Homeland Security

S&T Stakeholders Conference

Aircraft Blast Mitigation

Herman Rediess, Ph.D.
Transition Program Executive
Explosives Division
Science and Technology Directorate

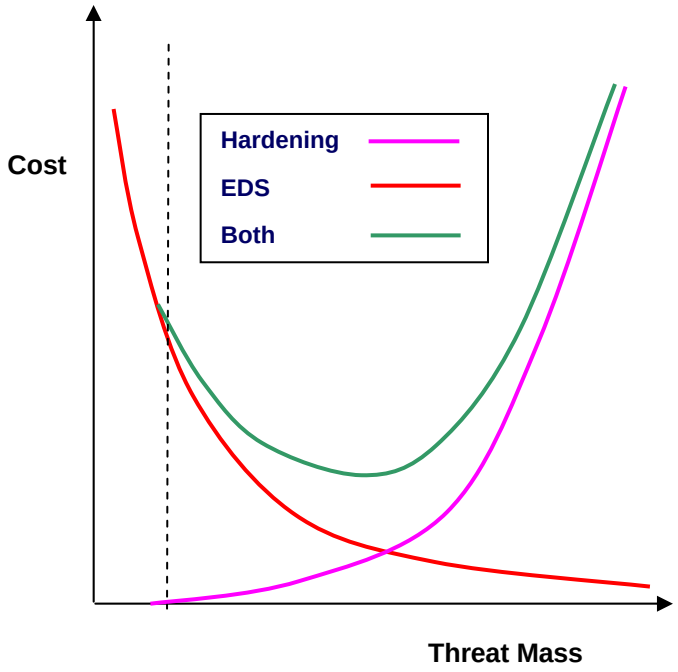
June 2-5, 2008

PARTNERING FOR A SAFER NATION

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"



Homeland Security

Research Objectives

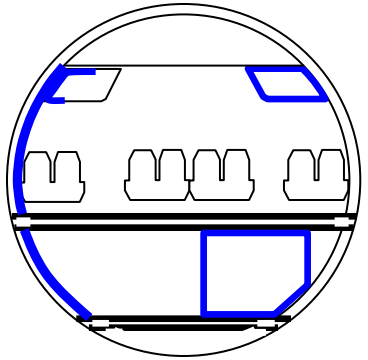
- Determine and Demonstrate the Feasibility of Blast Mitigation Technologies to Enhance the Survivability of Civil Aircraft

- 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).

Homeland Security

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

Homeland Security

Hardened Sidewall Panel Tests

B-737, March 2008

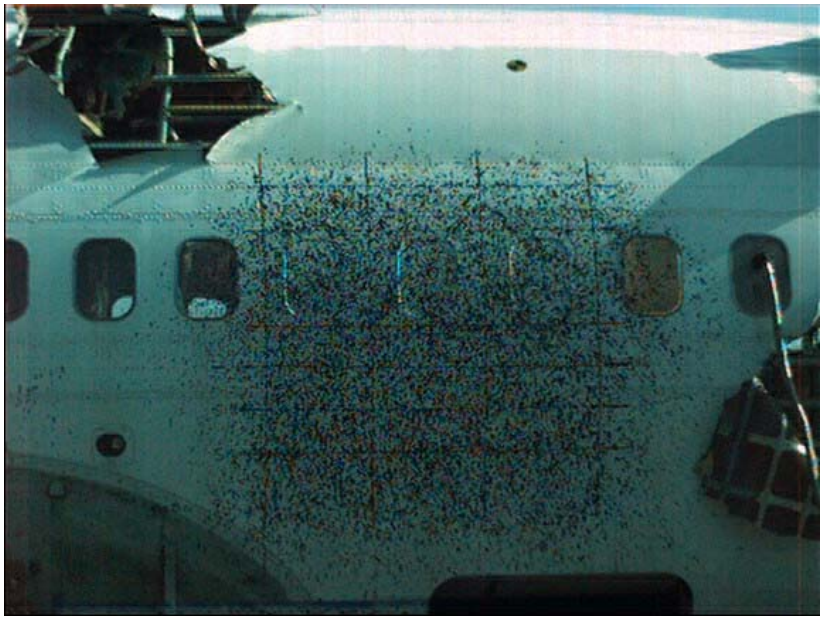
- Panel Development:
  - Boeing Phantom Works (BPW) in cooperation with Boeing Commercial Aircraft (BCA), Aircraft Interiors Group
  - Panel material was successful in prior tests for FAA flammability conformance, blast fragmentation/ shockholing resistance, and blast resistance test
- Panel Design:
  - Kevlar/Resin composite material composition: Kevlar 745 plain weave fabric, K29, 3000D, 13.2 oz/sqyd, Cytech Cycom 2282 resin.
  - 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

Standard Panel (L)
BPW Panel (R)

Homeland Security

B-737 BPW Sidewall Panel

Un-pressurized Test, March 2008



Homeland Security

B-737 Standard Panel

Un-pressurized Comparison Test, March 2008

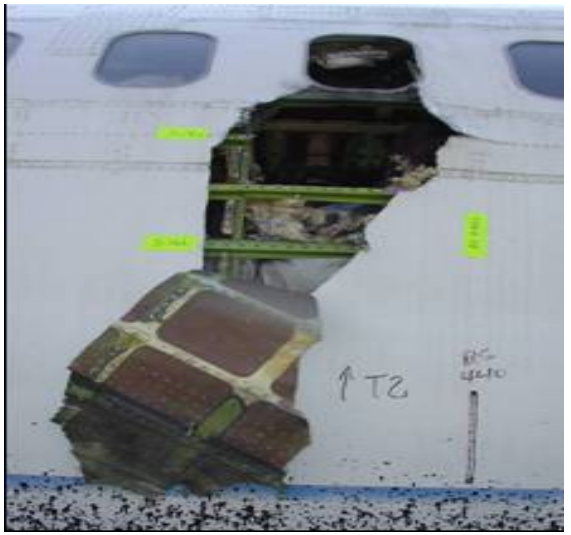
Homeland Security

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)

Homeland Security

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

Homeland Security

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

Homeland Security

Homeland Security