Aircraft Blast Mitigation

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Problem Definition

Blast mitigation uses advanced structural materials and design to prevent an internal blast from resulting in catastrophic loss of the aircraft and its passengers.

- Explosives detection increasingly difficult and/or expensive as threat mass decreases.
- Aircraft hardening weight and costs increases as threat mass increases.
- Combination of detection and hardening may cost-effective “system solution.”

Graph showing:
- Cost on the y-axis.
- Threat Mass on the x-axis.
- Lines for Hardening, EDS, and Both, indicating cost changes with threat mass.
Research Objectives

• Determine and Demonstrate the Feasibility of Blast Mitigation Technologies to Enhance the Survivability of Civil Aircraft

• Key requirements for commercial transport application -
  • Security – threat mass protection requirements, areas of protection
  • Operational/End-User – minimize weight and life-cycle cost impact (capital investment, installation, maintenance, etc.)
  • Airworthiness – material and installation must meet FAA airworthiness certification regulations (flammability and other safety issues).
Aircraft Hardening Research Approach

• Aircraft blast mitigation areas:
  • Overhead bins and bin liners
  • Passenger cabin liners
  • Cargo hold liners
  • Hardened luggage containers
  • Least risk bomb location

• Address specific threat weights determined by limits of Explosives Detection Systems (EDS) performance coupled with aircraft survivability

• Evaluate basic characteristics and acceptability of materials before developing prototypes (material strength, flammability, adaptability for aircraft installations, etc.)

• Address concepts of operations, implementation approach, and airworthiness/certification issues with TSA, FAA and industry (Boeing and Airbus)

• Perform cost/benefit analysis of ballast mitigation technologies and installation
Hardened Sidewall Panel Tests
B-737, March 2008

• Panel Development:
  • Boeing Phantom Works (BPW) in cooperation with Boeing Commercial Aircraft (BCA), Aircraft Interiors Group
  • Panel material was successful in prior tests for FAA flammability conformance, blast fragmentation/shockholing resistance, and blast resistance test

• Panel Design:
  • Panel dimensions – 30” wide x 52” high x 0.4” thick
  • Panel weight – 19 pounds

• Installation Location:
  • Aircraft body stations 480R and 500R
  • Installed using existing aircraft sidewall panel shock mounts
B-737 BPW Sidewall Panel
Un-pressurized Test, March 2008
B-737 Standard Panel
Un-pressurized Comparison Test, March 2008
Hardened Sidewall Panel Tests
B-737, March 2008

• Explosive Threat Scenario:
  • Military C4, molded spherical shape
  • Threat encased in representative passenger carry-on luggage

• Test Results:
  • With BPW liner: 26” longitudinal crack below window frame, and window pane intact. No failed stringers or frames
    • Probably not catastrophic
  • Without BPW liner: 33”H x 26”W breach to aircraft fuselage skin, multiple cracked stringers and cracked frame
    • Likely catastrophic at cruise altitude pressurization

BPW Liner, Post-test (Interior View)
Standard Liner, Post-test (Exterior View)
Summary of Blast Mitigation Tests

- 90 explosive mitigation tests conducted for commercial aircraft structures
  - 18 Tests on Narrow-Body Aircraft
    - 13 in passenger cabin
      - 6 bin insert tests
      - 2 hardened bin tests
      - 3 hardened liner tests
      - 2 side wall panel tests
    - 5 in cargo hold
      - 1 hardened container
      - 4 hardened liner test
  - 72 Tests on Wide-Body Aircraft
    - 5 in passenger cabin
      - 1 bin insert test
      - 1 hardened bin test
      - 3 hardened sidewall panel tests
    - 67 in cargo hold (all hardened container)
- Over 300 Supporting Data Tests
  - Includes determining suppressive and equivalence properties of passenger luggage and air cargo contents on explosive effects
Blast Mitigation Results and Status

• **Accomplishments:**
  - Fielded a practical solution for wide-body cargo holds (HULD)
    - TSA conducting pilot flight test program
    - Weight and cost are still issues
  - Demonstrated capability of hardened bins and liners for specified threat scenarios
    - Materials and design meet FAA airworthiness requirements
    - Weight and cost are still issues
  - Completed cost-benefit analysis on selected blast mitigation technologies to aid TSA in policy decisions
    - HULD, cargo liner, and hardened overhead bin

• **What is Needed:**
  - Practical blast mitigation solutions for narrow-body aircraft cargo holds
  - Assess effectiveness of blast mitigation technologies against other explosives
  - Low-weight/low-cost hardening solutions for all aircraft applications
  - Modeling and simulation capability for blast mitigation studies
    - New materials and explosives
    - Broad range of existing and emerging transports
  - Address passenger surface conveyance blast mitigation