

# **Air Transport Recorders Crash Survivability**

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- **What are Flight Recorders**
- **Why do commercial aircraft carry them**
- **How performance is specified**
- **TSO Specification evolution**
- **TSO Survival Requirements**

# What are Flight Recorders & why are they carried

- **Flight recorder [Black box]:**
  - ↳ **Cockpit Voice Recorder (CVR)**
  - ↳ **Flight Data Recorder (FDR)**
  - ↳ **Combination Cockpit Voice/Flight Data Recorder (CVFDR)**
  
- **Mandated equipment**
  - ↳ **14CFR25 & 14CFR121 (Large Transport Aircraft)**

# How is performance specified; equipment approval

- **Only approved parts (articles) may be installed on aircraft.**
- **Three (3) methods for equipment approval (14CFR Pt 21)**
  - ↙ **Type Certificate**
  - ↙ **Parts Manufacturer Approval (PMA)**
  - ↙ **Technical Standard Order Approval (TSOA)**
- **Part approval, or certification, cycle**
  - ↙ **Performance Specification**
  - ↙ **Part qualification**
  - ↙ **Part certification, ie. approval, including software**
  - ↙ **Certification for installation eligibility**

# Equipment Approval - Type Certificate

- **Approval by Type Certificate**
  - ↳ Performance spec issued by an airframe manufacturer
  - ↳ Qualification specified by the airframe manufacturer
  - ↳ Airframe manufacturer obtains FAA certification (approval) for the part (including software)
  - ↳ Airframe manufacturer establishes the installation requirements & obtains FAA certification for the installation
- **Production of the part is controlled by the type certificate holder's quality assurance program**
- **Finished parts may be shipped to the type certificate holder only (Including spares & repaired items.)**
- **Ex: landing gear strut**

Airframe manufacturer is the type & production certificate holder.

# Equipment Approval - PMA

- **Part Manufacturer Approval**
  - ↖ Performance spec issued by an airframe manufacturer
  - ↖ Qualification as specified by the airframe manufacturer
  - ↖ Airframe manufacturer obtains FAA certification for the part (including software)
  - ↖ Airframe manufacturer establishes the installation requirements & obtains FAA certification for the installation
  - ↖ Airframe manufacturer issues license to part manufacturer enabling application for PMA from FAA.
  - ↖ Part manufacturer obtains PMA from the FAA based on approval of part manufacturer's quality assurance program.
- **Production of the part is controlled by the PMA holder's quality assurance program**
  - ↖ Finished parts are labeled with aircraft type for which installation eligibility is certified.
  - ↖ Finished parts (Including spares & repaired items) may be shipped to anyone for installation in certified aircraft.
- **Ex: Flight phone**

# Equipment Approval - TSOA

- **Technical Standard Order Approval (TSOA)**
  - ↖ **FAA defines Minimum Operating Performance Standards (M[O]PS)**
  - ↖ **Qualification as specified by FAA in MOPS.**
  - ↖ **Part manufacturer obtains TSOA from the FAA**
    - ◆ **Performance & qualification data submittal.**
    - ◆ **Software validation data submittal.**
    - ◆ **Approved quality assurance program.**
  - ↖ **Airframe manufacturer establishes the installation requirements & obtains FAA certification for the installation**
- **Production of the part is controlled by the TSOA holder's quality assurance program**
  - ↖ **Finished parts are labeled with applicable TSO.**
  - ↖ **Finished parts (Including spares & repaired items) may be shipped to anyone.**
- **Ex: Cockpit Voice Recorder; Flight Data Recorder**

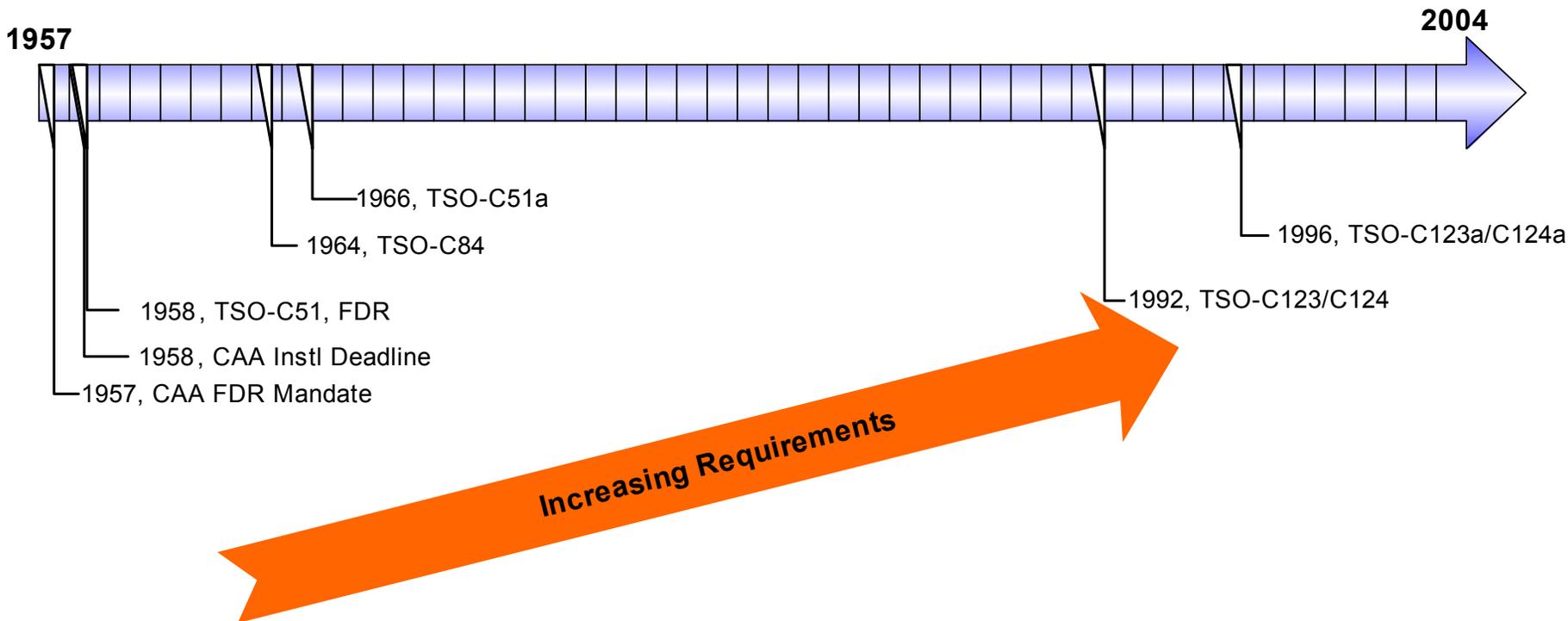
**TSOA: maximum design & production control**

# Preserving the Record: Survivability

- Hazards associated with an aircraft accident
  - Survivability criteria specified by TSO
- |                          |  |
|--------------------------|--|
| ↖ Impact shock           | → 3,400 g, 6.5 ms ½-sine                             |
| ↖ Penetration Resistance | → 500 Lb, 10-ft drop, ¼-in Dia pin                   |
| ↖ Static Crush           | → 5,000 Lb, 5 Min per axis                           |
| ↖ Fire Resistance        | → 1100°C, 1-hr, 100% coverage<br>50,000 BTU/sq ft/hr |
| ↖ Heat Resistance        | → 10-hr Bake @ 260°C                                 |
| ↖ Deep sea pressure      | → 20,000 ft, 24-hrs                                  |
| ↖ Salt water corrosion   | → 9 ft, 30-days                                      |
| ↖ Corrosive Fluids       | → Typical aircraft fluids                            |

# TSO Evolution

## ● TSO timeline



# Survival testing

Stopping distance for vehicle traveling 60 mph is 14.4 inch (367 mm)

Stopping distance for vehicle traveling 60 mph is 1.4 inch (36.7 mm)

Stopping distance for vehicle traveling 60 mph is 0.4 inch (10.8 mm)

Hazard	TSO C51	TSO C84	TSO C51a	TSO C123/124	TSO C123a/124a
Impact shock	100g	100g	1000g, 5-msec	3400g, 6.5-msec	3400g, 6.5-msec
Penetration resistance	None	None	500#, 10', .25"	500#, 10', .25"	500#, 10', .25"
Static crush	None	None	5,000#, 5-min	5,000#, 5-min	5,000#, 5-min
Fire resistance	1100°C, 30-min, 50% coverage	1100°C, 30-min, 50% coverage	1100°C, 30-min, 50% coverage	1100°C, 30-min, 100% coverage, 50,000 BTU/Hr/ft <sup>2</sup>	1100°C, 60-min, 100% coverage, 50,000 BTU/Hr/ft <sup>2</sup>
Heat resistance			None	10-hr @ 260°C	10-hr @ 260°C
Deep sea pressure		None	None	20,000', 24-hrs	20,000', 24-hrs
Salt water corrosion	48-hrs	36-hrs	30-days	9-ft, 30-days	9-ft, 30-days
Corrosive fluids	None	None	Specified fluids, 24-hours	Specified fluids, 48-hours (ED-56A)	Specified fluids, 48-hours (ED-56A)

**Increasing Requirements**

Related information available at [http://aviation-safety.net/cvr/cvr\\_tso.htm](http://aviation-safety.net/cvr/cvr_tso.htm)

And at [http://www.nts.gov/Events/symp\\_rec/proceedings/May\\_3/SessionI/Pres\\_grossi.ppt](http://www.nts.gov/Events/symp_rec/proceedings/May_3/SessionI/Pres_grossi.ppt)

Test protocols established by ED55, ED56A & incorporated in C123/124/123a/124a.

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