The Terrorist Threat to Commercial Aviation

• Commercial aviation is constantly under threat of terrorist attacks

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Effect of Explosion in a Cargo Hold Aircraft

Explosions in aircraft cargo holds

PROTECTION MEASURES ARE NEEDED

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Blast Containment on Cargo Hold - HULDs: Past Attempts

- Since the Lockerbie disaster in 1988, development of HULDs for cargo holds:
  - Never gained wide market acceptance:
    - Too heavy
    - Too bulky
    - Too expensive
    - Easily damaged during use and/or by environment
- Only for wide bodies!
Aviation regulations mandates that a **Least Risk Bomb Location (LRBL)** is identified on each aircraft.

Existing solutions for blast containment are based on:
- phase-changing materials
- thick reinforced plates

Drawbacks:
- Weight
- Cost
- Bulkiness
- Explicit presence of a blast disposal container onboard can give rise to panic
FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes

Project Type: Collaborative project
Call: FP7-AAT-2012-RTD-1
Topic: AAT.2012.5.1-1. Aerostructures
Start date: August 2012
End date: July 2015
Coordinator: Alessandro Bozzolo, D’Appolonia S.p.A. (RINA Group)
FLY-BAG2 Partners

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Introduction: from FLY-BAG1 to FLY-BAG2
FLY-BAG2: follow-up of FLY-BAG1 Project

- FLY-BAG2 is a follow-up of the previous FP7 Research Project FLY-BAG (GA No. ACP7-GA-2008-213577)
- FLY-BAG developed and successfully tested a blast-resistant flexible composite luggage container for the protection of aircrafts from on-board explosions from explosives hidden in luggage in the cargo hold
FLY-BAG1 Demonstrator

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG1: Installation trials into Meridiana Airbus A319
Blast Event

• Four possible causes of damage:
  • High speed fragments ejection
  • Shock peak pressure (duration: few ms)
  • Quasi static pressure (duration: few s)
  • Fire/heat
Blast Test of a LD3-45 ULD

WOULD MOST LIKELY LEAD TO FUSELAGE COLLAPSE

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG blast test with the same explosive charge that destroyed the ULD

THE FLY-BAG SURVIVES SUBSTANTIALLY INTACT!
FLY-BAG2 Project

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Why FLY-BAG2?

- FLY-BAG1 has demonstrated the feasibility of a textile-based blast resistant container, but:
  - For a **specific configuration** (narrow-body, the container stays in the cargo hold)
    - No use for wide-body aircrafts
    - No use against suicide bombers
  - FLY-BAG1 was only **blast-tested in open air**
  - The **interaction with airframe** was only known from simulations, not tested
FLY-BAG2 Objectives

- FLY-BAG2 developed two entirely new classes of bomb-proof devices, namely:
  - **cabin device**, meeting the *Least Risk Bomb Location* (LRBL) requirements
  - **cargo device**, for cargo holds of narrow body and wide body aircrafts
- **Full scale blast tests** on disused aircrafts were performed
Material Selection & Testing Campaign

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Dynamic Tests on Fabrics / Zips

- Test program: >50 tests conducted in total
- All samples 5cm wide by 40cm long
- Strain rates ~2-20 strain/second

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Mechanical, Flame & Burning Tests on Fabrics

- Abrasion resistance tests
- Burning Tests
- Wheatering Tests

**FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes**
Tests on Composites

**FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes**
FLY-BAG2 Blast Containment Units: Design & Prototyping

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
## FLY-BAG2 Products

<table>
<thead>
<tr>
<th>FB2 Products</th>
<th>Type of aircraft</th>
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<tbody>
<tr>
<td></td>
<td>Narrow body</td>
<td>Wide Body</td>
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<tr>
<td>FB2 cabin version</td>
<td>X</td>
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<tr>
<td>FB2 cargo version (see FB1)</td>
<td>X</td>
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<tr>
<td>FB2 AKE version (ULD)</td>
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<tr>
<td>FB2 PMC-pallet (ULD)</td>
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<td></td>
</tr>
<tr>
<td>FB2 Hardened composite panels (for LRBL)</td>
<td>X</td>
<td>X</td>
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**FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes**
FLY-BAG2 Cabin Version

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 Cabin Version

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FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 Cargo Version (for A320)

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 Cargo Version (for A320) – Composite Floor
FLY-BAG2 Cargo Version (for A320) – Zip

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 AKE Version

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 AKE Version – Composite Parts

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 PMC Pallet

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 PMC Pallet

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2 PMC Pallet – Stabilizer Rack

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Numerical Simulation
FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Numerical Simulations

NO FLY-BAG!

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Blast Tests

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
FLY-BAG demonstrators tested on board of a Boeing747 and Airbus A320:

- FLY-BAG Cabin variant
- Wide bodied – FLY-BAG for A320
- Narrow bodied – FLY-BAG AKE variant
FLY-BAG Cabin Version successfully tested onboard of a BOEING747

NO AIRCRAFT DAMAGE!
Full Scale Blast Tests - Cargo Variant (A320)

FLY-BAG Narrow Body Cargo Version successfully tested onboard of an Airbus A320!

NO AIRCRAFT DAMAGE!
Full Scale Blast Tests - Cargo Variant (B747)

FLY-BAG2 AKE Cargo Version successfully tested onboard of a BOEING747

NO AIRCRAFT DAMAGE!
Full Scale Blast Tests - No FLY-BAG Protection

NO PROTECTION

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Full Scale Blast Tests - No FLY-BAG Protection

NO PROTECTION

FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes
Conclusions

- FLY-BAG is a proofed-’bomb-bag’ technology able to limits on-board explosions that could seriously damage the fuselage
- FLY-BAG is a patented technology
- FLY-BAG cargo unit tailored for narrow-body aircraft has been certified by MERIDIANA
- The FLY-BAG cabin and wide-body cargo solutions (AKE; PMC Pallet) do not need any certification
- FLY-BAG products are now ready for commercialisation
- Visit to our stand 5-03!
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