National Aeronautics and Space Administration

2nd Generation ELT Performance Specification Development

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NASA Project Overview

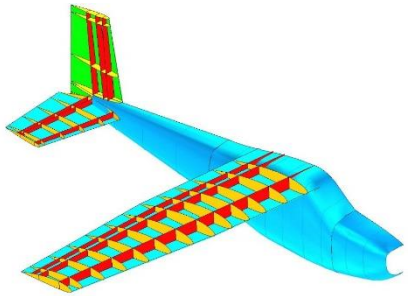
NASA SAR is supporting RTCA with the goal of making "*significant improvement to ELT performance*" through a multi-faceted research, analysis and test effort

Research:

- **Historic and current failure rates and modes**
  - Crash data from NTSB and other international sources
  - Compare current to historic trends
  - Identify previous improvements to avoid duplication of effort
  - Identify primary failure modes

Analysis:

- **Nonlinear dynamics analysis of severe but survivable airplane crash scenarios**
  - Validate models through test correlation
  - Investigate various installation plans



Test:

- **Ground-based unit testing and installed system crash testing**
  - Crash safety testing
  - Helicopter crash test
  - Vibration testing
  - 3 GA airplane crash tests

Deliverables:

- **Recommendations to RTCA/EUROCAE regarding Minimum Operational Performance Standards (MOPS) for 2nd Generation ELTs**

RTCA
THE GOLD STANDARD FOR AVIATION SINCE 1935

EUROCAE

Research Summary

- Historical Performance
  - ELT success rate estimated to be 25% with TSO C-91 and earlier beacons [1]
- Current Performance
  - ATSB estimated success rate at 40-60% with high degree of uncertainty in fitment (69%) [2]
  - Canada DR&D estimated success rate at 74% with high degree of uncertainty due to sufficient ELT data provided in only 13% of cases [3]
  - German BFU summarized 6 cases involving beacon mount failures and cited the antenna connection as the weak link in the system [4]
  - Cospas-Sarsat proceedings discuss the reliability of ELT performance statistics as information is recorded in only 10% of accidents resulting in substantial damage to the aircraft [5]
  - NASA/NTSB special study revealed 58% success rate in TSO-C91a and later ELTs involved in injurious accidents over the period Jan 2009-Mar 2014 and no correlation between performance and aircraft [6]
- Enhanced Data Collection
  - NTSB Form 6120.1 has been updated to include additional fields for ELT information

ELT failure is responsible for the loss of more than 1 life per week on average [1]

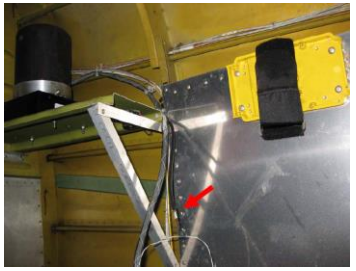
List of references included in backup

Findings & Action Plan

- Research revealed similar themes to those reported historically by NASA as well as more contemporary studies by international stakeholders
- Current MOPS falls short of defining requirements that ensure robust systems in a number of areas, including:
  - Vibration
  - Fire/Flame Survivability
  - Automatic Activation
  - Crash Safety
  - System Installation
- NASA will provide research and test data to support improved MOPS in each of the above areas
- A representative sample of GA AF-type ELTs from each vendor represented on RTCA SC-229 will be evaluated

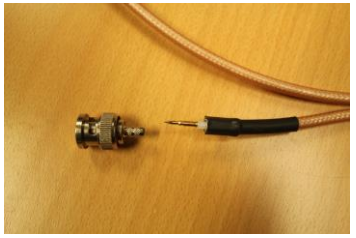
Laboratory Testing

- Crash Safety & Automatic Activation
  - Previously qualified systems have exhibited structural deficiencies in the field, resulting in disconnected antenna due to beacon ejection from its mounting
  - NASA tests have reproduced the behavior by modifying the test parameters to be more representative of actual crash environments and include confirmation of functionality during the crash event
- Vibration
  - Crash sensors have exhibited sensitivity to vibration exposure
  - NASA will evaluate the performance of current systems after exposure to robust vibration environments
- Antenna Cable System
  - No strength requirements exist for the cabling system
  - NASA has performed static and dynamic strength testing and will compare results to cable loads recorded during full-scale crash testing
- Fire
  - Current test duration is shorter than the time required for satellite transmission
  - NASA will test antenna systems for functional performance during fire exposure with and without additional COTS thermal protection



Disconnected antenna due to beacon ejection

Section view of typical crash sensor



Typical cable system failure

Survivable crash with fire

Full-scale Crash Testing

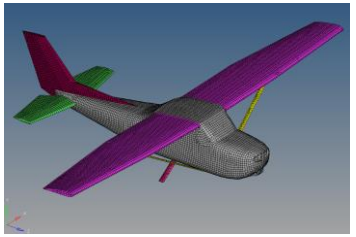
- Series of tests at NASA Langley Research Center's (LaRC) Landing and Impact Research Facility (LandIR)
  - 1 CH-46E Helicopter Fuselage
  - 3 Cessna 172 Airplanes
- "Severe but survivable" crash conditions
- Live testing of SARSAT system with multiple full ELT systems onboard each test
- Data used to calibrate and validate simulations of additional crash scenarios

Objective: Identify enhanced installation guidance for functionality and crashworthiness of the entire system

NASA LaRC LandIR

Helicopter crash test

C172 test preparations



C172 analysis model

Summary

- Several failure modes have been identified that stem, in part, from inadequate performance specifications
- NASA will provide performance-based recommendations to RTCA that will result in significant improvements in 2nd Generation ELTs

Questions?

Backup Charts

References

1) NASA CR-4330, “Current ELT Deficiencies and Potential Improvements Utilizing TSO-C91a ELTs”, Trudell, B. and Dreibelbis, R., dated 1990.
2) ATSB Report AR-2012-12B, “A Review of the Effectiveness of Emergency Locator Transmitters in Aviation Accidents”, dated 21 May 2013.
3) Defence R&D Canada Report TR 2009-101, “ELT Performance in Canada from 2003 to 2008”, Keillor, J. et al, dated September 2009.
4) German BFU Presentation to the Cospas-Sarsat Experts Working Group, “Reliability of 406 MHz ELT in Aircraft”, Lampert, P., dated January 2011.
5) Cospas-Sarsat Council 45th Session Open Meeting Agenda Item 8.2, “Continuous Monitoring of the Performance of Beacons Through Integrated Safety Analysis”, ICAO, dated 7 September 2010.
6) NASA Presentation to RTCA SC-229 WG-2 at Plenary #2, “ELTSAR Phase 1: Research & Work Plan”, Stimson, C., dated 3-5 September 2014.