

# Concerns with Fire Safety in Hidden Inaccessible Areas

**Gus Sarkos**

Manager, Fire Safety Section  
FAA Wm. J. Hughes Tech. Ctr.  
Atlantic City Airport, NJ

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# Presentation Outline

- Accidents/Incidents
- Thermal Acoustic Insulation
- Insulation Tape and Hook & Loop (“Velcro”)
- PVC Wiring
- Drip Shield/Ducting Adhesive Problem
- PSU Dust Seal Problem
- Contamination

# Accidents/Incidents

## Swiss Air MD-11 Accident

- 9/3/98; 229 Fatalities
- Origin: Forward Cabin/Cockpit Attic Area
- Cause: Appears “Probable Cause”  
Undetermined

# Accidents/Incidents

## Swiss Air MD-11 Accident (Continued)

- TSB Material Flammability Standard Recommendations
  - Revise standards to prohibit materials that propagate fire
  - Mandate a certification test for Wiring Failure under realistic conditions (Mitigate Risk of Ignition)
  - Evaluate Systems Failure to Prevent Exacerbation of Fire in Progress

# Accidents/Incidents

## Swiss Air MD-11 Accident (Continued)

- Swiss Air Internal Improvements
  - Detection/Suppression System in Cockpit/Forward Cabin Attic
  - Improved Training and Awareness of Mechanics
  - Periodic cleaning of contaminated areas
  - Other items were being considered/pursued

# Accidents/Incidents

- Recent Incidents

- World Airways' MD-11 Freighter, San Bernadino, 3/30/99
- Delta MD-88, Cinn/N. Kentucky A/P, 9/17/99
- Air Tran DC-9, Greensboro, 8/8/00
- Boeing 757, Copenhagen, 11/15/00
- American MD-80, Dulles, 11/29/00
- Air Tran DC-9, Atlanta, 11/29/00

World Airways  
MD-11 Freighter  
San Bernadino, California  
March 30, 1999



Delta MD-88  
Cincinnati, Ohio  
September 17, 1999



# Air Tran DC9

Greensboro, NC

August 8, 2000



# Boeing 757

Copenhagen, Denmark

November 15, 2000



# American MD-80

Dulles Airport  
November 29, 2000



# Air Tran DC9

Atlanta, GA

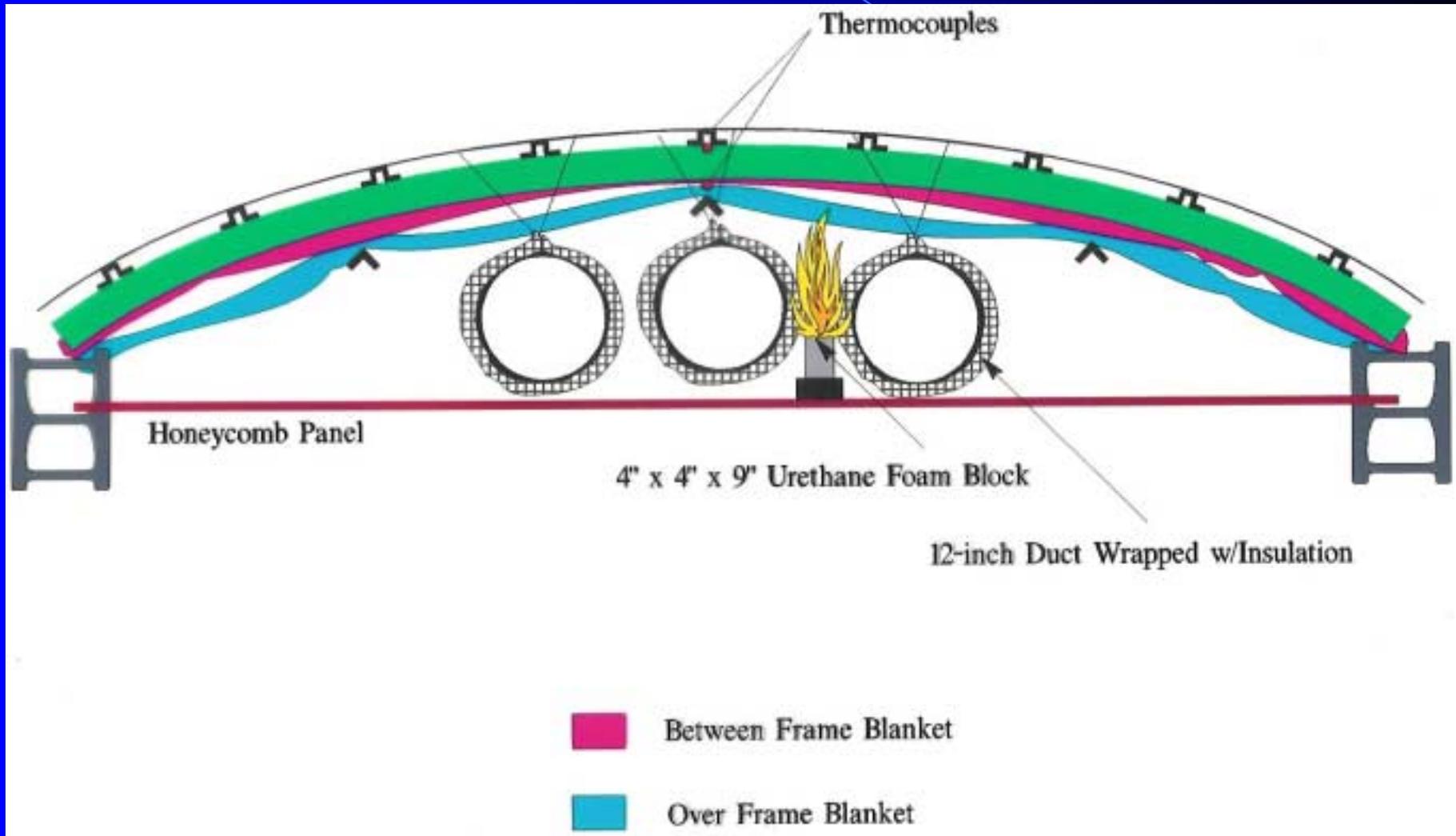
November 29, 2000



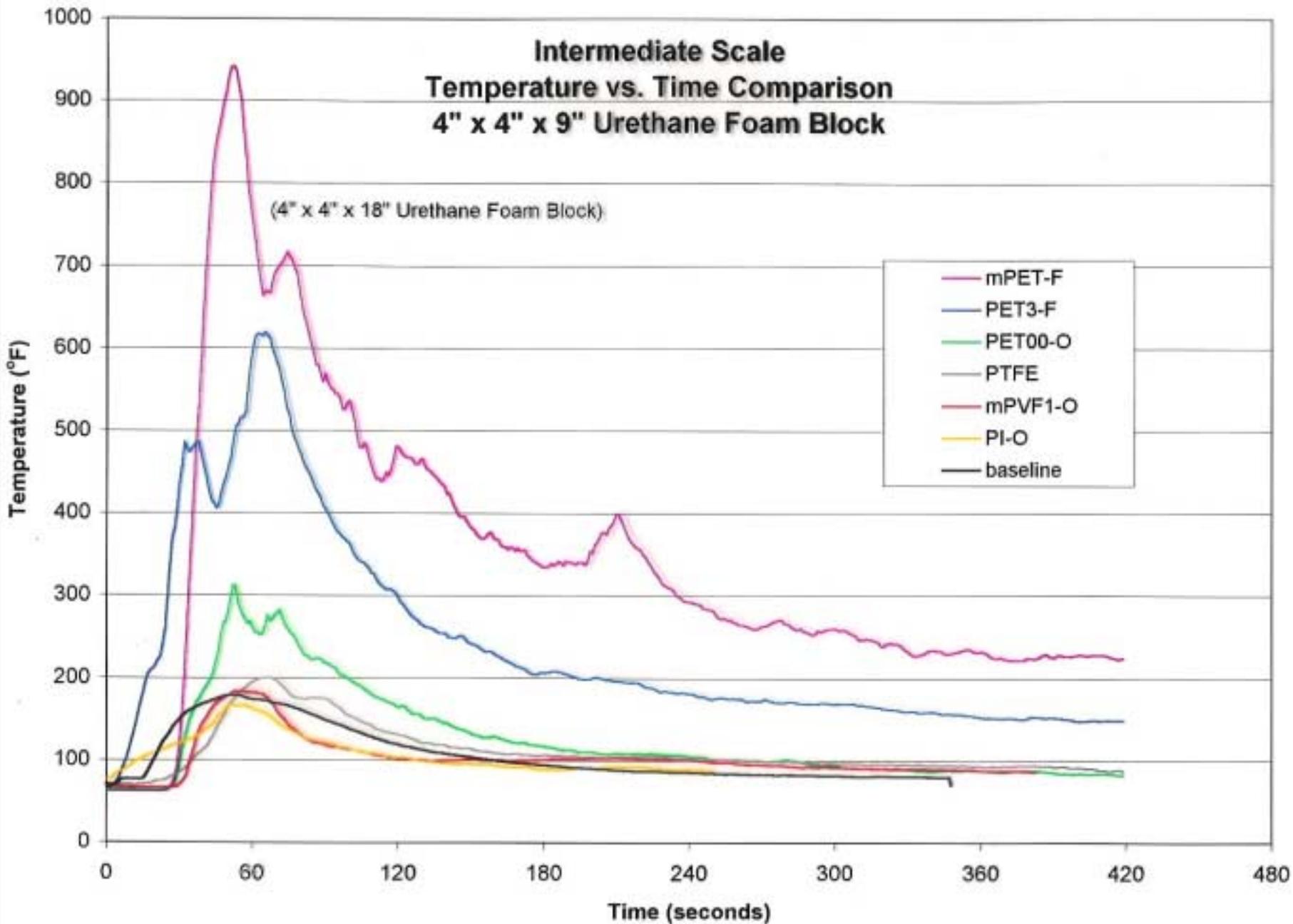
# Thermal Acoustic Insulation

- FAA Developed Improved Fire Test Method (Radiant Panel Test) (DOT/FAA/AR-99/44)
- Drivers
  - Swiss Air MD-11 Accident
  - Prior Incidents in China, Italy, and Copenhagen
  - Demonstrated Inadequacy of Vertical Bunsen Burner Test Method (DOT/FAA/AT-97/58)
- Attic Mock-Up Test Results
  - Films exhibit range of Fire Performance
  - Fire Performance a function of ignition source intensity

# Intermediate Scale Flame Propagation Test Arrangement



### Intermediate Scale Temperature vs. Time Comparison 4" x 4" x 9" Urethane Foam Block



# Thermal Acoustic Insulation

- **AD Issue in May 2000**

- Requires replacement of Metallized Mylar Film (>700 A/C) within 5 years (6/05)
- MM only film consistently ignited with Electric Arc (DOT/FAA/AR-TN00/20)
- Replacement films require zero flame spread in new Radiant Panel Test

- **NPRM Issued in September 2000**

- Requires Zero Flame Spread Films in production aircraft within two years of the effective date

- **Concern**

- Presence of MM and Non-Zero Flame Spread Films in Majority of Fleet

# Insulation Tape and Hook & Loop

- Tape and H&L used in Production Aircraft
- Tape used to repair insulation batts
- Tape and H&L are tested for flammability per FAR 25.853
  - TSB unable to determine if MD-11 tape tested for Flammability

# Insulation Tape and Hook & Loop

- Recent FAA Flammability Tests
  - Taped Swiss Air MD-11 Batts and Supplier H&L more flammable than film covers
  - Tape Results Variable (Good/Bad)
- FAA developing standard test procedures for Tape and H&L to support planned AC for Insulation Final Rule
- Concern: Flammable Tape and H&L in In-Service Aircraft

# PVC Wiring

- PVC wiring used in early aircraft
- PVC is significantly more flammable than Kapton or Fluoropolymer Wiring
- Recent FAA Flammability Tests (Large Scale)
  - PVC most flammable aircraft wiring tested
  - PVC produced largest quantity of smoke
  - PVC failed FAR 25.869 (60° Test)

# 60° Bunsen Burner Test Results for Aircraft Wiring

Wire Description	Burn Length (Inches)	After Flame (Seconds)	Drippings
PVC/Nylon	14.8	121	0
Crosslinked ETFE	1.8	0	0
PTFE/Polyimide/PTFE	1.2	0	0
PTFE/Mica	1	0	0
Polyimide	1.5	0	0
Crosslinked Polyalkene	3	<1	0
Zero Halogen	3.1	60.3	0
Plenum Cable	2.5	0	0
Riser Cable	2.5	0	0

Averages from Three Tests

# Intermediate Scale Wiring Fire Test Fixture



# Intermediate Scale Fire Test Results for Aircraft Wiring

<b>Wire description</b> (Test bundle- number of wires)	<b>Length</b> (inches)	<b>Flame</b> (seconds)	<b>Drippings</b> (seconds)	<b>Smoke</b> (subjective)
PVC/Nylon -25	28	45	0	dense
Crosslinked ETFE- 25	12	0	0	medium
PTFE/Polyimide/PTFE -25	8.5	0	0	low
PTFE/Mica -25	6	0	0	low
Polyimide -25	8	0	0	low
Crosslinked Polyalkene -25	12	0	0	low
Zero Halogen -10	44	140	10 drips reported	dense
Plenum Cable -10	29	0	0	medium
Riser Cable -10	31	0	0	medium

# PVC Wiring

- 60° Bunsen Burner Test
  - Not a severe test
  - Does not challenge superior fire resistance of Kapton and Fluoropolymer Wiring
  - Added to FAR's in 1972
  - Prior to 1972, no explicit test requirement for wiring
- Concern: flammability of PVC wiring in older aircraft

# Drip Shield/Duct Adhesive Problem

- Discovered that adhesive used in Cockpit Drip Shield and ECS ducts did not meet FAR 25.853
  - Also failed proposed Radiant Panel Test for insulation
- Problem corrected in production aircraft
- AD Issued for In-Service Aircraft in Fall 2000
  - Install Burnthrough Resistant Barrier to isolate area above cockpit drip shield
  - Remove insulation/glue from duct and replace with FR materials
  - Six year compliance period

# Drip Shield/Duct Adhesive Problem

- Concerns:
  - Flammability of Drip Shield/Duct adhesive
  - Vulnerability of Drip Shield/Adhesive to lightning strike
  - Flammability of Kevlar Drip Shield

# Dust Seal Problem

- Dust seal protects Emergency Oxygen Unit
- MD-80 Incident on November 30, 1999 at Raleigh Durham
  - PSU fire at Gate
  - Fire damaged oxygen canister, masks, metallized Mylar insulation, dust seal, etc.
  - Dust seal not tested/not compliant with FAR 25.853
- AD to be Issued
- Concern: Flammable Dust Seals

# Contamination

- Contamination causes materials to be more flammable
- Includes lint, dust, combustion inhibiting compounds, etc.
- Classic Example (Delta L-1011, 3/17/91)
  - In flight fire enroute Frankfurt to Atlanta
  - Fire started below floor and spread up sidewall
  - Extinguished with Halon 1211

# Delta

L-1011

Frankfurt to Atlanta (Goose Bay, Canada)

March 17, 1991



# Contamination

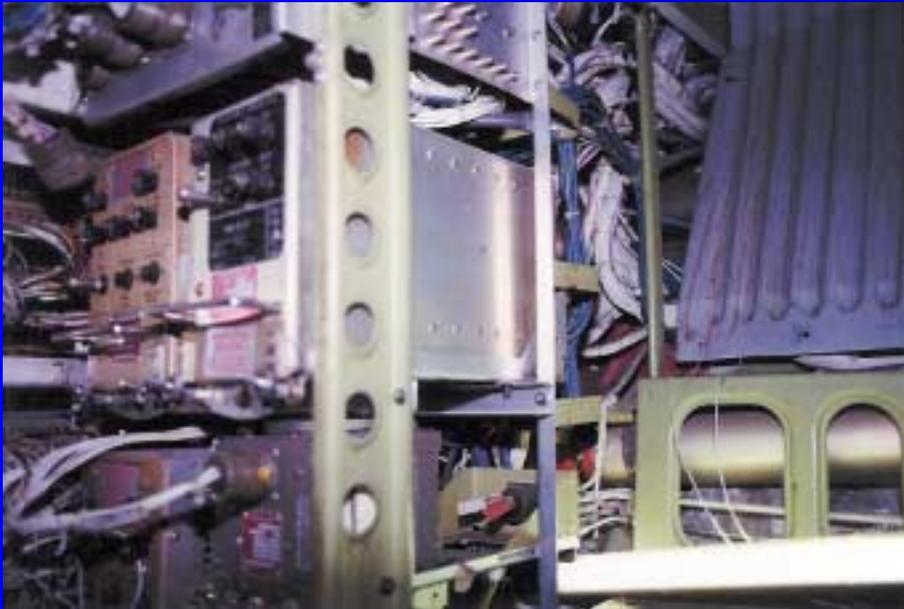
- TSB/NTSB Concerns with Contamination
  - Significant: 3/8 inch average; over 2 inches in some areas
  - Contamination also found in random inspection of other aircraft
  - Recommended changes in maintenance to address



# Contamination

- Past FAA Fire Tests (DOT/FAA/CT-91/2)
  - Insulation without CIC Self-Extinguishing
  - Insulation with CIC Burned Completely
- CIC Residue found on materials
- Concern: Enhanced material flammability caused by contamination

US Air  
MD-80  
Buffalo, NY  
January 18, 1990



# Conclusions

- In-Flight fires originating in Hidden Areas are a risk to aviation safety
- Most hidden fires are caused by electrical problems
- Non-Compliance with Fire Safety Regulations have been uncovered
- Fire Safety Problems and Improvements are in various stages of correction and study
- It is impossible to predict the relative risk of serious fires occurring in Hidden Areas or Locations