Development of a Burnthrough Test Standard
For Thermal Acoustic Insulation

Tim Marker
FAA Technical Center
Manchester 737 Accident, 1985
Full-Scale Testing of Surplus Aircraft
Full-Scale Burnthrough Test Rig

TEST SECTION

Existing B707 Fuselage

Curved Steel Channel

Aluminum Skin

Steel Skin

Vertical Former

Floor Vents

Fire Pan

Existing B707 Fuselage

20'

12'

8'
Full-Scale Test Results Using Various Materials

- Aluminum Skin
- 0.42 lb/ft³ Fiberglass with Metallized PVF Film
- 0.42 lb/ft³ Fiberglass with Polyimide Film
- Fiberglass/Ceramic Paper with Metallized PVF Film
- Rigid Polyimide Foam/Ceramic/Quartzel
- Ceramic Fibers with Polyimide Film
- Oxidized Polyacrylonitrile Fiber with Polyimide Film
Laboratory Scale Test Development
Initial Lab-Scale Burnthrough Test Apparatus
Initial Lab-Scale Burnthrough Test Apparatus

- Test Box
- Sample Holder
- Insulation Sample
- Aluminum Skin
Initial Burnthrough Testing
Second Generation Curved Test Frame
Third Generation Frame with Aluminum Skin
Initial Blanket Installation Method

"X-mas Tree" Fastener
Washer
Cap Strip
Burnthrough
Field Blanket
Alum Skin
Hat-Shaped Stringer
Burnthrough
Curved Z Former
Cap Strip
Overlapped Insulation Attachment
Third Generation Test Frame
Third Generation Frame
With 24- by 24-inch Void
Third Generation Frame
Without Lower Skin
Proposed Combination Test Rig

Adjustable Angle

Burn Length Determination

Opening - Fire Entry
Finalized Test Frame
Heat Flux Measurement on Backface of Samples
Heat Flux Measurement on Backface of Samples

- Calorimeter 2
- Calorimeter 1
- Spring Clip Squeezes Insulation Sample
- Field Blanket
- Hat-Shaped Stringer
- Steel Z Former
- Burner Cone

Dimensions:
- 4" (102 mm)
- 6"
Finalized Test Rig
Typical Blanket Installation on Test Rig
Laboratory-Scale Test
Refinements to Calibration and Test Procedures
Individual Calibration Rigs
Data Collection Procedure is Critical

Effect of Soot Buildup on Calorimeter Performance
(2 minute warm-up away from calorimeter surface)

Date: 11/24/99

Time (minutes)

Heat Flux (Btu/ft² sec)
Data Collection Procedure is Critical

Average Rake Temperature Vs. Time
At Various Air Velocity Settings

Temperature (°F)

1600
1700
1800
1900
2000

Time (minutes)

0
2
4
6
8
10

Data Collection Period

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Data Collection Period

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1900 ft/min
2000 ft/min
2100 ft/min
2200 ft/min
2400 ft/min
Laboratory-Scale Test
Refinements to Burner Equipment
Different Types of Stators

2 3/4” I.D.  2 5/8” I.D.
C.W.          C.W.

C.C.W.

4” O.D.      3 7/8” O.D.
No Disc      Disc
Monarch H215 Internal Stator with Static Disc
Preferred Position of Igniters to Achieve Calibration

10-11 o’clock
Laboratory-Scale Test
Measurement of Intake Air Velocity
Park DPL Burner Air Intake
Intake Airbox Holding Air Velocity Meter
Intake Air Velocity Measurement System
Primary Factors Influencing Calibration/Test Results

- Air Intake Velocity
- Fuel Flowrate
- Proper Burner Components/Adjustments (stators, position of igniters, correct fuel nozzle)
- Instrumentation (type/size of thermocouple, calorimeter type, method of collecting/reducing data)
- Fuel Temperature
- Environmental Conditions (relative humidity, barometric pressure)
Burner Correlation With Full-Scale Test Results
Correlation Using 6 GPH Burner (Full-Scale vs. Lab-Scale)

Full Scale Tests in 707

Lab Scale Tests with Burner

Failure Time (Seconds)

- 0.63-Inch Alclad + 3 Layer Aerocoi
- 0.63-Inch Alclad + 4 Layer Aerocoi

- 2000 ft/min: 1:24 Avg, 1:38 Avg
- 2100 ft/min: 1:24 Avg, 1:37 Avg
- 2200 ft/min: 1:22 Avg, 1:37 Avg
Round Robin Testing

Objective:

To identify and correct problems with proposed burnthrough test equipment to ensure similarity between labs

Methodology:

Prove similarity of test equipment between labs through testing of identical samples

Participants:

7 Domestic Labs, 3 European Labs

Status:

4 round robins completed

Additional smaller round robins scheduled
Round Robin I Histogram

Round Robin I Material A Distribution

Avg = 102.9
Standard Dev = 68.8
Round Robin I Modified Histogram

Avg = 83.0
Standard Deviation = 28.0
## Variety of Burner Components Used in Early Round Robins

### Round Robin I & II

<table>
<thead>
<tr>
<th>Lab Code (A-J)</th>
<th>Internal Turbulator O.D. (inches)</th>
<th>Internal Turbulator Type</th>
<th>End Turbulator Rotation</th>
<th>End Turbulator I.D. (inches)</th>
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<th>Tabs Used (Y/N)</th>
<th>Nozzle Type</th>
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<td>Y</td>
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Round Robin III Histogram

Average = 30 seconds

Standard Deviation = 12 seconds

Failure Range (Seconds)
Round Robin IV Histogram

Average = 28 seconds
Standard Deviation = 8 seconds
Standard Deviation Trend

- FG (0.60 lb³/ft)
- Oxidized Polyacrylonitrile

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<th>RR II</th>
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<tr>
<td>Standard Deviation (Seconds)</td>
<td>70</td>
<td>40</td>
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Conclusion, Round Robins I, II, III, and IV

Decreasing standard deviation trend result of:

Standardization of Calibration and Test Procedures

Standardization of Test Burner/Apparatus

Overall Increased Familiarization with Proposed Test Method
Future Considerations

Conduct additional round robin test series to fully refine test method

*Calibration of heat flux transducers (completed)*

*Calibration of air velocity meters (current)*

*Standardization of air velocity measurement*

Conduct laboratory scale tests to investigate installation requirements

*Overlap at vertical formers*

*Overlap at horizontal seams*

*Attachment Methods*

Conduct full-scale confirmation tests in support of Advisory Circular
Blanket Overlap Testing
Full-Scale Overlap Testing
### Task Group Participants

**Task Group Meeting: Wednesday morning 9:00**

<table>
<thead>
<tr>
<th>Becky Wulliman</th>
<th>John Brooks</th>
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<td>Dan Trahan</td>
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