Johns Manville

# Flame Propagation

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

**For Non-Encapsulated Fiber Glass Insulation**

**M. Shumate & J. Stacy**

# 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”**

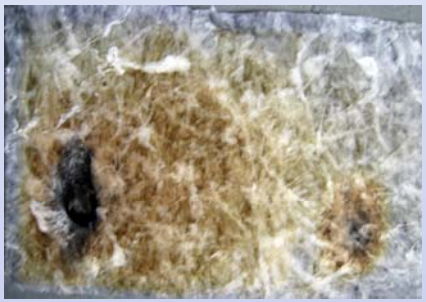
**Standard 0.42 pcf x 1”**

**Standard 1.5 pcf x 3/8”**

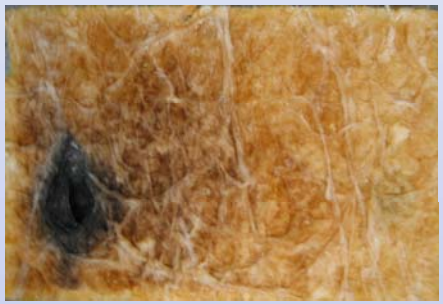
# Test Results

- **Flame propagation** — **No failures**
- **After flame** — **No failures**

**>200 samples tested**



**Pass**



**Pass**

**Pass**

***Test equipment – FAA test rig (gas & electric)***

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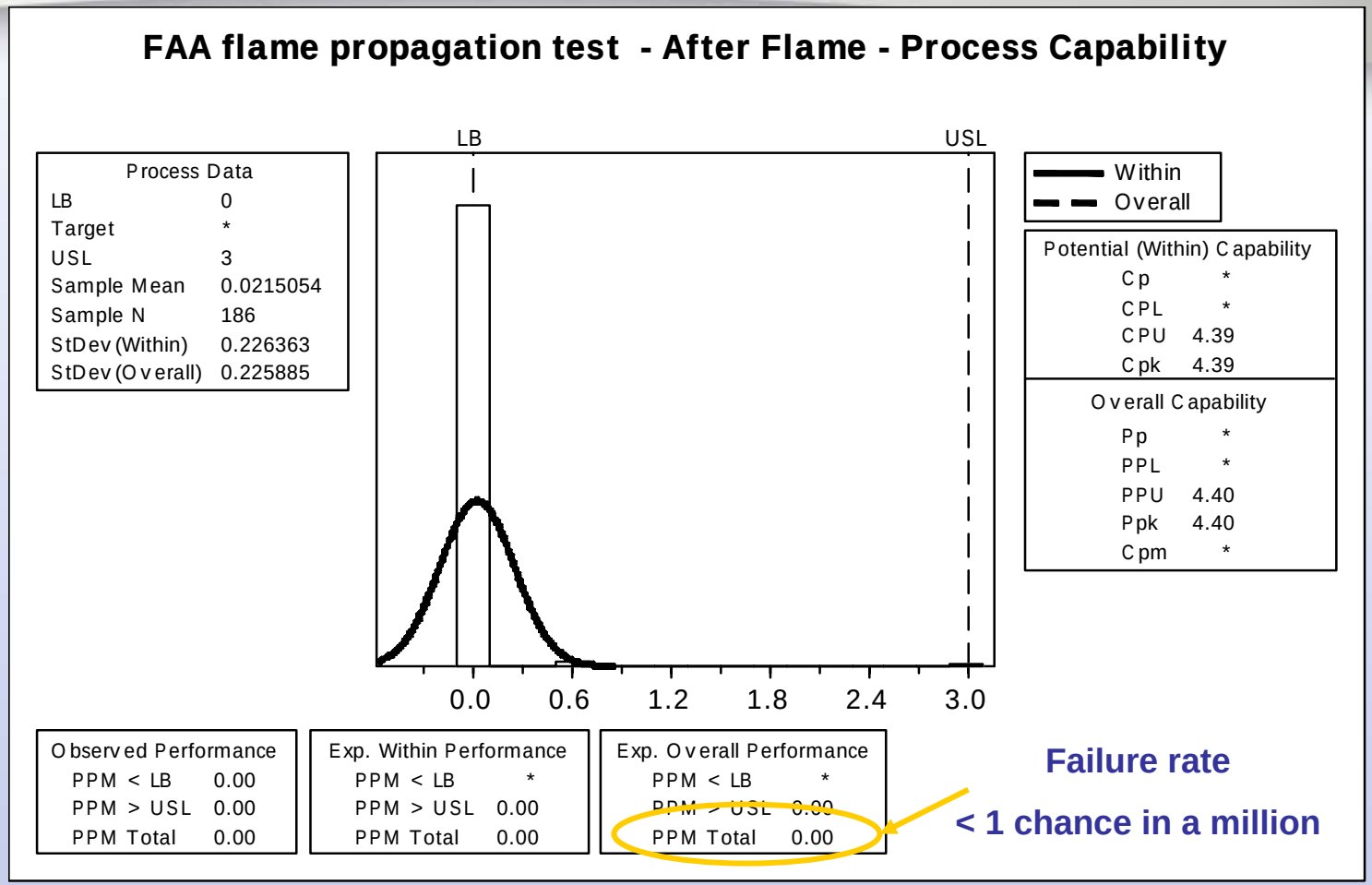
# Test Results – Example

| 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




**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

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**Reproducible Correlation to FAA test**

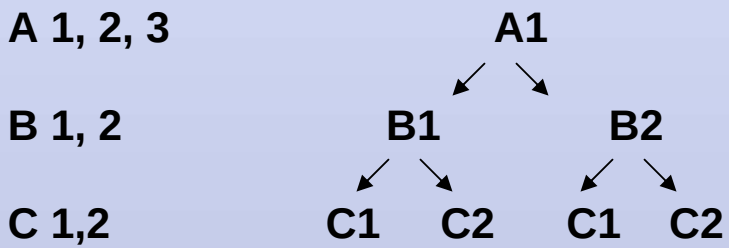
# Methodology

- **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**

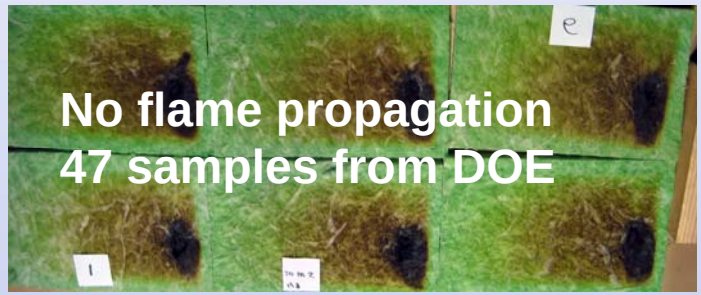


# FAA Radiant Panel Tests
(Electric panel)

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

## Results:

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



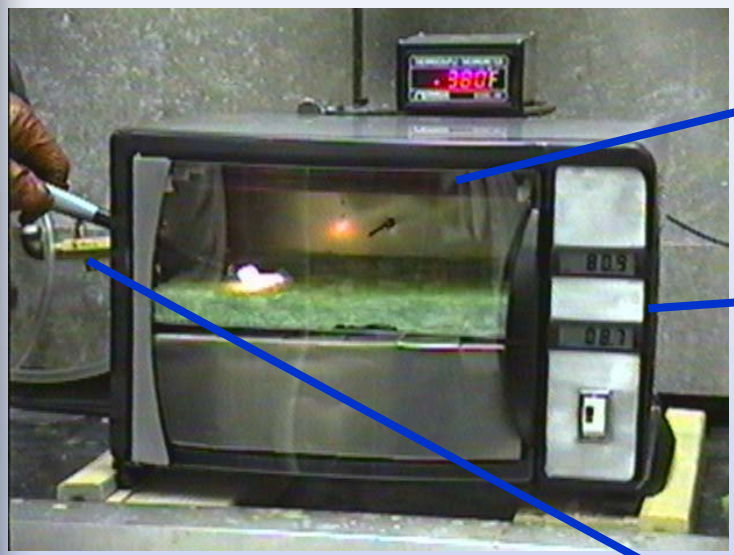


**With this designed failure, small scale test method could be developed**

# Radiant Panel

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

# Equipment



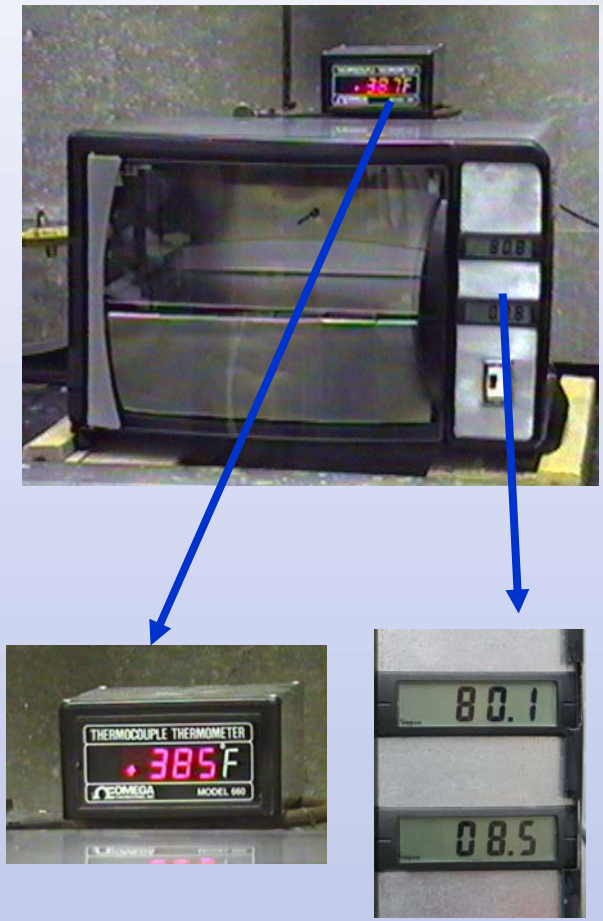

Radiant heat

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

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# Gage R&R
(Reproducibility & Repeatability)

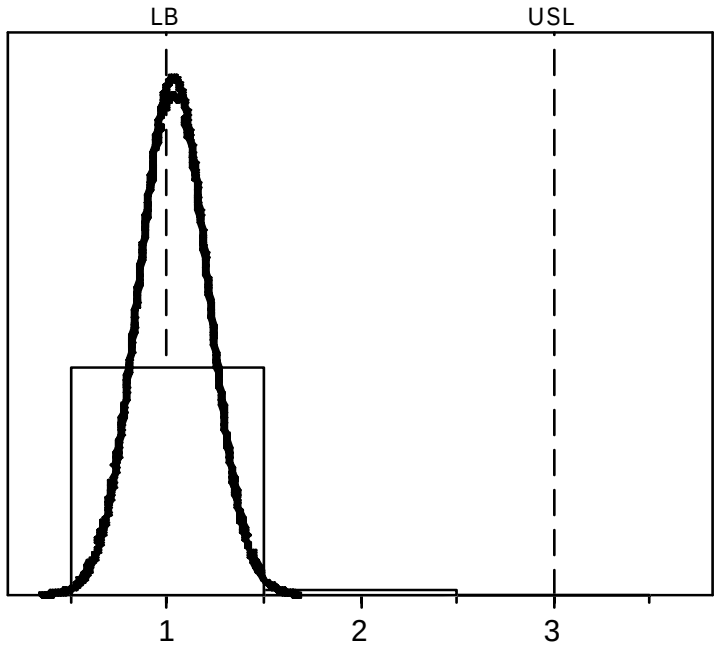
- **< 2% for Reproducibility**
  - operator factor
- **< 23% Repeatability**
  - equipment factor
- **Gage R&R was < 23%**
  - Statistical baseline gage R&R allows for process control <30%

**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 |

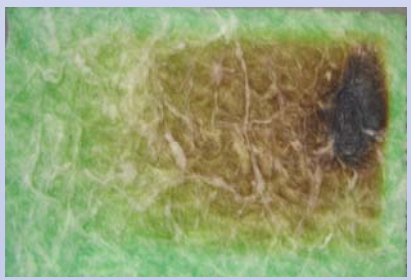
**Failure rate < 1 in a million**

**FAA and Small scale tests show the same results**

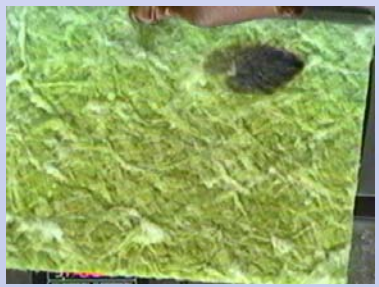
# FAA radiant panel vs. Small scale test

- **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**

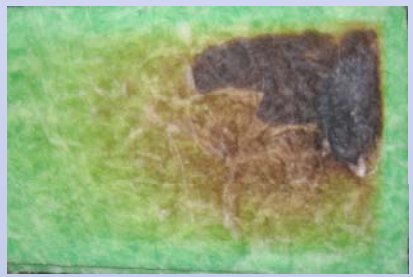


**FAA**

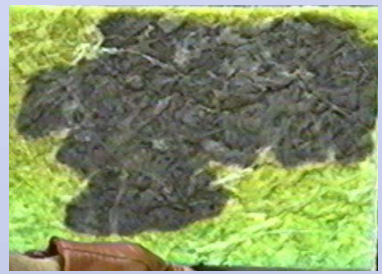


**Small scale**

**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

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