicated its willingness to work with NASA on this effort. Since this action is under the purview of the FAA, the schedule of milestones will be established by the FAA. As of 12/17/86, no change. As of 1/5/87, no change. As of 1/29/87, letter in EPS. As of 3/4/87, no change. As of 4/14/87, no change. As of 7/17/87, no change, FAA has action. As of 8/18/87, no change, FAA has action. As of 10/7/87, they still have not identified a formal FAA contact.

COMMITMENT	TITLE	ASSIGNED TO	DUE DATE	COMPLETED
86-7d	ST Early Operations Experience Report	EZ/Pellerin	11/01/89	N

SOURCE: House of Representatives Authorizing Appropriations to NASA for FY 1986 (Report 99-32, dated 3/28/85, p. 22)

DESCRIPTION: The Subcommittee further recommends that NASA in consultation with the appropriate existing advisory groups consciously document the early operations of the Space Telescope Science Institute with a view toward producing and publishing an analytical report that will aid such future space science activities. Commitment per meeting of 2/22/85 with S. W. Keller, R. Byerly and J. Madison. Report on the early post-launch operations of the ST Science Institute by January 15, 1988.

STATUS: Launch date is 1988. Report due 1 year after launch. Reassigned to EZ 12/1/86. As of 12/5/86, response is awaiting launch. As of 12/17/86, no change. As of 1/5/87, no change. As of 1/30/87, no change. As of 3/5/87, no change. As of 4/14/87, no change. As of 7/27/87, HST launch + 1 year (August 1990). As of 8/28/87, report date delayed to 1990 due to launch delay to 1989. As of 9/16/87, no change.

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB Accident/Incident Number

Supplement A—Wreckage Documentation, Single and Twin Reciprocating Engine and Unpowered Aircraft (continued)

Fuel Tanks	Fuel on Board at Accident			D Tank Construction				F Spillsafe Fittings			H Fuel Leakage/Rupture				
	A Gallons Estimated	B Gallons Verified	C Other	1 Wet Wing	2 Bladder	3 Metal	E Other	1 Yes	2 No	G Other	1 None	2 Line	3 Fitting	4 Tank	I Other
33 Left Wing															
34 Right Wing															
35 Left Tip															
36 Right Tip															
37 Fuselage															
38 *(Specify)*															

41 Fuel Found In #1 Engine *(Multiple entry)*
1 ☐ None
2 ☐ Lines
3 ☐ Gascolator/strainer
4 ☐ Carburetor/fuel injector
5 ☐ Engine driven pump
6 ☐ Auxiliary fuel pump
7 ☐ Filter(s)
8 ☐ Selector valve
9 ☐ Fuel manifold/spider
10 ☐ Accumulator tank
A Other

42 Fuel Found In #2 Engine *(Multiple entry)*
1 ☐ None
2 ☐ Lines
3 ☐ Gascolator/strainer
4 ☐ Carburetor/fuel injector
5 ☐ Engine driven pump
6 ☐ Auxiliary fuel pump
7 ☐ Filter(s)
8 ☐ Selector valve
9 ☐ Fuel manifold/spider
10 ☐ Accumulator tank
A Other

43 Flight Controls, Evidence or Operational Failure or Malfunction *(Multiple entry)*
1 ☐ None
2 ☐ Pitch control
3 ☐ Roll control
4 ☐ Yaw control
A Other

44 Airframe/Structure, Evidence of In-Flight Separation/Failure *(Multiple entry)*
1 ☐ None
2 ☐ Helicopter *(Complete Supp. G)*
3 ☐ General disintegration
4 ☐ Left wing
5 ☐ Right wing
6 ☐ Left stab/elevator
7 ☐ Right stab/elevator
8 ☐ Vertical fin/rudder
9 ☐ Canard
10 ☐ Powerplant
11 ☐ Cabin/cargo door
A Other

45 Propeller, Evidence of In-Flight Separation/Failure
1 ☐ Yes
2 ☐ No
A Other

46 Powerplant, Evidence of In-Flight Mechanical Malfunction
1 ☐ Yes
2 ☐ No
A Other

47 Fuel, Evidence of Improper Grade or Contamination *(Multiple entry)*
1 ☐ None
2 ☐ Improper grade
3 ☐ Contamination
A Other

48 Oil, Evidence of Improper Grade or Contamination *(Multiple entry)*
1 ☐ None
2 ☐ Improper grade
3 ☐ Contamination
A Other

Emergency Locator Transmitter (ELT) Information

51 ELT Manufacturer
____
A Other

52 ELT Model No.
____
A Other

53 ELT Battery Type
1 ☐ Alkaline
2 ☐ Cadmium
3 ☐ Nicad
4 ☐ Nickel
5 ☐ Lithium
A Other

54 ELT Battery Expiration Date *(Nos. for M, D, Y)*
____
A Other

55 Preimpact ELT Location(s) *(Multiple entry)*
1 ☐ Cockpit
2 ☐ Cabin
3 ☐ Tailcone
4 ☐ Empennage
5 ☐ Raft
6 ☐ Survival Kit
A Other

56 ELT-Reason for Noneffectiveness/Failure *(Multiple entry)*
1 ☐ Operated effectively
2 ☐ Insufficient G's
3 ☐ Improper installation
4 ☐ Battery dead
5 ☐ Battery corroded
6 ☐ Battery installation incorrect
7 ☐ Incorrect battery
8 ☐ Fire damage
9 ☐ Impact damage
10 ☐ Antenna broken/disconnected
11 ☐ Water submersion
12 ☐ Unit not armed
13 ☐ Shielded by wreckage
14 ☐ Shielded by terrain
15 ☐ Internal failure
16 ☐ Test satisfactorily after accident
17 ☐ Signal direction altered by terrain
18 ☐ Packing device still installed
19 ☐ Remote switch off
A Other

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Attachment 3

ELT FIELD TEST PROCEDURE/DATA SHEET

1. Is the ELT mounted rigidly in all axes and in the direction for crash activation? YES _____, NO _____

Describe mounting: ____

____

____

2. Determine the position(s) of the ELT switch and remote switch, if installed. Remove the ELT from the aircraft. Switch(es) should be in the off position before removing.
   ELT SWITCH: ON _____, OFF _____, ARMED_____, OTHER _____
   REMOTE SWITCH: ON _____, OFF _____, ARMED_____, OTHER _____

3. Perform a functional check by activating the ELT with a quick rap from the palm of the hand in the direction of force activation. (The EBC 302 and TSO-C91a ELT's can be activated by using a forward throwing motion coupled by a rapid reversing action. The ARNAV ELT-100 also requires jumping pins Nos. 5 & 8). Turn off the ELT as soon as the ELT's signal is verified by any convenient means:

OK _____, Not OK _____

4. Inspect the mounting, the ELT, and disassembled battery pack for corrosion, defects, etc. Photograph the best view(s) of the ELT and battery pack. OK _____, Not OK _____

5. Connect the reassembled ELT to a wattmeter. Wrap the ELT and connections in aluminum foil to minimize the emission of spurious RF energy. Activate the ELT for three minutes and record power output: Start mw __________ Finish mw __________ This should be greater than 75mw (50mw for TSO-C91a).

6. After removing foil, secure the ELT to the G-switch go/no go test fixture. Perform the G-switch test with the ELT armed; the point of activation is verified by use of the wattmeter or any other convenient means (see operating instructions).
   ACTIVATED WITHIN LIMITS: YES _____, NO _____
   IF NO: TRAVEL ABOVE/BELOW HIGH ____ LOW ____ LIMIT SWITCH ____ IN.

Note: Operation of the test fixture (cannot be used for TSO-C91a) requires some set-up technique and should be demonstrated to personnel who are using it for the first time.

7. Inspect antenna(s), wire terminals, etc: OK ____, Not OK _____

8. Reinstall the ELT. Turn on the ELT (use remote switch if installed) and determine if the antenna(s) radiates a strong signal. The signal can be heard through an AM broadcast receiver (any frequency) held about 6 inches away from the antenna(s). A field strength meter may also be used to measure a radiated field of a least 1 volt/meter or equivalent.
OK _____, Not OK _____

9. Reset the ELT: OK _____

ELT FIELD TEST PROCEDURE/DATA SHEET

Location ______________________
Date ______________________
Person performing the test ______________________

AIRPLANE
Manufacturer ______________________
Model # ______________________
Reg # ______________________
Inspection Program ______________________
Last Insp Date ______________________
Ops/hrs Last Insp ______________________

ANTENNA
Location ______________________
Manufacturer ______________________
Model # ______________________
Ser # ______________________
Part # ______________________
TSO # ______________________

ELT
Location ______________________
Manufacturer ______________________
Weight ______________________
Model # ______________________
Ser # ______________________
Part # ______________________
TSO # ______________________
Installation Date ______________________

ATTACH PHOTO(S) HERE

BATTERY PACK
Manufacturer ______________________
Model# ______________________
Ser # ______________________
Part # ______________________
TSO # ______________________
Expiration Date ______________________
Installation Date ______________________

REMOTE SWITCH, if installed ______________________

COMMENTS/RECOMMENDATIONS/DESCRIPTION OF ITEMS NOT OK

____

____

Enclosure (7)

Attachment 4

U.S. Department of Transportation
Federal Aviation Administration

Alaskan Region

FSDO-63
4510 W. Int'l. Airport Road, Su
Anchorage, Alaska 99502-1088

December 30, 1987

Colonel Robert Michaelson
Headquarters ARRS
Scott AFB, IL 62225-5009

Dear Colonel Michaelson:

As per conversation with Gary Bennett of Northern Lights Avionics, I am enclosing the ELT check results collected throughout 1987. I've also included some FCC and NTSB data that might be of assistance.

I would also advise that you contact Phillip J. Akers, Engineering Division-Aircraft Certification, FAA-DOT, AWS-120, 800 Independence Avenue SW, Washington D.C. 20591. I have been providing Mr. Akers the same information for possible preparation of notice of proposed rulemaking concerning testing standards for ELT's. Our program in Alaska apparently has caused a lot of concern and interest from all angles, and it would be more significant if all simlarly concerned parties could unite their efforts.

Please let me know what I can do to further assist you.

Sincerely,

Valerie Aron
Accident Prevention Specialist

Enclosures

CC: Philip J. Akers

ELT TEST RESULTS

MAKE/MODEL	RESULTS	S/N	DATE
NARCO	OK		4/4/87
POINTER	DEAD BATTERY		4/4/87
SHARC-7	OK		4/4/87
NARCO	BATTERIES NOT HOOKED UP		4/4/87
EBC 102	1969 BATTERY		4/5/87
EBC 102A	EXPIRES 1/1/87		4/5/87
EBC 102	OK		4/5/87
POINTER	NO "G" ACT		4/5/87
NARCO ELT-10	INOP-SENT TO FACTORY	50982	4/5/87
POINTER 3000	CAUSES INTERFERENCE IN RADIOS/RETURNED-FACTORY	326264	
LARAGO	DEAD BATTERIES	7241	
SHARC-7	DEAD BATTERIES	14083	
POINTER C-4000	DEAD BATTERIES	401390	
SHARC-7	DEAD BATTERIES	145923	
POINTER 3000	CAUSES INTERFERENCE/CUSTOMER DISCONNECTED ANT & USED PERSONAL ELT		
POINTER 3000	CAUSES INTERFERENCE/SENT TO FACTORY	326262	
POINTER 3000	CAUSES INTERFERENCE/SENT TO FACTORY	322096	
CIRII-2	INOP/SENT TO FACTORY	25455	
DM ELT 1-3	CORRECTED-"G" SWITCH BROKEN/ ANTENNA MOUNT LOOSE/ SWITCH WON'T STAY ON		
CHROMALLOY	LOW POWER/ DOWNSWEEP WRONG RATE/ POSSIBLE LOW BATT./ UNABLE TO MEASURE DUE TO DESIGN		
EBC 102A	DEAD BATTERIES (6 MONTHS LEFT)		
EBC 102A	DEAD BATTERIES/ BATTERY EXPIRED 10 YEARS AGO		
MARTECH	BATTERY CONNECTION LOOSE/ PLUG FELL OFF WHEN TOUCHED/ PINS ON BATTERY SMASHED OPEN AND NOT GRASPING CONNECTOR		
DM ELT-6	LOW POWER/BATTERIES WEAK/WOULD NOT COME UP TO VOLTAGE		
NARCO ELT-10	INOP		
SHARC-7	"G" SWITCH INOP/ UNIT CORRODED		
SHARC-7	UNIT IN OFF POSITION IN AIRCRAFT/ CHECKED OK		
NARCO ELT-10	INOP/BATTERY DEAD & OUT OF DATE	10918	
MARTECH EB-2BLD	BAD SWITCH	660095	6/24/87
LARAGO	NO SWEEP/POWER 1/2/ BATTERY OK/SENT TO FACTORY	7167	6/24/87
NARCO	T-TERMINAL LOOSE/ PC BOARD CORRODED	48180	6/24/87
DM ELT-6	INOP/ BATTERIES EXPIRED UNIT ACTS IN AUTO/ TRASHED	9079	8/13/87
EBC-102	WON'T TURN ON/SENT TO FACTORY	64482	
DM	INOP/BATTERIES OK/ TRASHED	33637	5/11/87
POINTER	BATTERIES OK/POWER 70 mW/CUSTOMER SEND TO FACTORY	307737	7/27/87
DM	'G' SWITCH RATTLING AROUND/CENTER PIN COAX STILL IN FEMALE	499	7/1/87
COM.COMPONENTS	ALWAYS ON/SENT TO FACTORY	4709	7/2/87
POINTER 3000	COMPLETELY RUSTED/THROW AWAY	313949	7/7/87
SHARC-7	NO "G" ACTION/"G" SWITCH LOOSE/POWER LOW	153857	
LARAGO	DIDN'T GO OFF IN ACCIDENT/LEADS CORRODED OFF/ REPAIRED AND REPLACED BATTERY	2847	7/15/87
CIR-10-30	NO OUTPUT/INOP/TRASHED	NSN	7/17/87
RESCUE 88	INTERMITTENT INOP/WAS FOUND ON ANNUAL	75C6265	7/20/87
POINTER 3000	INOP/FIXED X-MITTER/BAD FINAL	320175	7/27/87

MAKE/MODEL	RESULTS	S/N	DATE
LARAGO	INOP/TRASHED	7860	8/7/87
LARAGO	INOP/TRASHED		8/7/87
POINTER	INOP/SENT TO FACTORY	323378	8/7/87
SHARC-7	REPLACED BATTERIES & CHECK FREQUENCY/BATTS DEAD	145135	
POINTER 3000	INOP/BAD CIRCUIT OSC TRAN/COAX END MISSING	322509	5/11/87
DART	BATTERY EXPLODED/TRASHED	3693	
LELT-1005-AF	BAD BATTERIES	9283	5/27/87
POINTER 4000	BAD CIRCUIT/OSC TRANSISTER REPLACED	405531	5/26/87
EBC 102A	INOP/SENT TO FACTORY	30332	
CHROMALLOY ACR/ RCB-101	BATTERY INOP		6/1/87
EBC 102C	NO TEST POSITION	30660	6/3/87
DART II	CORRODED/INOP/TRASHED	1768	6/4/87
NARCO-ELT-10	INOP/SENT TO FACTORY	10985	6/10/87
NARCO-ELT-10	BATTERY DEAD/CORROSION/CLEANED & REPLACED BATTERY	48180	6/14/87
COM.COMPONENTS	INOP/TRASHED	13221	
SHARC-7	INOP/BATTERY&BOARD CORRODED/DATE STILL OK	145927	6/19/87
POINTER	INOP/BATTERY GOOD/BAD OSC TRANX	316079	6/23/87
SHARC-7	INOP/BATTERY CORRODED/1 YEAR LEFT	3564	6/23/87
SHARC-7	INOP	135415	6/24/87
SHARC-7	INOP/BAD BOARD	134869	9/11/87
DM ELT-6	INOP/SENT TO FACTORY	1216	9/13/87
POINTER	INOP/BATTERY DEAD, FINAL SHORTED/REPLACED BOTH	313721	9/18/87
CIR-II-2	INOP/SENT TO FACTORY	20383	9/18/87
POINTER	INOP/BAD OSC TRANSMITTER/BAD BATTERY	319272	9/23/87
POINTER	BAD FINAL/NO POWER OUT/REPLACED FINAL	315479	9/28/87
POINTER	LOW OUTPUT/INTERFERENCE WITH UHF/SENT TO FACTORY	317278	10/29/87
POINTER	LOW OUTPUT/INTERFERENCE WITH UHF/SENT TO FACTORY	316536	10/16/87
CIR-II-2	INOP/CORRODED/TRASHED	20383	9/14/879
POINTER	BAD DRIVER/BAD FINAL/REPLACED BOTH	322656	10/2/87
NARCO-ELT-10	RUSTED OUT/INOP/THROWN AWAY	53554	
NARCO-ELT-10	ACTIVATED ALL THE TIME	36509	
NARCO-ELT-10	OSC INOP/SENT TO FACTORY	60271	10/27/87
EBC 102A	OK		10/28/87
NARCO-ELT-10	BAD ON/OFF/BATTERY 100-60/OK	56711	10/28/87
EBC 102	WORKS FINE/OUT OF DATE	64467G	10/28/87
NARCO-ELT-10	11654	OK	10/28/87
LARAGO ELEC	OK	7391	10/28/87
EBC 102A	OK	32GB	10/28/87
EBC 102A	BATTERY OUT OF DATE		10/28/87
EBC 102A	OK	62077GB	10/28/87
NARCO-ELT-10	BATTERY DATE OK/VOLTAGE 6V	56711	10/28/87
EBC 102	SEPTEMBER BATTERY/OPERATIONAL	64467A	10/28/87
EBC 102A	BATTERY OUT OF DATE	N/A	10/28/87
SHARC-7	OK	5687	11/3/87
SHARC-7	OK/BATTERY EXPIRED 9/87	146982	11/3/87
EBC 102A	OK	6845	11/3/87
EBC 102A	OK	6854	11/3/87
POINTER 3000	INOP	318494	11/4/87
MARTECH EB-23CD	EAGLE-BATTERY OUT OF DATE/USED AS PERSONAL ELT	13775	11/4/87
EBC 102A	OK		11/4/87
EBC 102	OK		11/5/87
EBC 102	BATTERY OUT OF DATE	N/A	11/05/87
EBC 102	BATTERY OUT OF DATE	N/A	11/5/87
EBC 102	OK/BATTERY OUT OF DATE		11/5/87

MAKE/MODEL	RESULTS	S/N	DATE
EBC 102A	OK/BATTERY OUT OF DATE		11/5/87
EBC 102A	OK/BATTERY EXPIRES NOVEMBER 87		11/5/87
SHARC-7	OK	5697	11/8/87
NARCO-ELT-10	G-SWITCH INOP/BATTERY OUT OF DATE	53554	11/10/87
SHARC-7	BATTERY OUT OF DATE/WHITE POWDER&PC BOARD GREEN	161166	11/10/87
SHARC-7	G-SWITCH INT	127109	11/12/87
NARCO-ELT-10	NO TAB ON EXT ANT COAX	72584	11/12/87
NARCO-ELT-10	BATTERY OUT OF DATE/NO TOP ON COAX	20468	11/12/87
NARCO-ELT-10	OFF FREQUENCY 6-7 MHZ	C12028	11/18/87
POINTER 3000	BATTERY VOLTAGE 7.8/DROPS TO 3-5V DC/LOW POWER	325209	11/18/87
D/M ELT U	MOD 200Z	48904	11/18/87
D/M ELT 1-3	75mw/PWR LOW/THIS UNIT USES FLASHLIGHT BATTERIES NO DATE	1120	11/18/87
EBC 102A	BATTERY OUT OF DATE/XMITTER OFF 10KC/REPL. BATT NOTIFIED CUSTOMER	51851	11/21/87
EBC 102A	BATTERY OUT OF DATE/REPLACED BATTERY		11/27/87
LARGO 100S	INOP/CHECKED/BATTERY DEAD/REPLACED BATTERY	862	11/27/87
NARCO-ELT-10	BATTERY CONNECTION INT	21447	12/1/87
NARCO-ELT-10	MOD 150Z	10351	12/1/87
NARCO-ELT-10	INOP/BATTERY DEAD/21 MONTHS OUT OF DATE/REPL./OK	34966	12/7/87
POINTER 3000	INOP/BATTERY DEAD/REPLACED/BATT DATE WAS STILL OK	319391	12/8/87
SHARC-7	GOES OF INT/SOMEONE INSTALLED A POINTER G-SWITCH GLUE BROKE LOOSE/THROW OUT	19242	12/11/87
SHARC-7	INOP/1975 BATTERY/REPLACED BATTERY	7733	12/28/87

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15. Supplementary Notes

16. Abstract

In response to the Congressional mandate to support the FAA to improve the problems being experienced by ELTs currently in use, NASA conducted an analysis of current ELT problems and potential improvements that could be made by employing the TSO-C91a ELTs to replace the current TSO-C91 ELTs. The scope of the NASA study included the following: 1. validate the problems; 2; determine specific failure causes; 3. determine false alarms causes; 4. estimate improvements from TSO-C91a; 5. estimate benefits from replacement of the current ELTs; and 6. determine need and benefits for improved ELT inspection and maintenance. A detailed comparison between the two requirements documents (TSO-C91 and -C91a) was made to assess improved performance of the ELT in each category of failure cause and each cause of false alarms. The comparison and analysis resulted in projecting a success of operation rate approximately 3 times the current rate and a reduction in false alarms to ¼ of those generated by TSO-C91 ELTs. These improvements led to a projection of benefits of approximately 25 additional lives to be saved each year with TSO-C91a ELTs and an improved inspection and maintenance program.

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