Federal Aviation Administration

International Aircraft Materials Fire Test Forum

Cargo Liner & Seat Cushion Shroud Testing, & Thermocouple Comparison

Presented to: International Aircraft Materials Fire Test Forum

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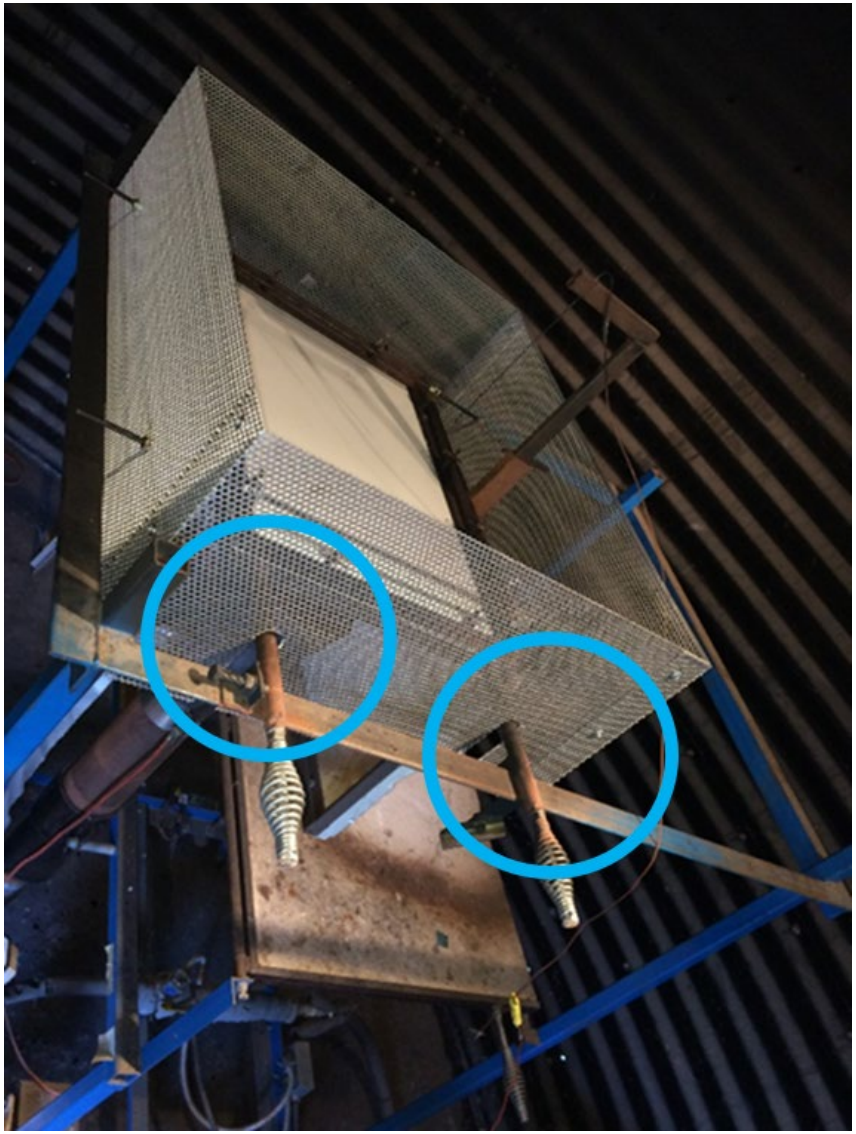
Sonic Burner Cargo Liner Test: Air Shroud Update

Background

- Where we left off since last year…
- Phase 1 of the cargo liner shroud study has been completed
- Phase 1 data indicates the shroud improves test repeatability and temperature reading stability
- No evidence of increased test severity nor elevated temperatures measured above the cargo liner sample

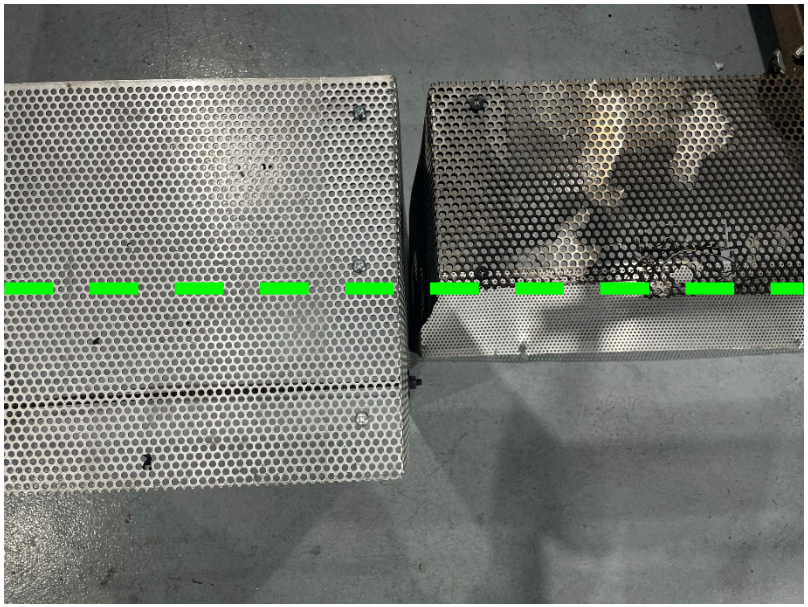
Background

- **Fitment issues in Phase 1…**
- **Portion of the shroud extending below the plain of the test sample encountered interference issues with sample frame support rigging**
- **3 labs modified the shroud to fit the sample frame support rig**
  - Test frame support design/method not defined in the test method



Background

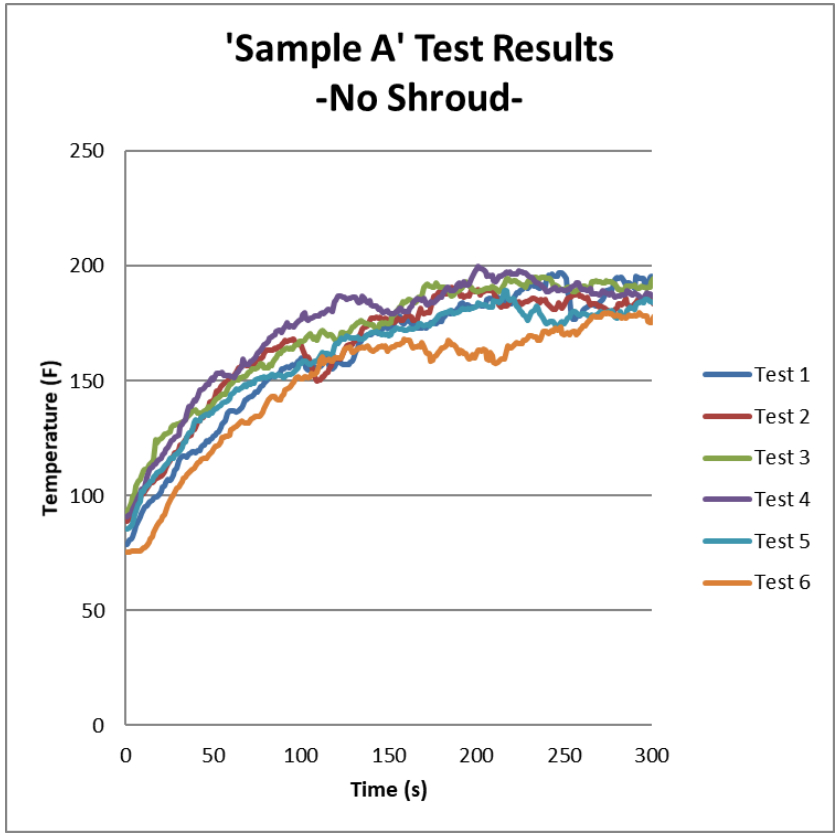
- **Result:**
  - Remove bottom portion of shroud
    - Overall height trimmed from 12” to 7” height
- **Concern**
  - Modified shroud may not perform as intended compared to original shroud
- **Confirmation:**
  - Run comparison tests with, and without shroud, using two different cargo liner sample types to confirm

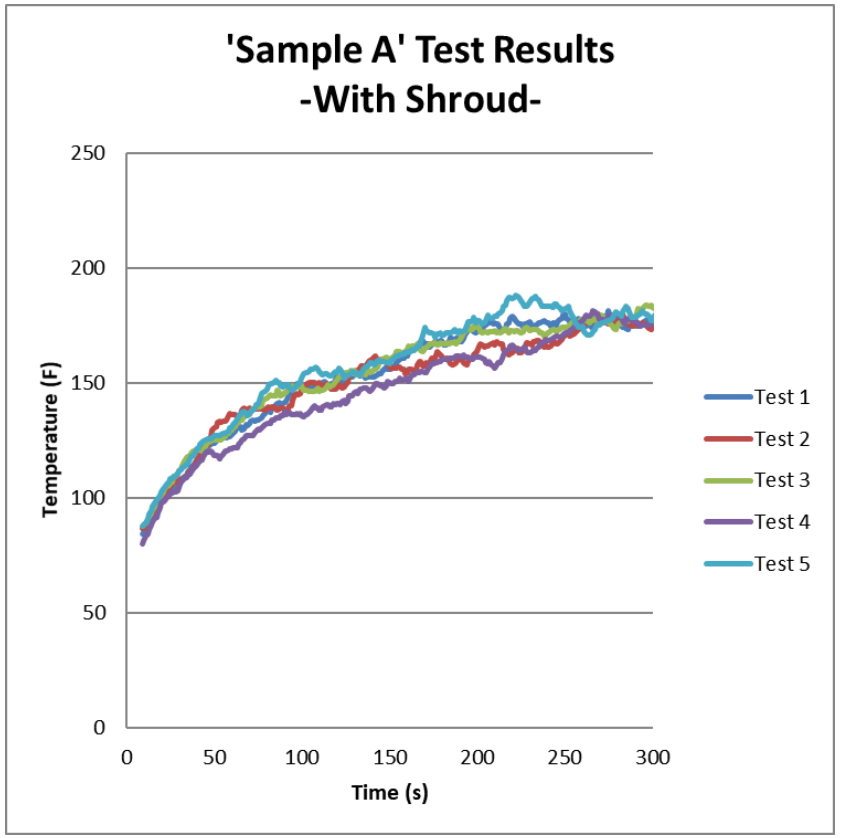


Cargo Liner Samples Tested

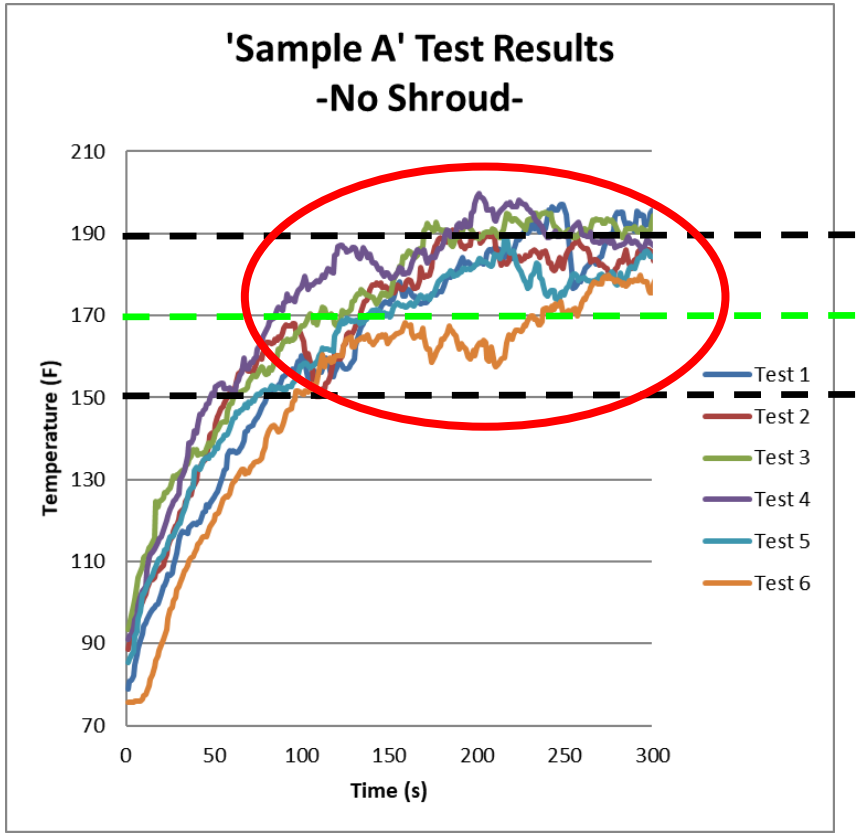
- **‘Sample A’**
  - Heavy woven fiberglass and polyester resin
  - 5 test samples **without shroud**
  - 5 test samples **with shroud**
- **‘Sample B’**
  - Thin woven fiberglass/polyester with Tedlar coating
  - 5 test samples **without shroud**
  - 5 test samples **with shroud**

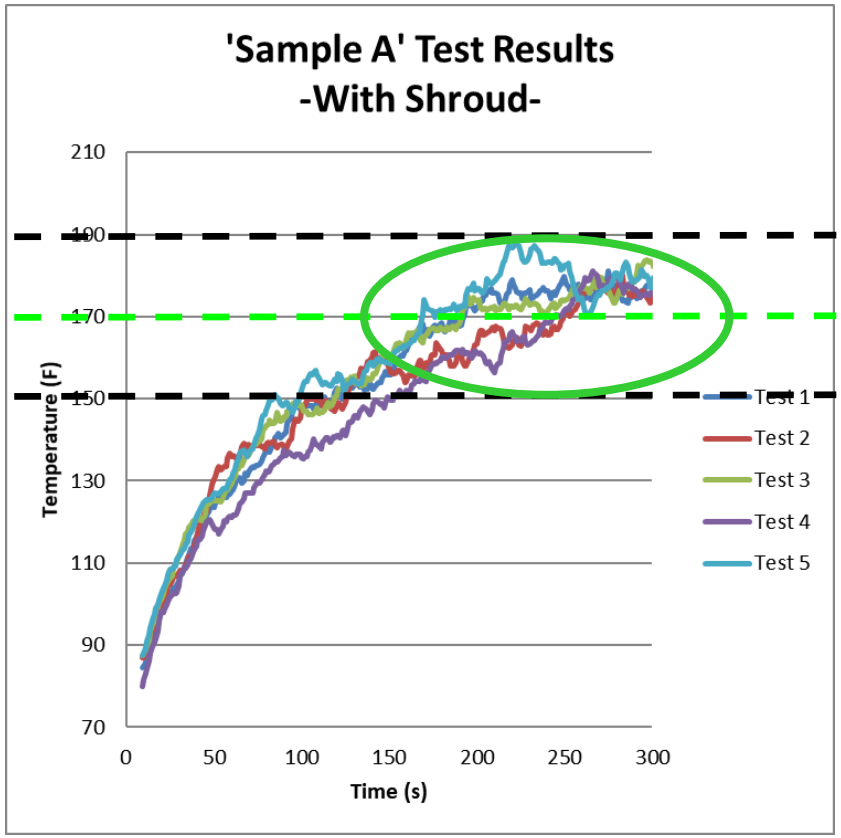
‘Sample A’ Test Results





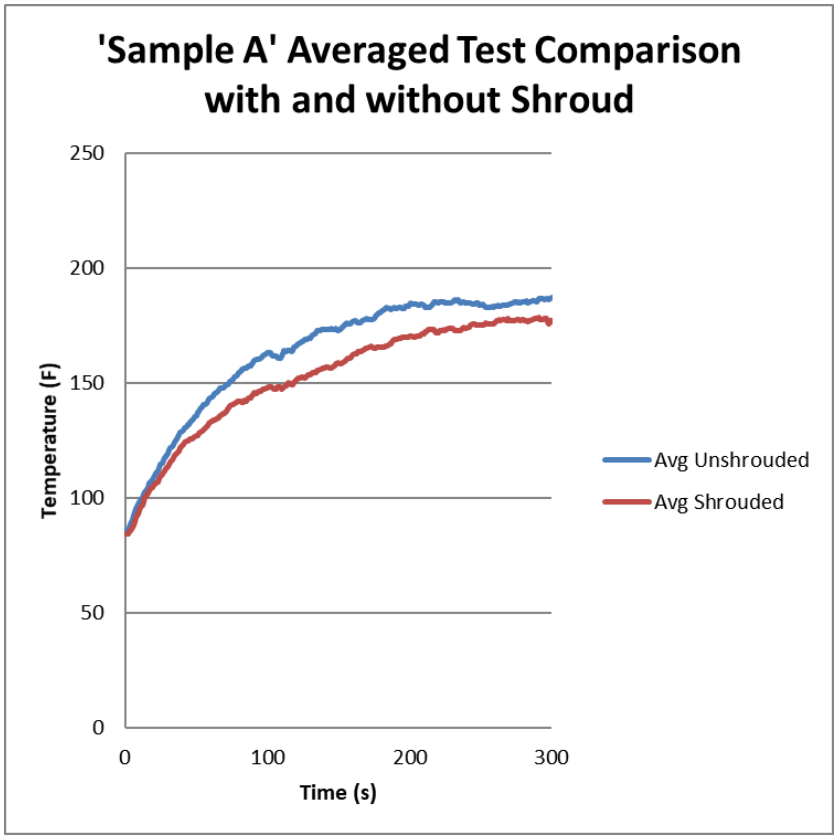
‘Sample A’ Test Results



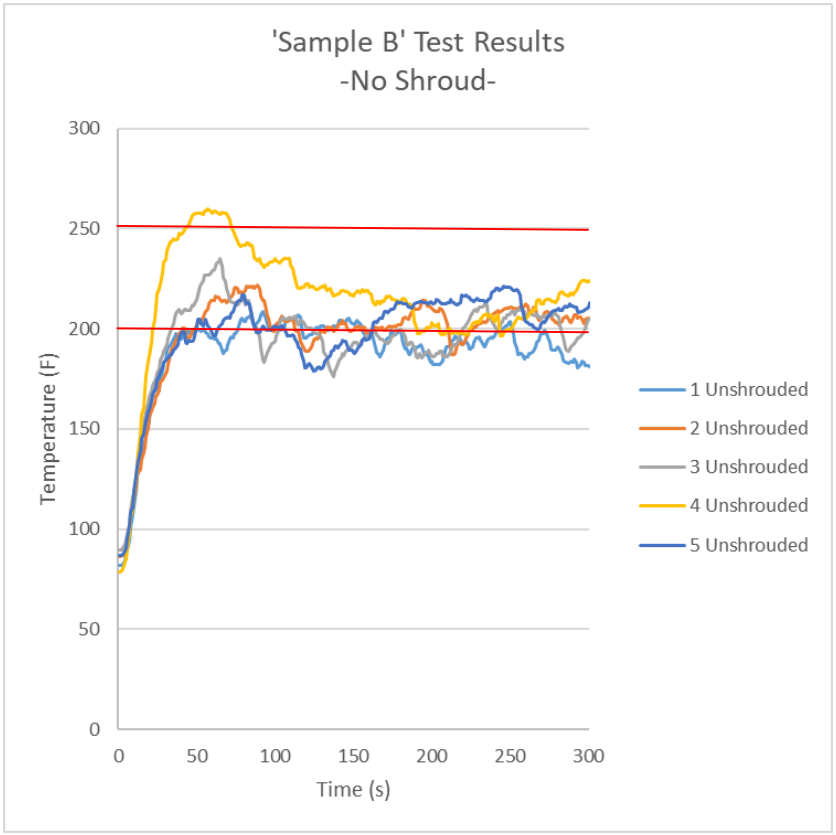


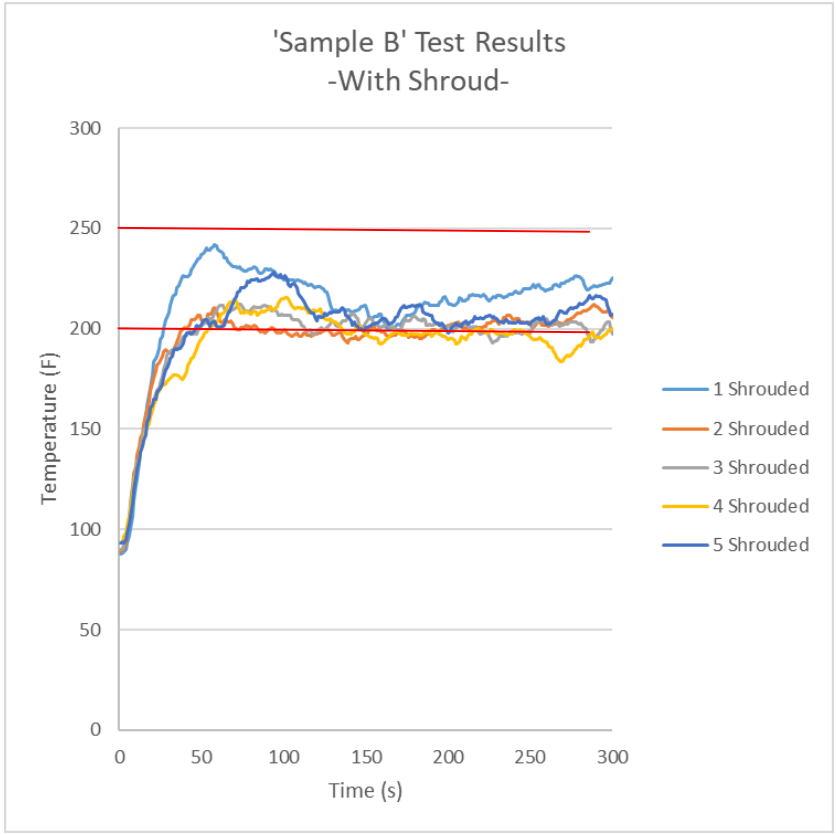
‘Sample A’ Test Results

- **<u>With</u> Shroud:**
  - Reduced peak temperatures
  - Increased test repeatability
  - Reduced ‘noise’ in data

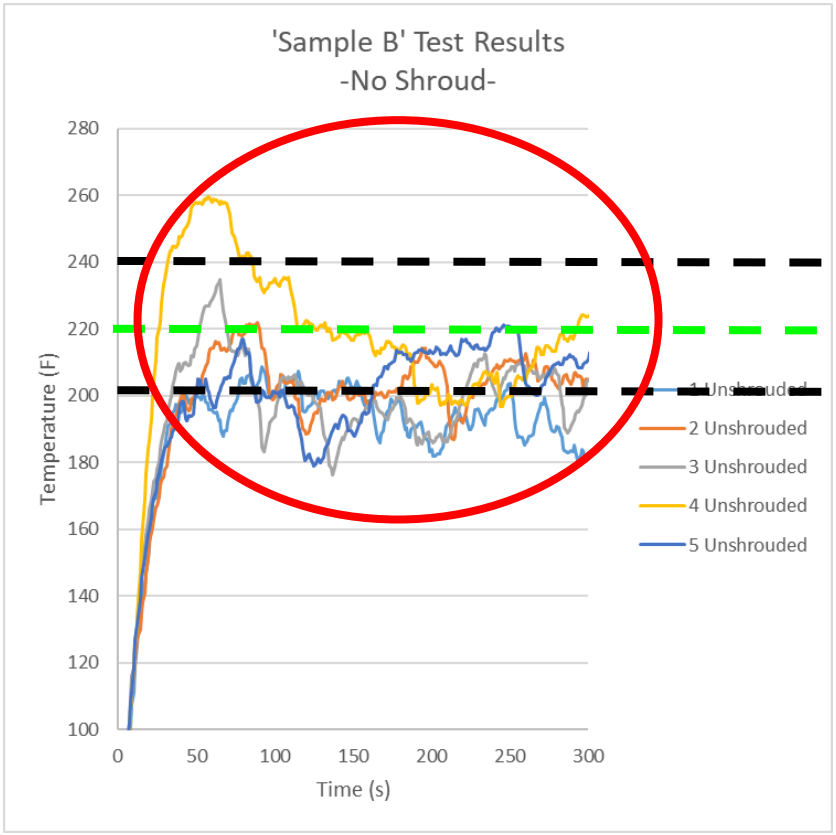


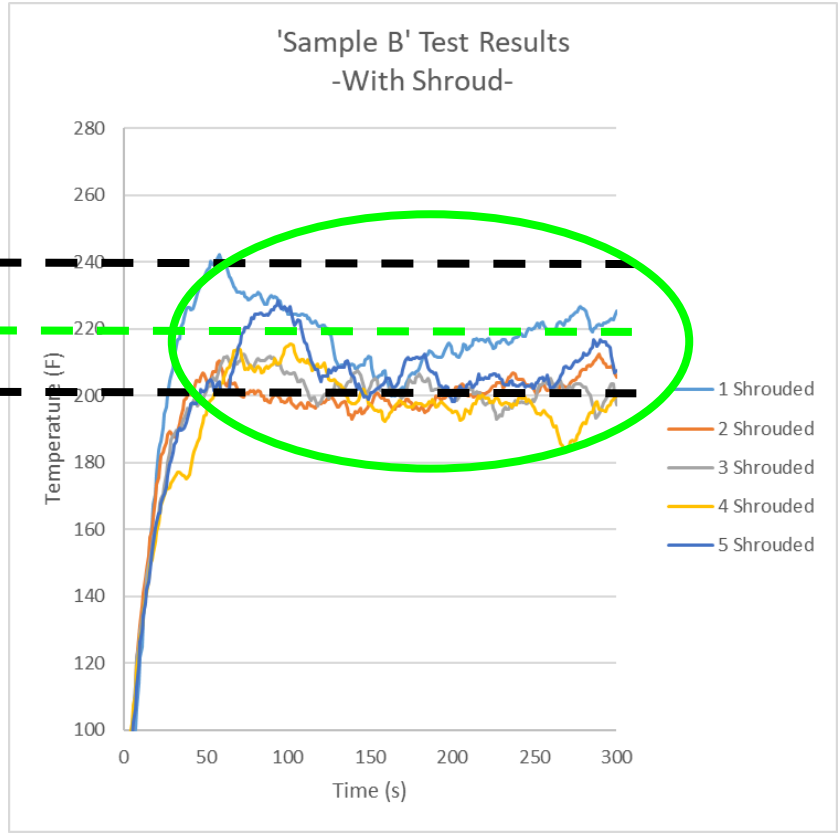
‘Sample B’ Test Results





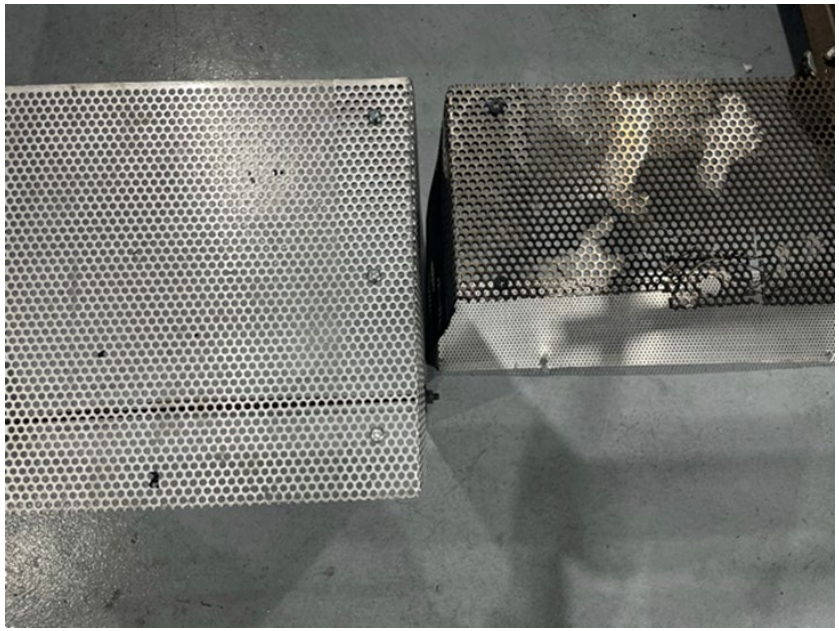
‘Sample B’ Test Results





Cargo Shroud Study: Phase 2

- **Repeat testing as in Phase 1 using modified shroud design**
- **Samples and shroud supplied to participants if necessary**
  - Modify shroud from ‘Phase 1’, if possible
- **Tighter control in Phase 2**
  - Greater detail for equipment used, ambient conditions, etc.
- **More consistent results with supplied test samples**
  - 2 different liner types used in phase 1 due to low stock of sample material



Sonic Burner Seat Cushion Test: Air Shroud Update

Seat Cushion Shroud Study

- Adapted cargo liner air shroud to fit seat cushion test method
- Planning interlab study for seat cushion shroud
- Delays of obtaining seat test samples for study

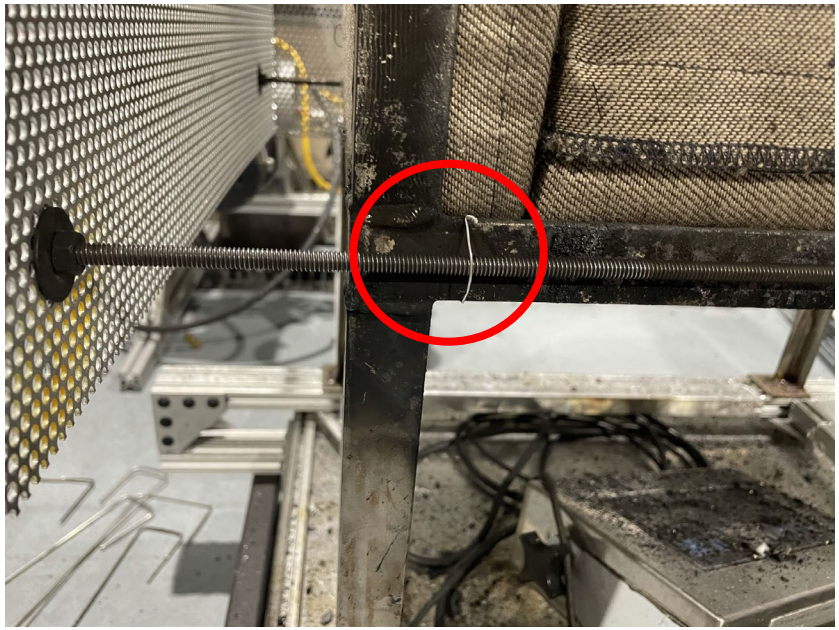
Seat Cushion Shroud Study

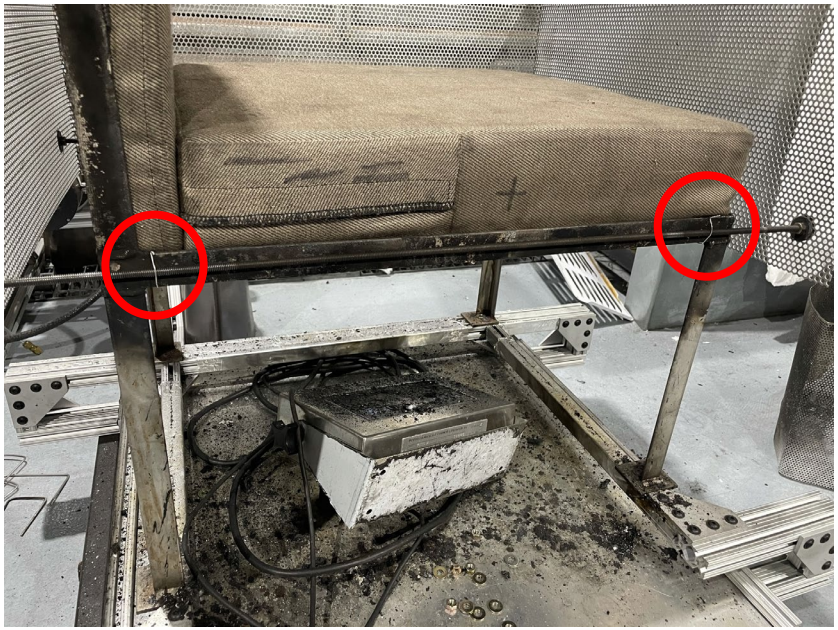
- **Same purpose as cargo shroud**
  - Reduced influence of air currents
- **Modified cargo shroud design**
  - Shroud on three sides
  - Open on flame side
  - Does not interfere with sample mounting
  - No frame modifications
  - Proven FAA TC results

Seat Cushion Shroud Study

- Currently, ready to launch interlab seat shroud study
- Comparison testing performed at FAA Technical Center
- Data confirms air shroud increases test repeatability

Seat Cushion Shroud Study



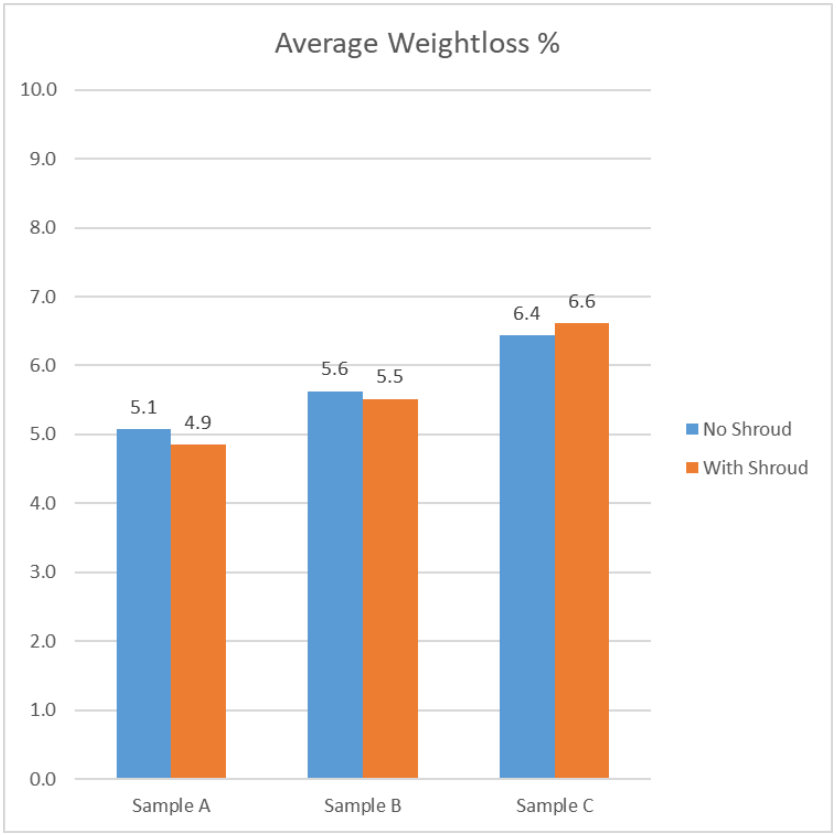


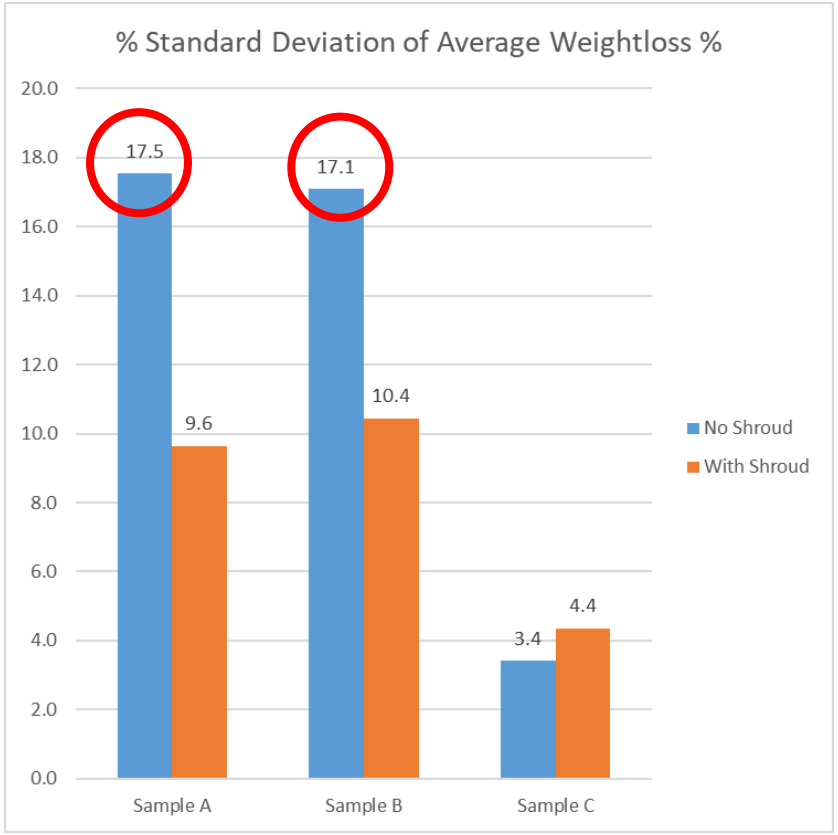
Seat Cushion Samples Tested

- **Sample A**
  - Fire blocked polyurethane foam
- **Sample B**
  - Fire hardened foam type 1 (Airflex)
- **Sample C**
  - Fire hardened foam type 2 (Dax)

- **3 of each sample type test without shroud**
- **3 of each sample type tested with shroud**
- **All samples have identical dress coverings**

Weight Loss Comparison





Seat Air Shroud

- **Interlab Study**
  - 3 sample foam types with 3 of each foam type provided to each participating lab
  - Same dress covers for all samples
  - Shroud provided with assembly and sample fire test instructions
  - No modifications to seat test frame are needed
  - Looking for participants willing to return data in a timely manner

Thermocouple Comparison Study

Background

- **Study driven by issues with thermocouple degradation and decreased temperature readings after heat cycling in the burner flame**
- **Determine if there is a more robust alternative while retaining functionality and economically practical**
- **Search for alternative TC types and/or sheathing materials**

Background

- **Standard TC used for burner flame measurement is 1/8” diameter, stainless steel sheathed, K-type**
  - Rated for approximately ~1900 F
- **N-type thermocouples similar to K-types**
  - Voltage output, temperature range, cost
  - Rated closer to ~2300 F
- **N-type TCs designed to be slightly more resistant to degradation and experience less temperature drift than K-type**

Background

- **Researched into R and S thermocouple types rated to withstand significantly higher temperatures**
  - Rated for close to ~2900 F
- **Cost of materials to construct these TCs 10x or more the cost of K-type TCs**
  - Platinum-rhodium
- **High price makes these TCs impractical for use with the oil burner application**

Thermocouple Comparison

- **K-type thermocouples**
  - 7 count
  - 1/8” diameter
  - 18” length
  - Pyrosil sheathed
  - (rated for ~2300F)

  - N-type thermocouples
  - 7 count
  - 1/8” diameter
  - 18” length
  - Pyrosil sheathed
  - (rated for ~2300F)

TC Pre-Testing Procedures

- **Computer data acquisition software calibrated using handheld millivolt generator for both N-type and K-type thermocouples to ensure accuracy**

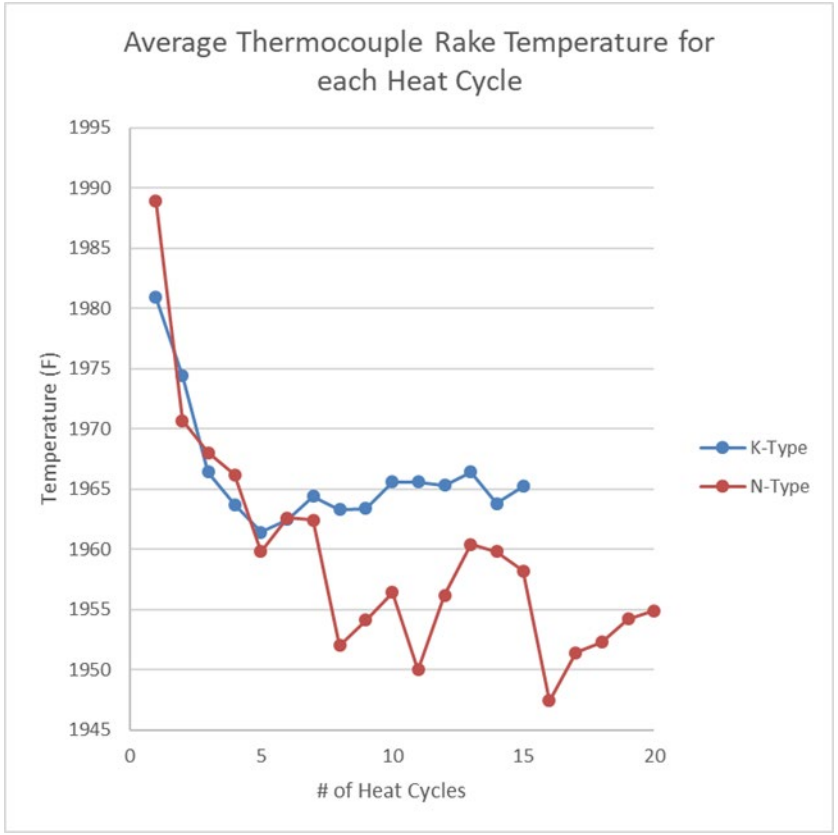
- **Heat cycled SS sheath K-type TCs used as initial baseline**

TC Testing Procedures

- New thermocouples mounted in 7 TC rake and aligned to burner
- Burner warm-up for 2 minutes
- Expose TC rake to burner flame for 1 minute
- Average TC temperature reading recorded once a second every second for 30 seconds
- Turn off burner and move TC rake to standby position
- Allow TC rake to cool for 5 minutes, or until all TC readings are below 90° F
- Repeat TC rake heat cycling procedure until temperature readings stop decreasing and level off
- Remove K-type TCs and install N-type TCs
- Repeat heat cycling procedures in same manner

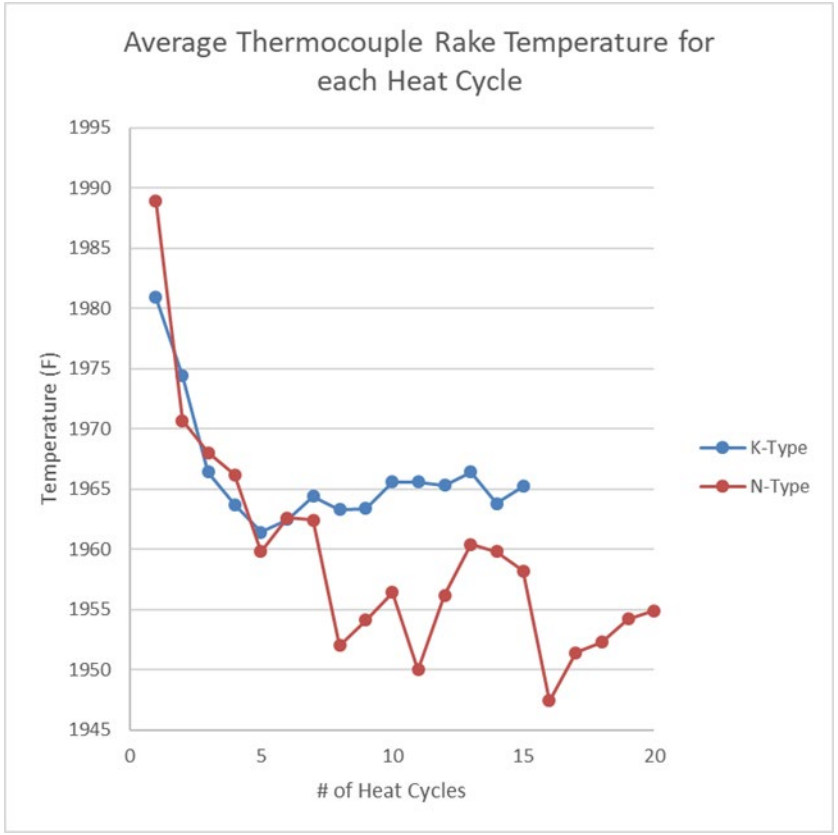
K-Type Test Results

- **K-type TC reads lower initial temperatures**
- **Temperature drops from 1989° to 1961°F**
- **Temperature remains relatively constant after 6 heat cycles**



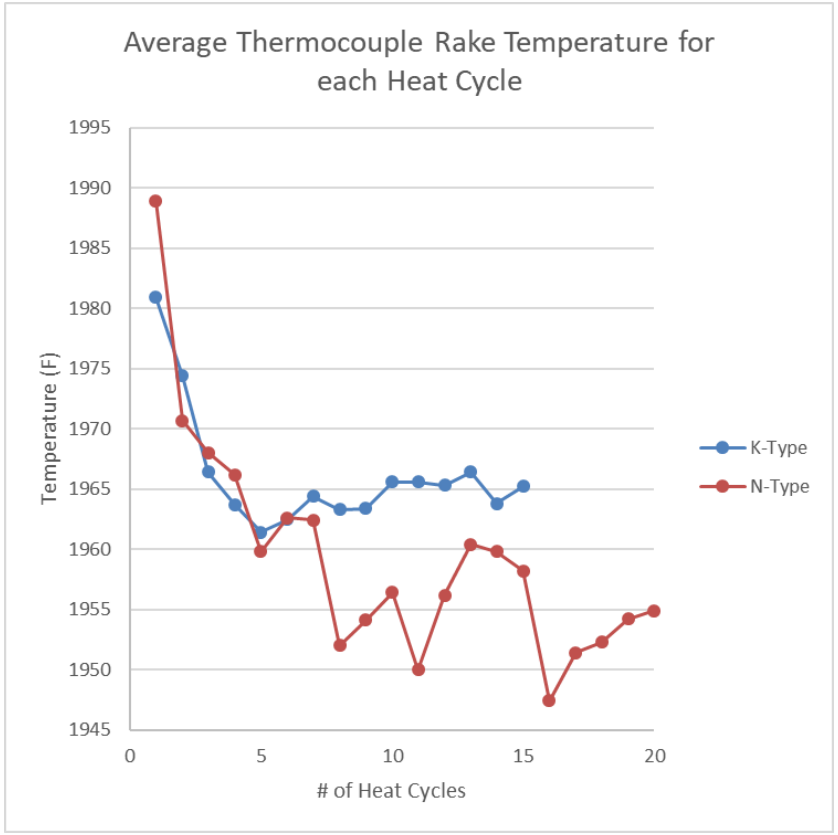
N-Type Test Results

- N-type reads higher initial temperatures
- Temperature drops from 1989°F to 1947°F
- Temperature drop less extreme after about 6 cycles
- Temperature appears to stop decreasing by 20 heat cycles



Comparison Results

- **K-types appear to be more resistant to temperature drift than N-types**
  - Unexpected result
- **Less temperature drop after heat cycling for K-type TCs**
- **More erratic readings using N-type TCs after heat cycling**
- **K-type outperforms N-type TCs in resisting temperature drift**



Final Notes

- N-type thermocouples did not appear to resist temperature degradation compared to K-type thermocouples
- Heat cycling did not appear to impact the response tie of the thermocouples
- Sheathing material seems to improve resistance to temperature drift compared to stainless steel sheathing

Questions or interest in participating with interlab studies

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