Proposed Radiant Heat Panel Test
For the Evaluation of Aircraft Duct Material
PRESENTATION OUTLINE:

- Task Group Objective
- October 2005 Meeting Minutes
- Test Results (Past Quarter)
- Status of Proposed Aircraft Ducting Test
- Summary & Final Remarks
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OBJECTIVES

- FAA's goal is to raise the standard for the airplane such that fires in inaccessible areas do not spread and create catastrophic conditions.
- The current test for aircraft ducts does not predict the behavior of the part in actual conditions and therefore suggests the need for a new standard.
- For the Task Group, is to develop a new fire test procedure to evaluate the fire-worthiness of aircraft ducting.
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OCTOBER 2005 TASK GROUP
MEETING MINUTES

- FAA test data available on-line (ftp://155.178.136.36)

- Task Group Members comments, concerns & questions:
  - Define ducting system boundaries & exclusions
  - Should insulated covered ducts be regulated under FAR 856 or should it be regulated by the test new protocol?
OCTOBER 2005 TASK GROUP MEETING MINUTES

- Task Group Members concerns & questions (Cont.):
  
  - Should ducts that transition between the cabin and inaccessible areas be regulated by current cabin federal regulations or the new test protocol?
  
  - Should the repair/replacement of existing parts meet the previous regulation test or the new test protocol?
  
  - When the duct is an integrated part of the structure, should it meet the new test protocol or the old one?
  
  - The task group members were assigned to review the test result data to assess the proposed radiant heat panel test.
  
  - Samples of less fire-worthy materials, with fire retardant coatings, to be provided to the FAA Technical Center for evaluation.
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LAST QUARTER TEST RESULTS

- Tested Taped N (IST and RP)
- Tested Coated Taped N (IST and RP)
- Tested Coated B (RP)
- Received Structural Adhesive (Scheduled for testing)
LAST QUARTER TEST RESULTS

- Intermediate-Scale Test Results:
  - Taped N
    - Peak Temp (degC) = 415
    - Heat Flux (kW/m²) = 61
    - Burning Time (min) = 10
    - Burned Area (cm²) = 111
LAST QUARTER TEST RESULTS (CONT.)

- Intermediate-Scale Test Results (Cont.):
  - **Coated/Taped N Test 1**
    - Peak Temp (degC) = 766
    - Heat Flux (kW/m²) = 59
    - Burning Time (min) = +40
    - Burned Area (cm²) = 4985
LAST QUARTER TEST RESULTS (CONT.)

- Intermediate-Scale Test Results (Cont.):
  - Coated/Taped N Test 2
    - Peak Temp (degC) = 698
    - Heat Flux (kW/m²) = 39
    - Burning Time (min) = 2.18
    - Burned Area (cm²) = 336
INTERMEDIATE-Scale FIRE TEST
Aircraft Ducting Materials / Narrow-Body Configuration

Heat Flux (kW/m²)

Material

Coated
Taped
N Test
2

Coated
Taped
N Test
1

Taped
N

Material
SAMPLE “TAPED N”
LAST QUARTER TEST RESULTS (CONT.)

- Radiant Panel Test Results:
  - Material Taped N:
    - FAA Radiant Panel Test Results
      - Burn Length (cm) = 0.67
      - After Flame Time (sec) = +40
    - Proposed Radiant Panel Test Results
      - Burn Length (cm) = 1.5
      - After Flame Time (sec) = 4.4
LAST QUARTER TEST RESULTS (CONT.)

- Radiant Panel Test Results:
  - Material Coated Taped N:
    - FAA Radiant Panel Test Results
      - Burn Length (cm) = 3.2
      - After Flame Time (sec) = 7.3
    - Proposed Radiant Panel Test Results
      - Burn Length (cm) = 9.7
      - After Flame Time (sec) = +40

Matches Performance of IST Test 1!
LAST QUARTER TEST RESULTS (CONT.)

- Radiant Panel Test Results:
  - Material Coated B:
    - FAA Radiant Panel Test Results
      - Burn Length (cm) = 3.6
      - After Flame Time (sec) = 3.6
    - Proposed Radiant Panel Test Results
      - Burn Length (cm) = 10.1
      - After Flame Time (sec) = +40
EXPERIMENTAL RADIANT PANEL TEST RESULTS
Aircraft Ducting Materials

FAA Requirement: Length < 5.08 cm
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PROPOSED RADIANT PANEL TEST:

Test Protocol: Based on Appendix F to Part 25 (Part IV) – Test Method To Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials

Sample Size: 215.9mm x 279.4mm

Heat Source: Propane Flame & Radiant Heating Coils (147 kW/m² pilot, 17 kW/m² panel).

Heat Source Exposure: One minute exposure to radiant heat, then 10 seconds pilot impingement.

Max Flame Propagation: < 5.08 cm

Max Flame Time: TBD
RADIANT PANEL TEST RESULTS
Aircraft Ducting Materials

FAA Requirement: Length < 5.08 cm, AF t < 3 seconds
EXPERIMENTAL RADIANT PANEL TEST RESULTS
Aircraft Ducting Materials

Max Time = ?

Suggested Maximum Propagation Length = 5.08 cm

After Flame Time (sec)

Burn Length (cm)
PROPOSED AIRCRAFT DUCTING TEST (CONT.):

- Some components or parts of the ducting system are installed between the hidden areas (such as the attic and cargo compartment) and the cabin area.

- **Suggestion**: Use the performance of materials that passed the OSU to determine the maximum “After Flame Time”.
FAA FIRE TESTS

FAA CABIN TESTS:
(1) 12 & 60 sec Vertical BB
(2) 15 sec Horizontal BB
(3) Seat Cushion Fire Blocking (Oil Burner)
(4) **OSU Heat Release & Smoke 65/65/200**
(5) Thermal Acoustic Insulation: Radiant Panel & Burn Through Tests
(6) Electrical: 60 deg Test

FAA “NOT OCCUPIED” AREAS TESTS:
(1) 12 sec Vertical BB
(2) Thermal Acoustic Insulation: Radiant Panel & Burn Through Tests
(3) Electrical: 60 deg Test

FAA CARGO TESTS:
(1) 45 deg Test
(2) 4.0-in/min Horizontal
(3) 12 sec Vertical BB
(4) Cargo Liner Penetration Test (Oil Burner)
(5) **OSU Heat Release & Smoke 65/65/200 (Combi/Class B+ Cargo)**
(6) Thermal Acoustic Insulation: Radiant Panel & Burn Through Tests
(7) Electrical: 60 deg Test
Experimental Radiant Panel Test Results

Aircraft Ducting Materials

Suggested Maximum After Flame Time = 45 sec

After flame > 40 sec

COATED K
C
D
K
N

After Flame Time (sec)

20
15
10
5
0

Burn Length (cm)

0 2 4 6 8 10 12 14 16 18

Taped N
X
F
2
R
E
P2
Z
T
Y

Passed All OSU
Passed One OSU
Failed All OSU
Not Tested OSU
PROPOSED AIRCRAFT DUCTING TEST:

Topics for Discussion with Task Group Members

(1) “After Flame Time” recommended to be 45 seconds

(2) Should we change the pilot flame impingement time back to 15 seconds?
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SUMMARY & FINAL REMARKS

- **OCTOBER MINUTES:** Task Group member’s policy questions cannot be answered at this time, but they will be included in the report for future reference.

- **LAST QUARTER TESTING:** There was a significant improvement (+10x) on the performance of material N during IST and RP tests when a fire retardant tape was applied to it. The same could not be said about the FR coating (Taped N or B).

- **PROPOSED TEST:** Obtain Task Group members’ feedback
  - “After Flame Time” recommended: 45 seconds (based on test data)
  - Extend pilot impingement time (from 10 sec to 15 sec)
  - Continue testing materials (as needed)
  - Initiate test protocol draft report
$T_i = 239 \, ^\circ C$
IST Burning Time = 5.58 minutes
IST Burned Area = 32,583 cm$^2$
IST Peak Temperature = 825 °C
RP Burned Length = 16 cm
RP After Flame = >40 sec
OSU Peak Heat Released = 82.8 kW/m$^2$
OSU Total Heat Released = 111.8 kW/m$^2$
Smoke Density = 130.7
$T_1 = 486 \, ^\circ C$
IST Burning Time = 1.18 minutes
IST Burned Area = 1190 cm$^2$
IST Peak Temperature = 641 $^\circ C$
RP Burned Length = 16 cm
RP After Flame = >40 sec
OSU Peak Heat Released = 66.3 kW/m$^2$
OSU Total Heat Released = 29.6 kW/m$^2$
Smoke Density = 4.5

SAMPLE “D”
$T_1 = 561 \, ^{\circ}\text{C}$
IST Burning Time = 0.51 minutes
IST Burned Area = 113 cm$^2$
IST Peak Temperature = 697 °C
RP Burned Length = 2.1 cm
RP After Flame = 0 sec
OSU Peak Heat Released = 30.2 kW/m$^2$
OSU Total Heat Released = 25.9 kW/m$^2$
Smoke Density = 19.4
Ti = 322 °C
IST Burning Time = 1.13 minutes
IST Burned Area = 750 cm²
IST Peak Temperature = 896 °C
RP Burned Length = 16 cm
RP After Flame = >40 sec
OSU Peak Heat Released = 70.5 kW/m²
OSU Total Heat Released = 72.9 kW/m²
Smoke Density = 189
T₁ = 554 °C
IST Burning Time = 0.93 minutes
IST Burned Area = 374 cm²
IST Peak Temperature = 816 °C
RP Burned Length = N/A (3.9 cm)
RP After Flame = N/A (6 sec)
OSU Peak Heat Released = 53.4 kW/m²
OSU Total Heat Released = 66.6 kW/m²
Smoke Density = 0.5
$T_i = 358 \, ^\circ C$
IST Burning Time = 30 minutes
IST Burned Area = 1752 cm$^2$
IST Peak Temperature = 708 °C
RP Burned Length = 16 cm
RP After Flame = > 40 sec
OSU Peak Heat Released = 179.3 kW/m$^2$
OSU Total Heat Released = 114.2 kW/m$^2$
Smoke Density = 175.8
SAMPLE “O”

$T_i = 615 \, ^\circ C$
IST Burning Time = 1.28 minutes
IST Burned Area = 510 cm$^2$
IST Peak Temperature = 825 $^\circ C$

RP Burned Length = 2.3 cm
RP After Flame = 2.9 sec

OSU Peak Heat Released = 40.7 kW/m$^2$
OSU Total Heat Released = 25.7 kW/m$^2$
Smoke Density = 1
$T_i = 615 \, ^\circ C$

IST Burning Time = 1.28 minutes

IST Burned Area = 347 cm$^2$

IST Peak Temperature = 797 °C

RP Burned Length = 4.2 cm

RP After Flame = 2.8 sec

OSU Peak Heat Released = 44.2 kW/m$^2$

OSU Total Heat Released = 39.8 kW/m$^2$

Smoke Density = 0.7
$T_i = 632 \, ^\circ C$
IST Burning Time = 1.47 minutes
IST Burned Area = 761 cm$^2$
IST Peak Temperature = 756 $^\circ C$
RP Burned Length = 3.0 cm
RP After Flame = 0.0 sec
OSU Peak Heat Released = 30.5 kW/m$^2$
OSU Total Heat Released = 8.9 kW/m$^2$
Smoke Density = 0.1
$T_i = 581 \, ^\circ C$
IST Burning Time = 1.21 minutes
IST Burned Area = 653 cm$^2$
IST Peak Temperature = 777 $^\circ$C
RP Burned Length = 3.8 cm
RP After Flame = 36.8 sec
OSU Peak Heat Released = 33.5 kW/m$^2$
OSU Total Heat Released = 24.4 kW/m$^2$
Smoke Density = 8.6
SAMPLE “TAPED N”

$T_i = N/A$
IST Burning Time = ~10 minutes
IST Burned Area = 111 cm$^2$
IST Peak Temperature = 415 °C
RP Burned Length = 1.5 cm
RP After Flame = 4.4 sec
OSU Peak Heat Released = N/A
OSU Total Heat Released = N/A
Smoke Density = N/A
SAMPLE “U & U2”

- $T_i = 578 \, ^\circ C$
- IST Burning Time = N/C minutes
- IST Burned Area = 1081 cm$^2$
- IST Peak Temperature = 779 °C
- RP Burned Length = 2.3 – 3.9 cm
- RP After Flame = 15.3 – 21.2 sec
- OSU Peak Heat Released = 42.0 kW/m$^2$
- OSU Total Heat Released = 34.6 kW/m$^2$
- Smoke Density = 17.6
T_i = 594 °C
IST Burning Time = 1.19 minutes
IST Burned Area = 610 cm^2
IST Peak Temperature = 816 °C
RP Burned Length = 2.1 cm
RP After Flame = 6.6 sec
OSU Peak Heat Released = 81 kW/m^2
OSU Total Heat Released = 48 kW/m^2
Smoke Density = 12
$T_i = 616 \ (366) \degree C$
IST Burning Time = 1.21 minutes
IST Burned Area = 302 cm$^2$
IST Peak Temperature = 787 °C
RP Burned Length = 2.2 cm
RP After Flame = 1.0 sec
OSU Peak Heat Released = 146.9 kW/m$^2$
OSU Total Heat Released = 132.7 kW/m$^2$
Smoke Density = 21.8
$T_1 = 359 \ (616) \degree C$

IST Burning Time = 2.56 minutes

IST Burned Area = 644 cm$^2$

IST Peak Temperature = 804 $\degree C$

RP Burned Length = 1.8 cm

RP After Flame = 26 sec

OSU Peak Heat Released = 115.3 kW/m$^2$

OSU Total Heat Released = 120.4 kW/m$^2$

Smoke Density = 42.7
$T_i = 623 \, ^\circ C$

IST Burning Time = 1.19 minutes

IST Burned Area = Film shrunk, Min to Duct

IST Peak Temperature = 834 \, ^\circ C

RP Burned Length = 2.8 cm

RP After Flame = 35 sec

OSU Peak Heat Released = 34.6 kW/m²

OSU Total Heat Released = 43.6 kW/m²

Smoke Density = 17.7

SAMPLE “Z”