

Flame Propagation

**Product Compliance and Capability
&
Alternate Test Method**

For Non-Encapsulated Fiber Glass Insulation

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Flame propagation

Product Compliance and Capability

14 CFR 25.856 (a)



FAA test rig



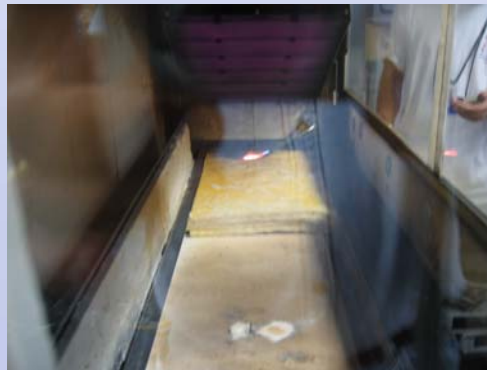
Alternate test method

Objective

- Microlite[®]AA fiber glass insulation blanket
 - Validate product meets FAA requirements
 - Demonstrate product capability
- Develop and qualify an alternate test method for use during manufacturing



Install Insulation



Test



After Test

Scope

- **Density**
 - 0.34 pcf to 1.5 pcf
- **Thickness**
 - 3/8" to 1"
- **Binder content range**
 - 10% to 20%
- **Insulation Surface**
 - Top vs bottom surface
- **Product evaluation**
 - 8 products
 - Multiple production runs (>32)
 - 6 year span



Premium .34 pcf x 1"



Standard 0.42 pcf x 1"

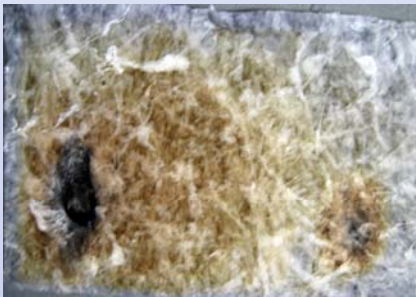


Standard 1.5 pcf x 3/8"

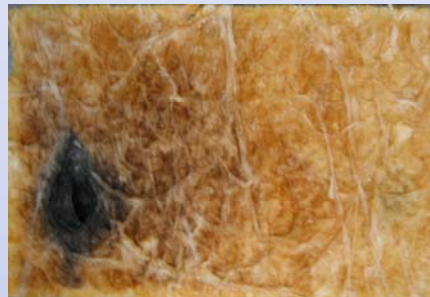
Test Results

- **Flame propagation**
- **After flame**
>200 samples tested

No failures
No failures



Pass



Pass



Pass

Test Results – Example

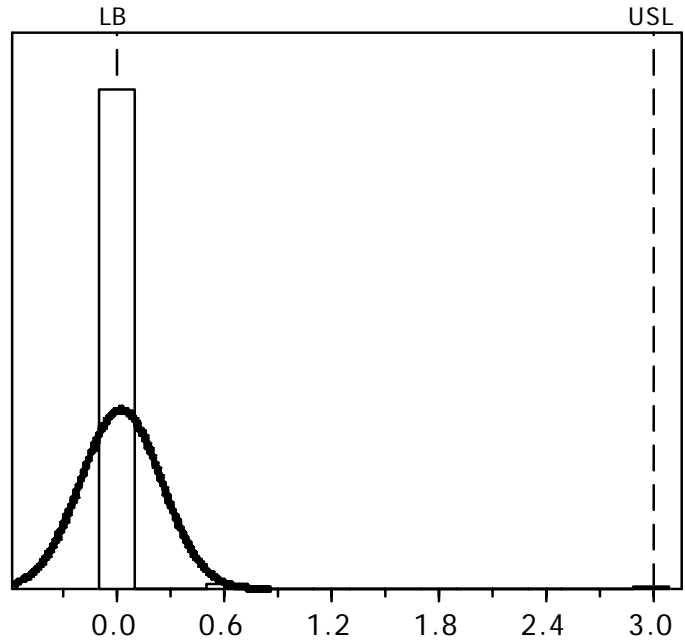
Product		Prem .34 pcf x 1"			Std 0.42 pcf x 1"			Std 1.5 pcf x 3/8"		
Sample #	Blanket Orientation	AF* (Sec)	FP (In)	R P/F	AF* (Sec)	FP (In)	R P/F	AF* (Sec)	FP (In)	R P/F
ID.		80402636			6246			90203630		
1	Top	0	0	P	0	0	P	0	0	P
2	Top	0	0	P	0	0	P	0	0	P
3	Top	0	0	P	0	0	P	0	0	P
4	Bottom	0	0	P	0	0	P	0	0	P
5	Bottom	0	0	P	0	0	P	0	0	P
6	Bottom	0	0	P	0	0	P	0	0	P
ID.		102202323			12212223 ½" thick			102212323		
1	Top	0	0	P	0	0	P	0	0	P
2	Top	0	0	P	0	0	P	0	0	P
3	Top	0	0	P	0	0	P	0	0	P
4	Bottom	0	0	P	0	0	P	0	0	P
5	Bottom	0	0	P	0	0	P	0	0	P
6	Bottom	0	0	P	0	0	P	0	0	P

AF – after flame FP- flame propagation R - results

Capability Analysis

FAA flame propagation test - After Flame - Process Capability

Process Data	
LB	0
Target	*
USL	3
Sample Mean	0.0215054
Sample N	186
StDev (Within)	0.226363
StDev (Overall)	0.225885



	Within
	Overall

Potential (Within) Capability	
Cp	*
CPL	*
CPU	4.39
Cpk	4.39

Overall Capability	
Pp	*
PPL	*
PPU	4.40
Ppk	4.40
Cpm	*

Observed Performance	
PPM < LB	0.00
PPM > USL	0.00
PPM Total	0.00

Exp. Within Performance	
PPM < LB	*
PPM > USL	0.00
PPM Total	0.00

Exp. Overall Performance	
PPM < LB	*
PPM > USL	0.00
PPM Total	0.00

Failure rate

< 1 chance in a million

Product capability - 4.40 6 sigma level

Small Scale Test Benefits

- In process test method
- Simple design/operation
- Simple/quick QA procedure
- Quick start-up
- Short test cycle



Reproducible Correlation to FAA test

Methodology

- **Establish product standards**
 - Utilizing FAA test rig
- **Develop multi-factorial design of experiment (DOE)**
 - Design samples for flame propagation testing
Key to develop new test
- **Design and build small scale radiant panel**
- **Develop & verify test parameters**
 - Establish robust test settings (2nd DOE)
 - Conduct gage R&R (Reproducibility & Repeatability)
- **Validate with FAA test rig**

Multi-Factorial DOE

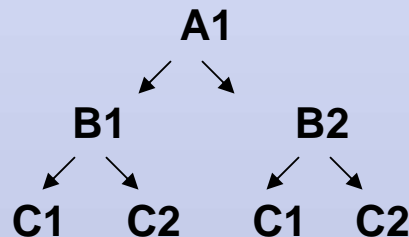
- **Design layout - 3 factor – multi-level**
- **Plant trial to produce samples**
 - Goal: Produce one product that will fail the FAA test
- **Evaluate samples at FAA**
 - Identify which samples show flame propagation and/or after flame

Multi-Factorial Design

A 1, 2, 3

B 1, 2

C 1,2



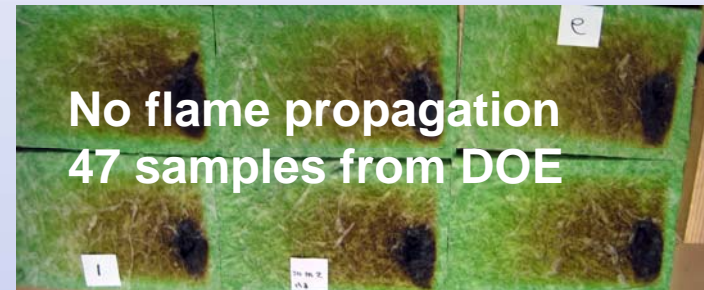
FAA Radiant Panel Tests

(Electric panel)

- Evaluate DOE samples
- Check for flame propagation
- Check for After flame

Results:

- One sample showed flame propagation
- No samples showed after flame



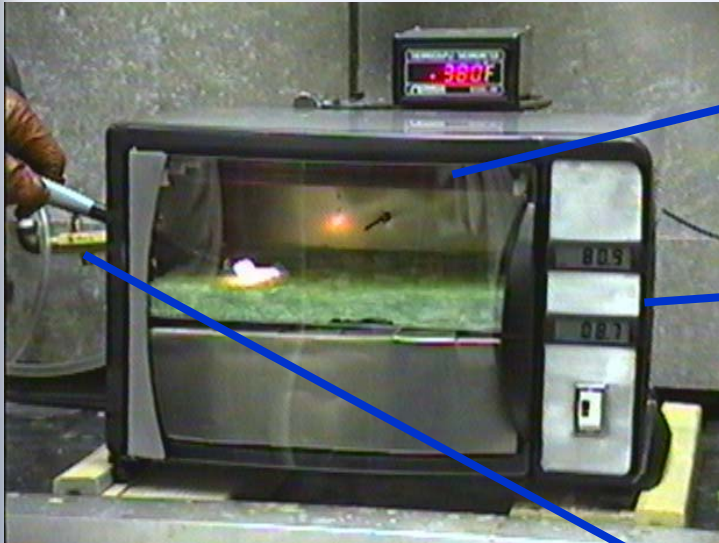
With this designed failure, small scale test method could be developed

Radiant Panel

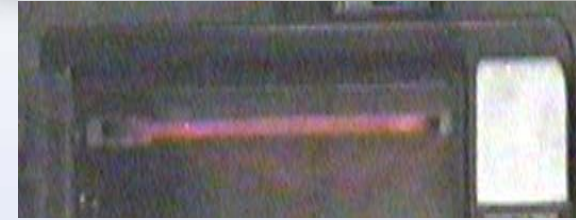
- **Small oven**
- **Large viewing window**
- **Radiant source**
 - Horizontal orientation
 - Multiple elements
 - Preset sample height



Equipment



Radiant heat



Power control



Flame source



Power Control

- **Heat flux control**
 - Constant power
 - Variable voltage regulator
 - Preset input - (voltage/amp)
- **Temperature measurement**
 - Type “K” thermocouple



Flame Source

- **Butane flame**
- **Continuous**
- **Flame length**
 - 1" to 1 ½"
- **Flame angled**
 - 20 to 30 degrees
- **Burner distance from sample**
 - ¼" - ½"



Develop Small Scale Test Parameters

- **Use FAA test rig as control**
 - Goal: Provide similar results as the FAA test
- **Establish test parameters (2nd DOE)**
 - Power setting
 - Temperature
 - Time
 - Measurement technique

Robust Test Setting

- **Settings**

- **Power settings**

- voltage & amperage

- **Temperature**

- Start temp 385F

- **Flame length**

- 1" to 1 1/2"

- **Test time**

- 7-10 seconds

>1700 tests conducted to establish robust settings

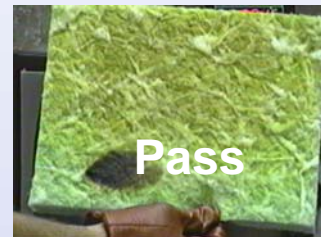
- **Results**

- **Flame propagation**

- Similar results to FAA tests

- **After Flame**

- No after flame was observed
 - Results same as FAA



Gage R&R

(Reproducibility & Repeatability)

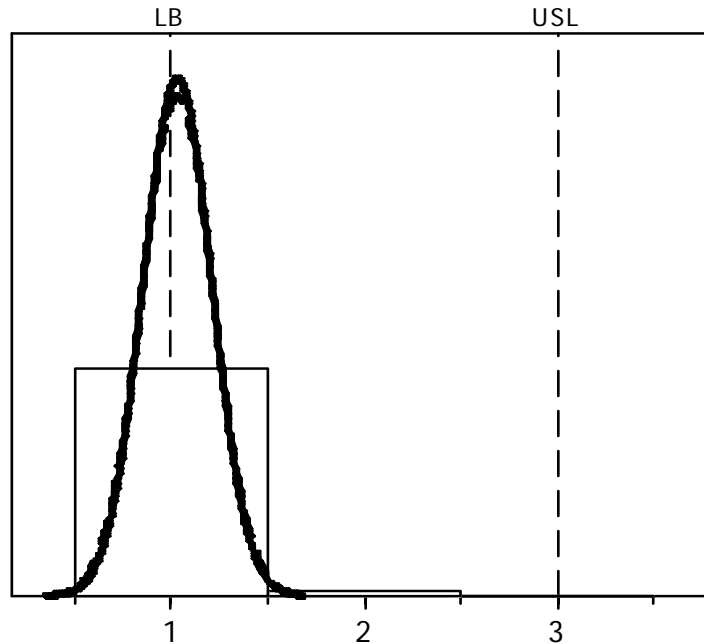
- **< 2% for Reproducibility**
 - operator factor
- **< 23% Repeatability**
 - equipment factor
- **Gage R&R was < 23%**
 - Statistical baseline gage R&R allows for process control <30%

Meets criteria for use as test method for process control

Process Capability

Small scale radiant panel

Process Data	
LB	1
Target	*
USL	3
Sample Mean	1.02822
Sample N	12615
StDev (Within)	0.178779
StDev (Overall)	0.185483



	Within
	Overall

Potential (Within) Capability	
Cp	*
CPL	*
CPU	3.68
Cpk	3.68

Overall Capability	
Pp	*
PPL	*
PPU	3.54
Ppk	3.54
Cpm	*

**Capability
6 sigma level**

Observed Performance	
PPM < LB	0.00
PPM > USL	0.00
PPM Total	0.00

Exp. Within Performance	
PPM < LB	*
PPM > USL	0.00
PPM Total	0.00

Exp. Overall Performance	
PPM < LB	*
PPM > USL	0.00
PPM Total	0.00

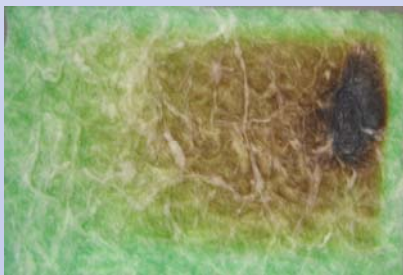
**Failure rate
< 1 in a million**

FAA and Small scale tests show the same results

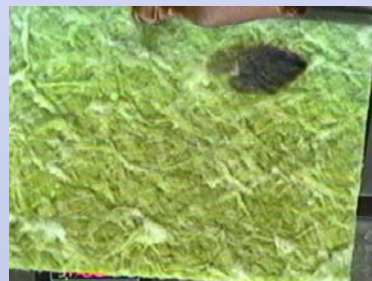
FAA radiant panel vs. Small scale test

- Results same for either method
- FAA radiant panel is primary test standard
- Small scale test method use by JM considered secondary standard
 - Small scale test acceptable for use as process monitor for testing non-encapsulated fiber glass

Pass

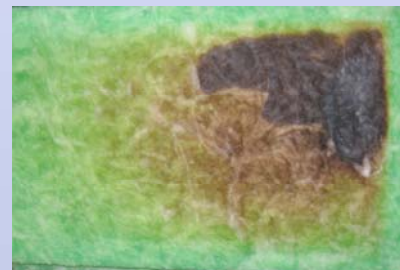


FAA

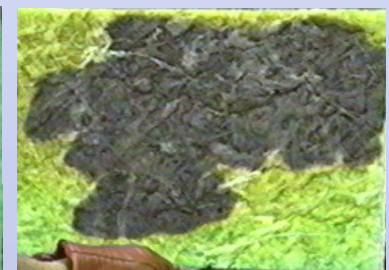


Small scale

Fail



FAA



Small scale

Summary

- **Capability analysis**

- <1 chance in a million for Microlite AA failure for after flame or flame propagation (using FAA radiant panel)

- **Certification**

- JM references FAR 25.856 (a) for un-faced or plain blankets as tested to the small scale radiant panel (periodically verified to the FAA standard)
- JM continues to certify to FAR 25.853 Appendix F part I standard for flame spread and punking

- **Product compliance**

- Small scale radiant panel as part of JM QA system (> 13,000 tests performed as process check)

- **Validation**

- Periodic comparison tests between FAA test rig and small scale test