

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 for additional detail).

Insulation types

Insulation

- Fiber Glass
- Polyimide Foam
- Melamine Foam
- PVDF** – FR Foam

Density

Low, Medium, High

Low(FS)*, Low, Medium,

Low, Medium

Low

*FS = flame seared pretreatment

** PVDF = Poly Vinylidene Flouride

Fiber Glass

- Density, low, medium, high
- Thickness at $\frac{3}{4}$ " or 1"



Polyimide Foam

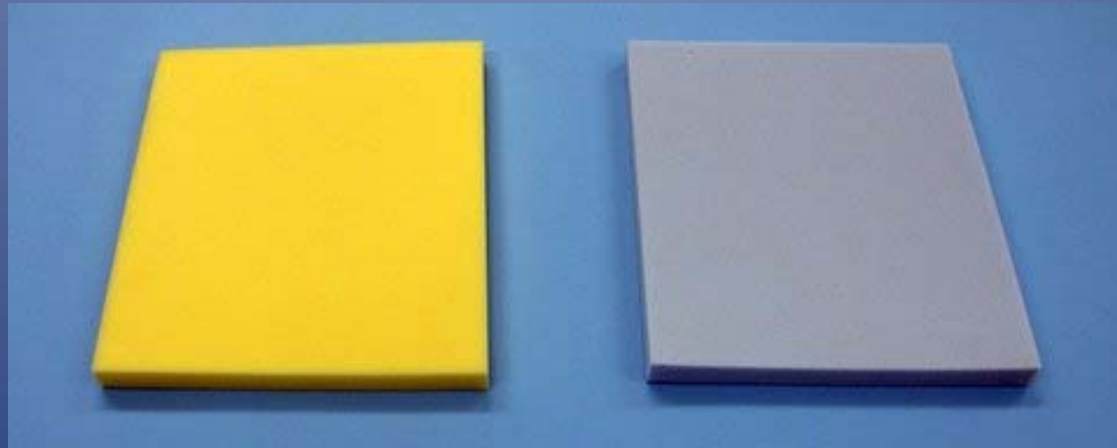
- Density low (fs), low, medium
- Thickness 1"



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

Melamine Foam

- Density, low, medium
- Thickness 1"



PVDF Foam

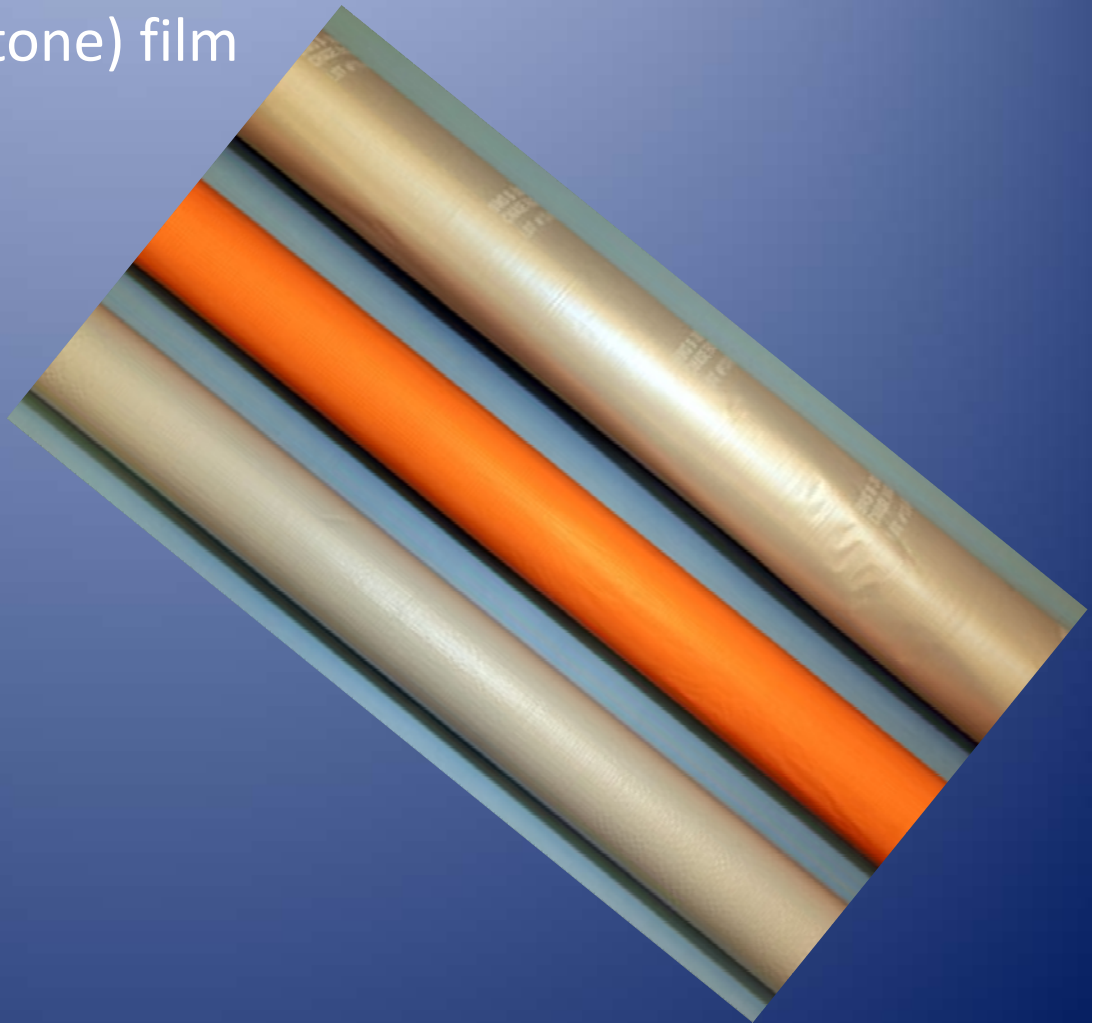
- Density, low
- Thickness 1"



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

Film	Fiberglass	Melamine	Polyimide	PVDF
Peek	Low* Medium High	Low Medium	Low Medium	Low
Polyimide	Low Medium High	Low Medium	Low Medium	Low
PVF	Low Medium High	Low Medium	Low(fs)** Low Medium	Low

* Product density

**fs (flame seared surface – pre-treatment)

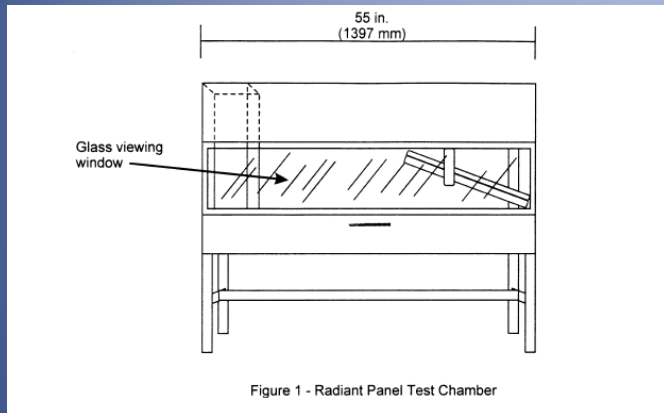
Fabrication

- 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 $\frac{3}{8}$ "

Test protocol



Equipment setup

Heat Flux Calibration
Chamber Temperature

Test Results

Initial 1.503 Btu/Sec Sqft
Initial 354 °F

Final 1.492 Btu/Sec Sqft
Final 354 °F

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

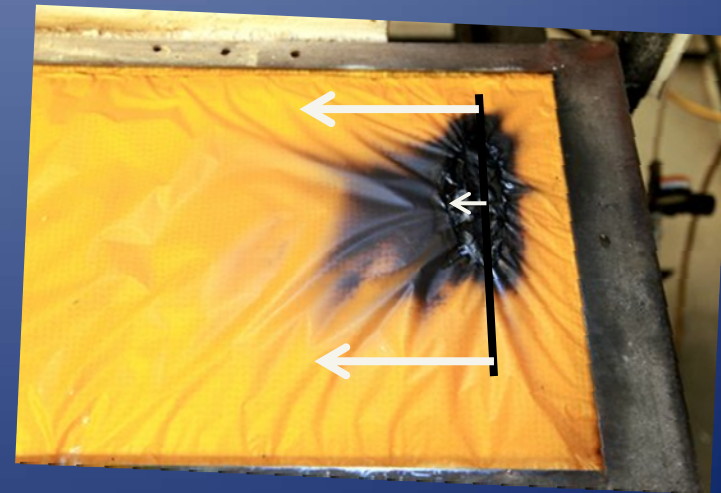
There must be no flame propagation beyond 2 inches (51 mm) to the left of the centerline of the pilot flame application. The flame time after removal of the pilot burner may not exceed 3 seconds on any specimen.

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

Insulation	Density	Film	After Flame	Flame Propagation
Fiber glass	Low	Peek	P	P
Fiber glass	Low	Polyimide	P	P
Fiber glass	Low	PVF	P	P
Fiber glass	Medium	Peek	R	P
Fiber glass	Medium	Polyimide	P	P
Fiber glass	Medium	PVF	P	P
Fiber glass	High	Peek	P	P
Fiber glass	High	Polyimide	P	P
Fiber glass	High	PVF	P	P

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

Insulation	Density	Film	After Flame	Flame Propagation
Melamine	Low	Peek	P	P
Melamine	Low	Polyimide	P	P
Melamine	Low	PVF	F	F
Melamine	Medium	Peek	P	P
Melamine	Medium	Polyimide	P	P
Melamine	Medium	PVF	P	P

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

Polyimide foam

Insulation	Density	Film	After Flame	Flame Propagation
Polyimide	Low (fs)	PVF	P	P
Polyimide	Low	Peek	P	P
Polyimide	Low	Polyimide	P	P
Polyimide	Low	PVF	F	F
Polyimide	Medium	Peek	P	P
Polyimide	Medium	Polyimide	P	P
Polyimide	Medium	PVF	P	P

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 PVDF FR foam

Insulation	Density	Film	After Flame	Flame Propagation
PVDF	Low	Peek	P	P
PVDF	Low	Polyimide	P	P
PVDF	Low	PVF	P	P

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
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