Vertical Flame Propagation (VFP) Test Method Update

Presented to: IAMFTWG, Kansas City, MO
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Introduction

- Carbon fiber composites are being used more frequently in aerospace applications
  - Increased strength
  - Lower density
  - Better corrosion resistance

- New designs of commercial transport airplanes include primary and secondary structure constructed from carbon fiber composites

- Current FAR’s do not require flammability testing for fuselage skins or structures, as traditional designs are inherently non-flammable
  - Special Conditions for certification of fire resistance of composite fuselage
  - Must demonstrate level of safety equivalent to or better than traditional constructions

- To continue with the FAA’s efforts to enhance in-flight fire safety, materials in inaccessible areas of the cabin should meet a flammability test based on the “block of foam” fire source
Objective

• Design, construct, and evaluate a new flame propagation test method
  – Determine effectiveness of evaluating flame propagation
  – Determine level of repeatability and reproducibility

• Deliver new test method to FAA Transport Directorate for use in certification of novel design airplanes
  – Inclusion in next-generation fire test requirements
  – Possibly replace current Special Conditions requirements

• Attempt to test other inaccessible area materials on same apparatus
  – Wire insulation
  – Ducts, hoses
Vertical Flame Propagation Test Apparatus

- Hood
- Voltage Control
- Thermocouple Arm
- Viewing Window
- Thermocouples
- Furnace
- Sample Door
- Sample Frame
- Pilot Burner
Ribbon Burner
\[ D_{\text{primary}} = 0.04 \text{ in}; \ A_{\text{primary}} = 0.00125 \text{ in}^2 \]
\[ D_{\text{pilot}} = 0.0175 \text{ in}; \ A_{\text{pilot}} = .0002405 \text{ in}^2 \]
\[ A_{\text{total}} = 51 \times 0.00125 \text{ in}^2 + 32 \times 0.0002405 \text{ in}^2 \]
\[ = 0.07145 \text{ in}^2 \]

Original Pilot Burner
\[ D = 0.050 \text{ in}; \ A = 0.001963 \text{ in}^2 \]
\[ A_{\text{total}} = 0.01178 \text{ in}^2 \]

Area Ratio
\[ A_{\text{ratio}} = \frac{A_{\text{ribbon}}}{A_{\text{original}}} = \frac{0.07145}{0.01178} = 6.06 \]
Original Burner

\[ A_{\text{total}} = 0.07145 \text{ in}^2 \]

\[ A_{\text{ratio}} = \frac{A_{\text{ribbon}}}{A_{\text{original}}} = \frac{0.07145}{0.01178} = 6.06 \]

Small Burner Plug
One Row Covered

\[ A_{\text{total}} = 0.04635 \text{ in}^2 \]

\[ A_{\text{ratio}} = \frac{A_{\text{ribbon}}}{A_{\text{original}}} = \frac{0.04635}{0.01178} = 3.93 \]

Large Burner Plug
Two Rows Covered

\[ A_{\text{total}} = 0.0251 \text{ in}^2 \]

\[ A_{\text{ratio}} = \frac{A_{\text{ribbon}}}{A_{\text{original}}} = \frac{0.0251}{0.01178} = 2.13 \]
Ribbon Burner – Summary

- Ribbon burner as received produced a flame too large and buoyant for VFP
- Modifications to reduce the exit area of the burner provided flames more similar to the original VFP pilot burner
- Test results obtained with the modified ribbon burner provided similar results to the original VFP pilot burner
  - A flame impingement time of 30 seconds seemed to provide the most similar test results to the original VFP pilot burner
- Advantages of using ribbon burner are clear, more work required to obtain the best possible pilot flame
  - Produces a flat, straight mostly uniform flame across 2"
  - Alignment with wires significantly improved over original VFP burner
  - A burner-to-sample distance of 7/8" or greater provides good results, and reduces the likelihood of melting or intumescing materials clogging the pilot burner
Ribbon Burner Status

• 3 different burners were ordered in February
• Manufacturer has had significant production delays
• They are hoping to deliver within the next 2 weeks
New Lab – Building 202

- New lab acquired by Fire Safety
  - VFP was moved in to B202
- Modifications necessary before testing can begin
  - Installation of exhaust hood and piping
  - Awaiting approval of design by facility safety and engineering
Introducing VFP 3.0

• New and improved VFP
• Features:
  – Smaller footprint
  – Controlled air inlet
  – Double-door system to keep backside smoke out of lab
  – Larger viewing windows
  – Improved sample frame
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