Aircraft Fire Safety R&D: Past, Present & Future

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An Awesome Challenge: Aircraft Fire Safety (and R&D)

• Fire Protection in a Densely Populated and Isolated Cylinder Amid:
  – Flammable Jet Fuel
  – Plastic Interior Materials and Wiring
  – Passenger Carry-Ons
  – Passenger Stowed Luggage
  – Cargo of all Sorts
  – Declared and Undeclared Hazardous Materials
1980’s

R&D Drivers

- Fire Fatalities in Survivable Accidents
- Material Flammability
- Material Smoke (Obscuration) Emissions
- Material Toxic Gas Emissions
- L-1011, Riyadh, 8/80
- DC9, Cincinnati, 6/83
- 737, Manchester, 8/85

R&D

- Seat Cushion Fire Blocking Layers
- Heat Release Rate (OSU) Test Method for Large Surface Area Cabin Materials
- Electrical Wiring Arc Tracking
- Cargo Liner Burnthrough Resistance
- Aircraft Material Fire Test Handbook
- Seat Gasoline Fire Extinguishment (Halon 1211 Hand-Held Extinguisher)
- Floor Proximity Lighting
- Passenger Smoke Hoods (Reexamined)
- Cabin Water Spray
- In-Flight Smoke Venting

Note: Full-Scale Fire Test Facility became Operational in 1980
Saudia L-1011
Riyadh, Saudi Arabia; August 19, 1980
Manchester Accident
Full-Scale Fire Test Facility

Fuselage Test Articles

Postcrash Fire Test

Control Room
Seat Fire Blocking Layer Benefits

Fire Test Standard

Full-Scale Test Benefit

Accident Benefit
Heat Release Rate Test for Cabin Materials
Cabin Water Spray Results (707)

External Fuel Fire/Fuselage Opening/Wind

Red = Standard & Green = Waterspray
1990’s

R&D Drivers
• Aviation Safety Research Act of 1988
• Ban on Global Production of Halon (1/94)
• DC9, Everglades, 5/96
• 747, New York, 7/96
• MD11, Nova Scotia, 9/98

R&D
• Halon Replacement
• Exploding Aerosol Cans
• Fuel Tank Flammability
• Ground Based Inerting Cost Analysis
• Thermal Acoustic Insulation
  – Radiant Panel Test (In-Flight Fire Ignition Resistance)
  – Oil Burner Test (Postcrash Fire Burnthrough Resistance)
• Flight Data Recorders Fire Resistance
• Aircraft Command in Emergency Situations (ACES)
• Fire Research Program (Ultra-Fire Resistant Materials)
Swiss Air MD-11
Peggy’s Cove, Nova Scotia; September 2, 1998
Current Usage of Halon 1301/1211

Cargo Compartments

Engine Nacelles

Hand Held Extinguishers

Lavatory Trash Receptacles
Schematic of Radiant Panel Test Apparatus

- Chimney Thermocouple
- Middle Thermocouple
- Gas Fueled Panel
- Radiating Surface
- 30°
- Specimen Holder
- Specimen
- Pilot Burner
- Position
- 14 cm

10 9 8 7 6 5 4 3 2 1 0
Burnthrough Test Apparatus

Burner Cone

Draft Tube

Calorimeter

4" (102 mm)

36" (914 mm)

12" (305 mm)
2000’s

**R&D Drivers**
- NTSB & TSB Accident-Related Recommendations
- Composite Transport Aircraft (B787)
- Halon Replacement Activities
- 737, Bangkok, 3/01
- DC8, Philadelphia, 2/06
- 747, Dubai, 9/10

**R&D**
- Insulation Advisory Circulars
- Next Generation Burner
- Improved Fire Tests for Ducting and Wiring
- On-Board Inerting System (OBIGGS)
- Limiting Oxygen Concentration
- Composite Fuselage and Wings
- Magnesium Seat Structure
- Lithium Battery Fire Hazards
- Freighter Fire Suppression
- Halon Replacement
- Fire Research Program
NTSB Recommendation to the FAA

“Require that fire suppression systems be installed in the cargo compartments of all cargo airplanes operating under 14 Code of Federal Regulations Part 121. (A-07-99)”
Test Apparatus

- On this horizontal surface, place the specimen holder so that the wire bundle specimen is 3±1/16 (7.62±0.16 cm) inches away from the radiant heat panel and clears the pilot burner.
Schematic of On-Board Inert Gas Generation System (OBIGGS)

Air Inlet Provides Cooling Flow to Heat Exchanger

Filter Captures Dust/Oil Contaminants

Heat Exchanger Cools Air to 180 Deg F

Line from Existing Bleed Air Duct Supplies Hot Pressurized Air

High/Low Flow Orifices Regulate Nitrogen Flow

Nitrogen Enriched Air Exits ASM and is Ducted to Fuel Tank

Oxygen Enriched Air Removed From the ASM and Dumped Overboard

Pressurized Air Enters Air Separation Module (ASM)

Air Separation Module (ASM) separates Oxygen from incoming air
Full-Scale Test Results, Structural Composite System

Post-Test
Lithium-Ion Batteries

Bulk Load Configuration before Testing

Bulk Load Configuration after Testing
Microscale Combustion Calorimetry Reproduces Elements of Flaming Combustion in Non-flaming Laboratory Test
2010’s?

- Freighter Fire Suppression
- Lithium Battery Safety
- Hidden Fire Detection and Extinguishment
- Halon Replacement
- Material Flammability FAR’s Improvement
- Powerplant Flammability Standardization
- Fire Research (Long Range)
- Oxygen Systems
COMPLACENCY

• Complacency is a Concern
• Major Reduction in Accident Rate Tends to Promote Status Quo
• Accident Statistics can be Misleading
• Aircraft Fire Safety Merits Continuous Improvement Because of Ever Present Potential
Cabin Fire Caused by Lightning Strikes

Two Weeks Later

Boeing 757
Copenhagen, Denmark
11/15/2000

American MD-80
Dulles Airport
11/29/2000
SUCCESS

Pursue Improvements that are **PRACTICAL** and **COST/BENEFICIAL**

Cooperation …
Cooperation …
Cooperation.