Radiant Panel Test

Impact of insulation density on approved aerospace insulation and code compliant films

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Project objective

- Resolve questions for encapsulated systems for low and high insulation densities covered with recognized code compliant films.
- Materials evaluated
  - Insulation: four types at low, medium and high densities
  - Encapsulating film: three types – does not include films used for burn through
Radiant panel test - general parameters

**FAA Flame Propagation test (FAR 25.856 a1)**
Test Method designed to determine the flammability and flame propagation characteristics of thermal/acoustic insulation composites (issued July 31, 2003). This test method is used to evaluate the flammability and flame propagation characteristics of thermal/acoustic insulation when exposed to both a radiant heat source and a flame (see [www.fire.tc.faa.gov](http://www.fire.tc.faa.gov) for additional detail).
## Insulation types

<table>
<thead>
<tr>
<th>Insulation</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Glass</td>
<td>Low, Medium, High</td>
</tr>
<tr>
<td>Polyimide Foam</td>
<td>Low(FS)*, Low, Medium,</td>
</tr>
<tr>
<td>Melamine Foam</td>
<td>Low, Medium</td>
</tr>
<tr>
<td>PVDF** – FR Foam</td>
<td>Low</td>
</tr>
</tbody>
</table>

*FS = flame seared pretreatment  
** PVDF = Poly Vinlydene Flouride
Fiber Glass

- Density, low, medium, high
- Thickness at ¾” or 1”
Polyimide Foam

- Density low (fs), low, medium
- Thickness 1”

Note: (fs) Darken surface was flame seared as a pre-treatment before testing
Melamine Foam

- Density, low, medium
- Thickness 1”
PVDF Foam

- Density, low
- Thickness 1”
Film types
FAA code compliant or approved

• PEEK (polyether ether ketone) film with nylon scrim
• Polyimide film with nylon scrim
• Non-metallized PVF (polyvinyl fluoride) film with nylon scrim
## Test Configurations

<table>
<thead>
<tr>
<th>Film</th>
<th>Fiberglass</th>
<th>Melamine</th>
<th>Polyimide</th>
<th>PVDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peek</td>
<td>Low* Medium High</td>
<td>Low Medium</td>
<td>Low Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Polyimide</td>
<td>Low Medium High</td>
<td>Low Medium</td>
<td>Low Medium</td>
<td>Low</td>
</tr>
<tr>
<td>PVF</td>
<td>Low Medium High</td>
<td>Low Medium</td>
<td>Low(fs)** Low Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

* Product density
**fs (flame seared surface – pre-treatment**
Fabrication

• Same film covering top and bottom surface
• Insulation thickness $\frac{3}{4}”$* or 1”
  – No special orientation for insulation except for Polyimide low(FS) – flame seared surface exposed to flame
• Size 12” x 24”
• Stapled around perimeter
• Sample slit at what would be the cool end approximately $1 \frac{1}{2}”$ centered and 4” from the end of the sample (allow for out-gassing)

* 2 layers at 3/8”
Test protocol

Equipment setup

| Heat Flux Calibration | Initial 1.503 Btu/Sec Sqft | Final 1.492 Btu/Sec Sqft |
| Chamber Temperature | Initial 354 °F | Final 354 °F |

Test Results

After calibration, tests performed by placing 12” x 24” x 1” samples in the test chamber. Product was exposed to radiant heat and direct flame impingement for 15 seconds as measured by placement then removal of propane ignition source onto the surface of the test sample. Upon removal of ignition source, observe sample for any after flame, burn length and melting of the test specimen.

Test Requirements

There must be no flame propagation beyond 2 inches (51 mm) to the left of the centerline of the pilot flame application. The flame time after removal of the pilot burner may not exceed 3 seconds on any specimen.

Report

Identify and describe specimen being tested
At completion of test:
- Report any shrinkage or melting of the test specimen
- Report the Burn length
- Report Extinguishing Time
Radiant panel – general test photos
Test results – Fiber glass

<table>
<thead>
<tr>
<th>Insulation</th>
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<th>Film</th>
<th>After Flame</th>
<th>Flame Propagation</th>
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</thead>
<tbody>
<tr>
<td>Fiber glass</td>
<td>Low</td>
<td>Peek</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>Low</td>
<td>Polyimide</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>Low</td>
<td>PVF</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>Medium</td>
<td>Peek</td>
<td>R</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>Medium</td>
<td>Polyimide</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>Medium</td>
<td>PVF</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Fiber glass</td>
<td>High</td>
<td>Peek</td>
<td>P</td>
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<td>High</td>
<td>PVF</td>
<td>P</td>
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</tr>
</tbody>
</table>

4-5 samples tested per configuration
Test criteria:
P = pass
R = rogue 1 failure of either after flame or flame propagation
F = fail – more than one test sample
# Test results
## Melamine Foam

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<tr>
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## Test results

### Polyimide foam

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<tr>
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<td>Low (fs)</td>
<td>PVF</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Polyimide</td>
<td>Low</td>
<td>Peek</td>
<td>P</td>
<td>P</td>
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4-5 samples tested per configuration

Test criteria:
- **P** = pass
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Test results
PVDF FR foam

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4-5 samples tested per configuration
Test criteria:
P = pass
R = rogue 1 failure of either after flame or flame propagation
F = fail – more than one test sample
Video of system failure

- Flame propagation – distance
- After flame – duration

Original screening - non-code compliant film
Video for system showing compliance

- Flame propagation – distance
- After flame - duration
General observations as required by FAA system standard
(FAR 25.856a1)

• Insulation system as designed must be tested to show compliance
  – Materials should not be substituted to show compliance
• Surface characteristics may influence system performance
  – Smooth vs rough
  – Pore size or void space – small vs large
  – Top vs bottom surface
  – Treated surface - as manufactured or treated before use
• Material reaction to elevated temperatures may influence system performance
  – Melting
  – Shrinkage or consolidation
  – Tearing
  – Adhesion/cohesion - sticky
  – Out-gassing – will or will not ignite
Limitations and concerns

- Each individual component may pass FAA test, but must be evaluated as a system; insulation, film, tape, hook & loop, etc. to assure there are no negative effect when combined.
- No one combination of materials should be used to show compliance for all configurations.
- Care should be taken if an insulation is pre-treated to ensure compliance – follow manufacturer guidelines.
  - Material orientation for use
  - Continued compliance to other requirements.
Acknowledgements

• Chase Facile
• E & H Laminating
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• Polymer Technologies
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