Tenth Triennial International Aircraft Fire and Cabin Safety Research Conference

Cargo Liner & Seat Cushion Shroud Testing, & Thermocouple Comparison

Presented to: 2022 Triennial Attendees

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Date: October 17-20, 2022

Federal Aviation Administration

Sonic Burner Cargo Liner Test: Air Shroud Update

Background

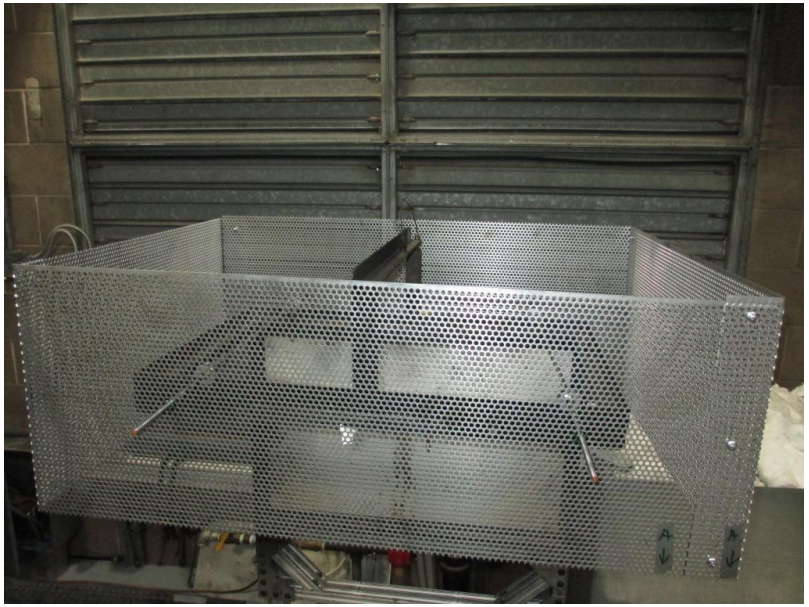
- **Where we left off since last meeting…**
- **Phase 1 of the cargo liner shroud study has been completed**
- **Phase 1 data indicated the shroud may improve test repeatability and temperature reading stability**
- **No obvious evidence of increased test severity nor elevated temperatures measured above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

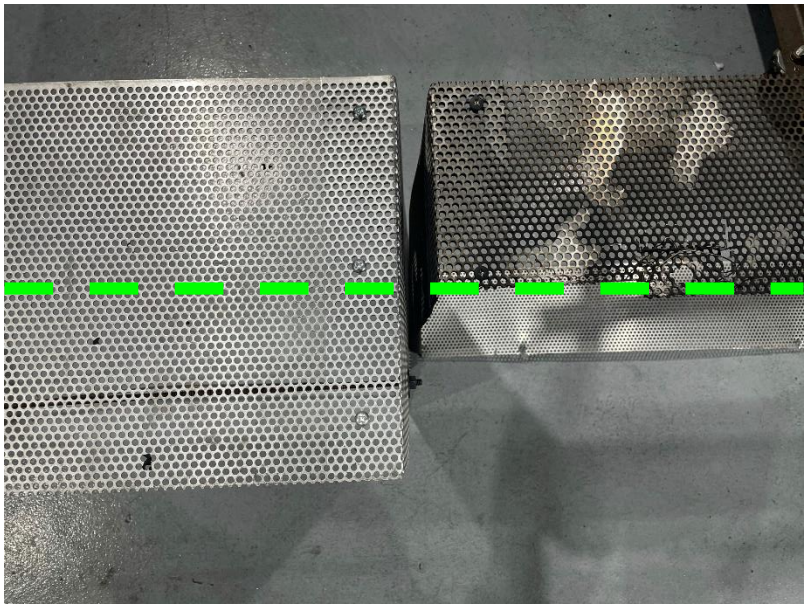
Background

- **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 shroud still functions as intended

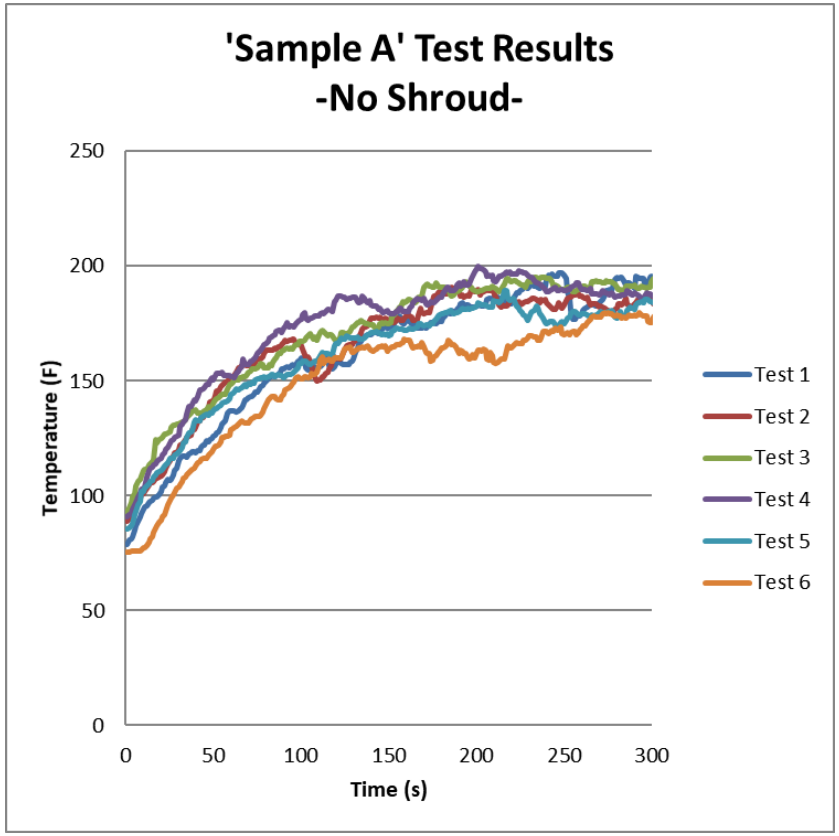


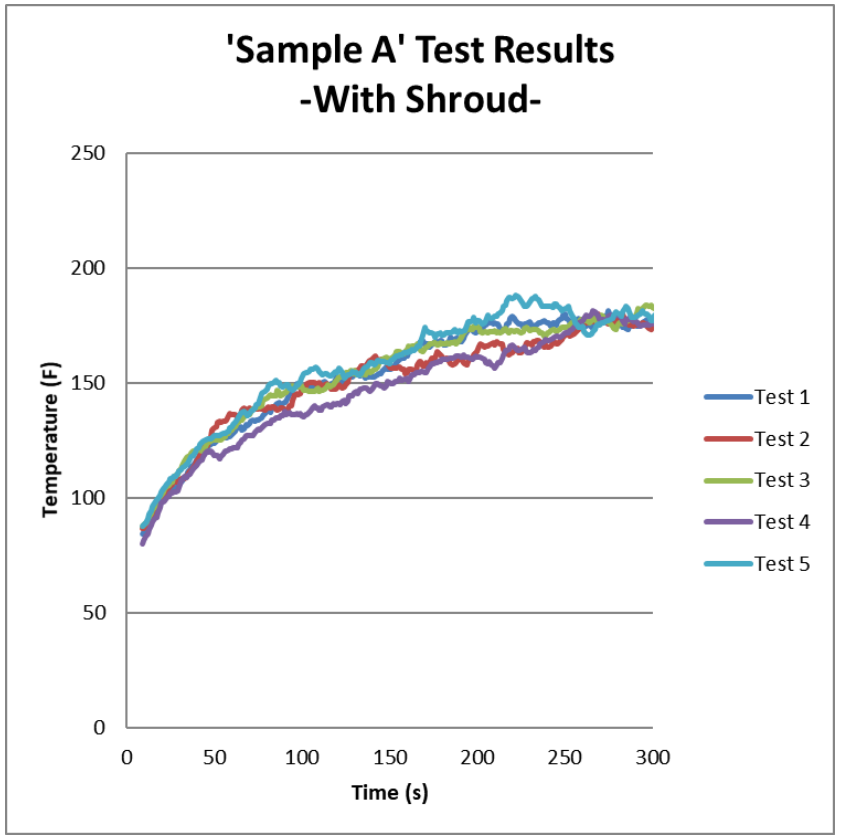


Cargo Liner Samples Tested

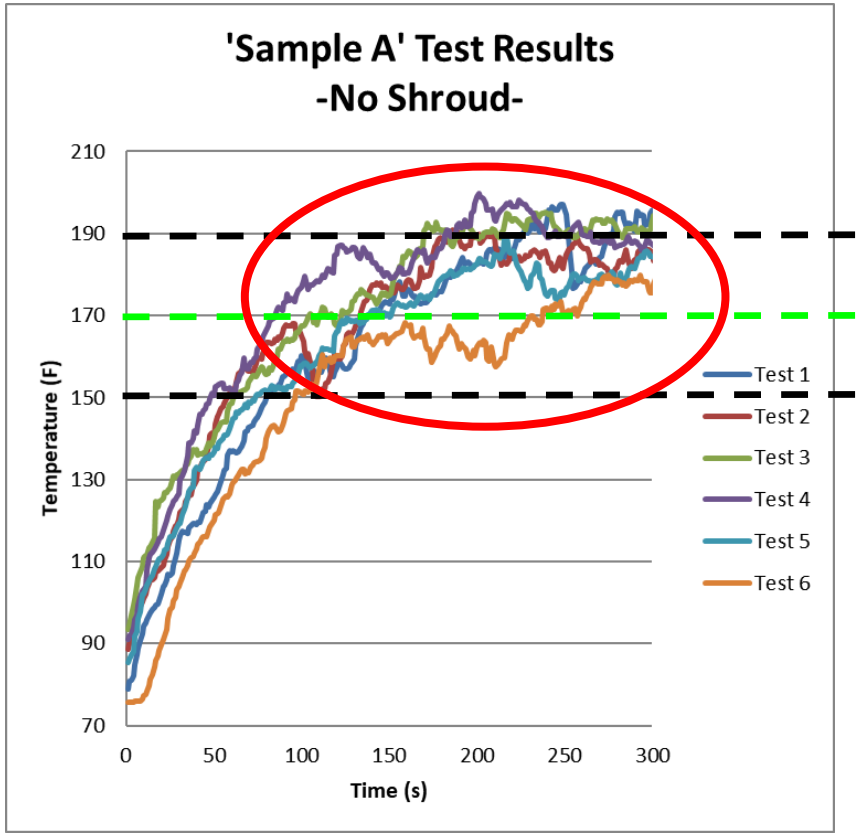
- **‘Sample A’**
  - Heavy woven fiberglass and polyester resin
  - 5 test samples **without shroud**
  - 5 test samples **with shroud**
- **‘Sample B’**
  - Thin woven fiberglass/polyester with Tedlar coating
  - 5 test samples **without shroud**
  - 5 test samples **with shroud**

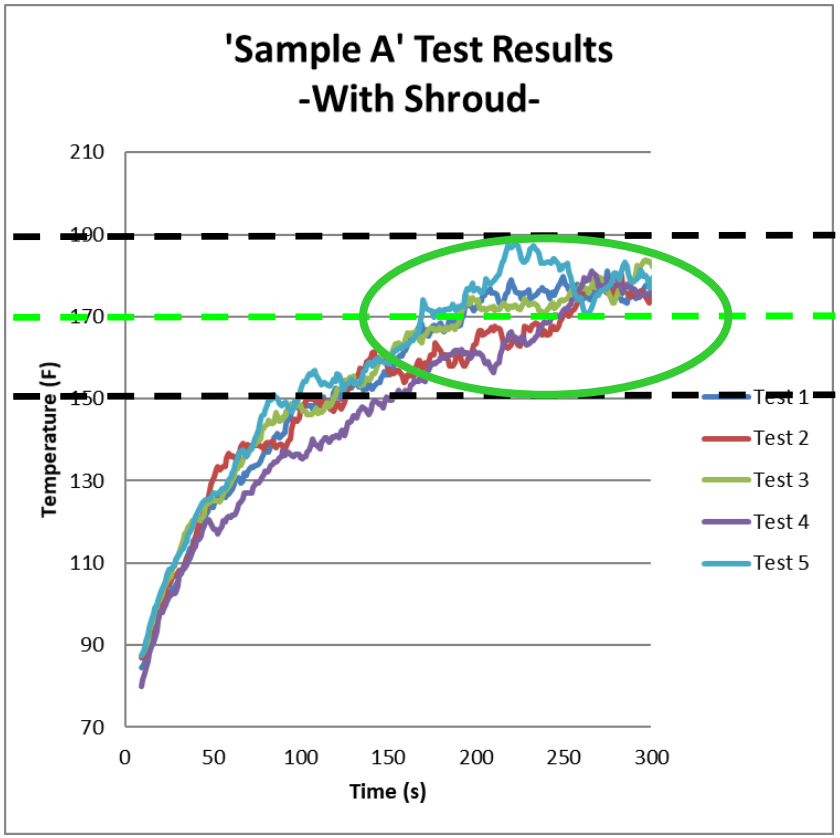
‘Sample A’ Test Results





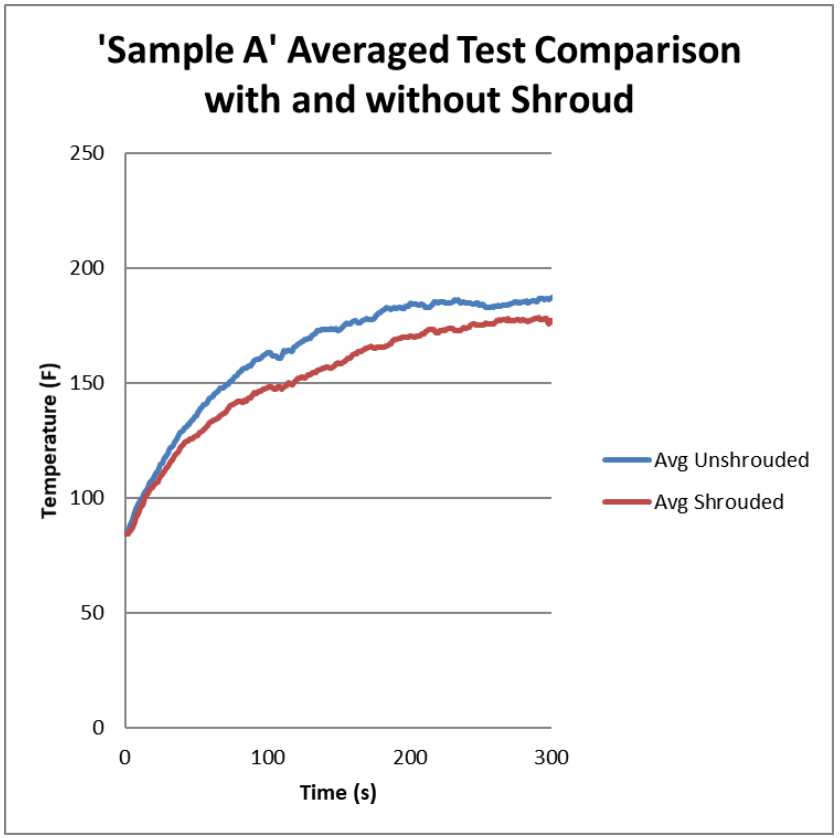
‘Sample A’ Test Results



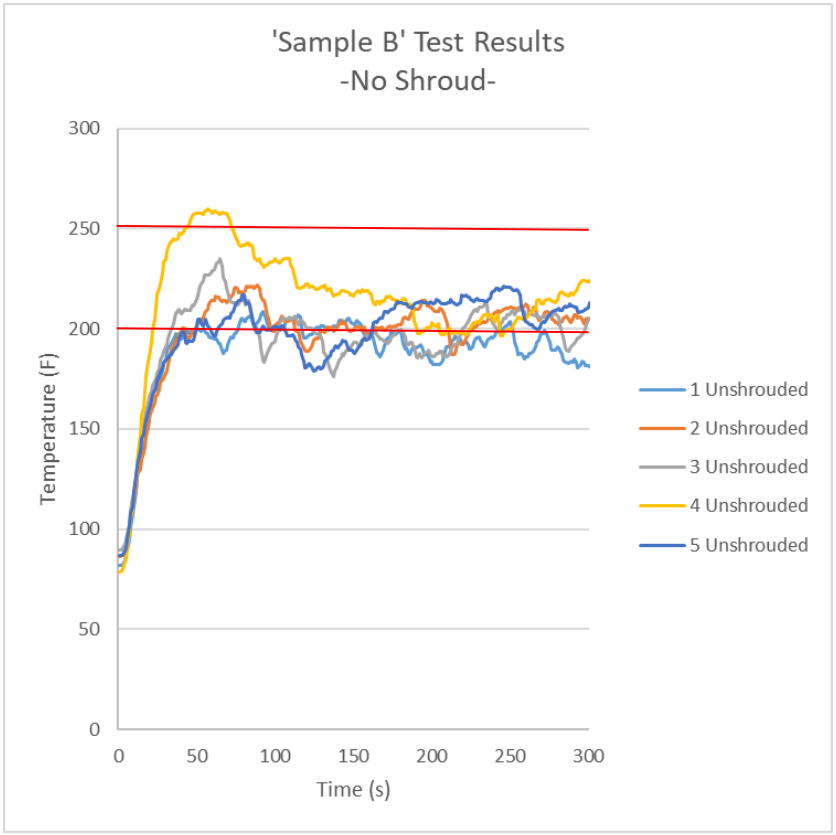


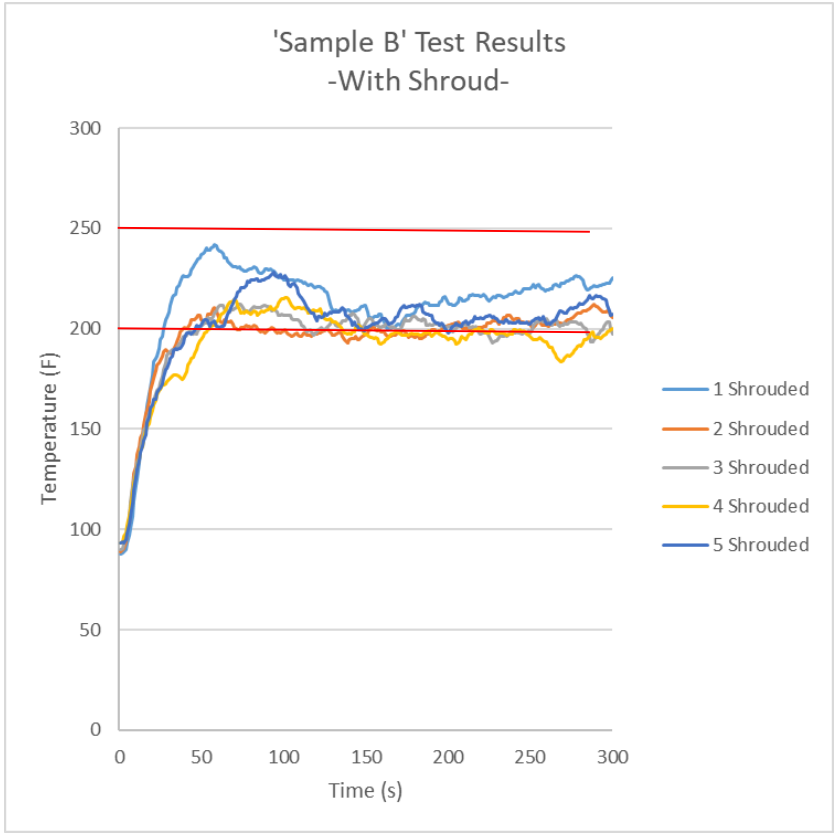
‘Sample A’ Test Results

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

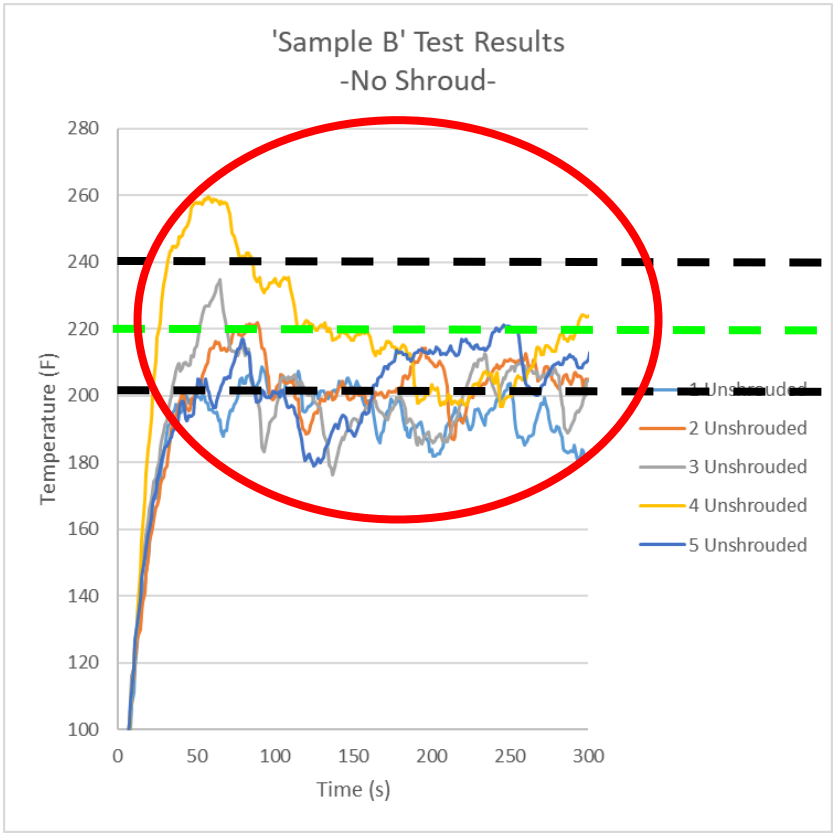


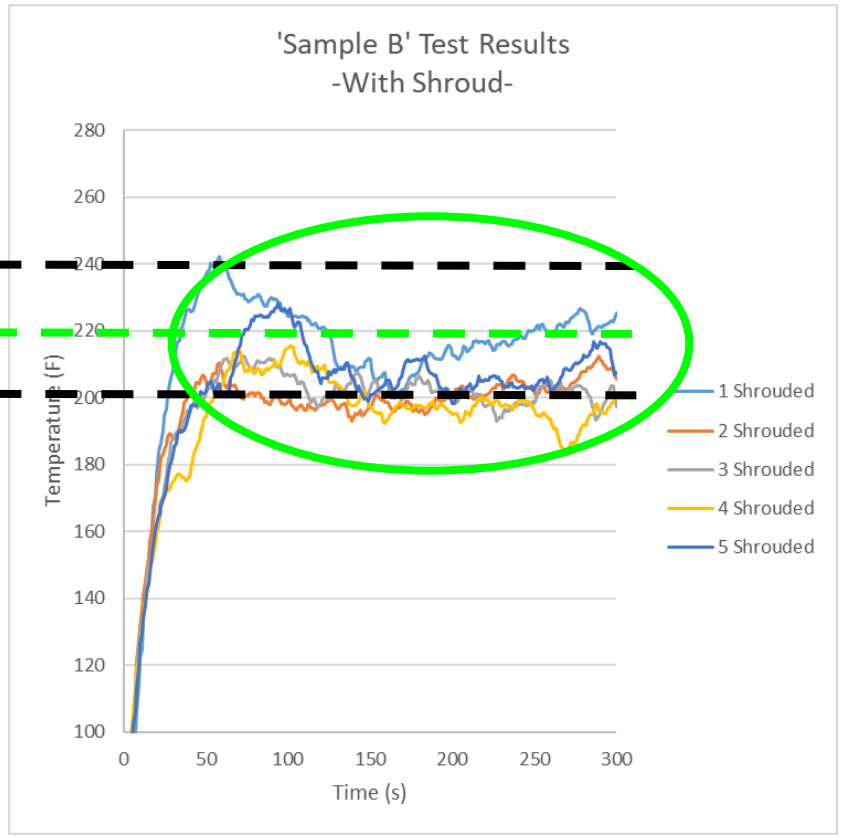
‘Sample B’ Test Results





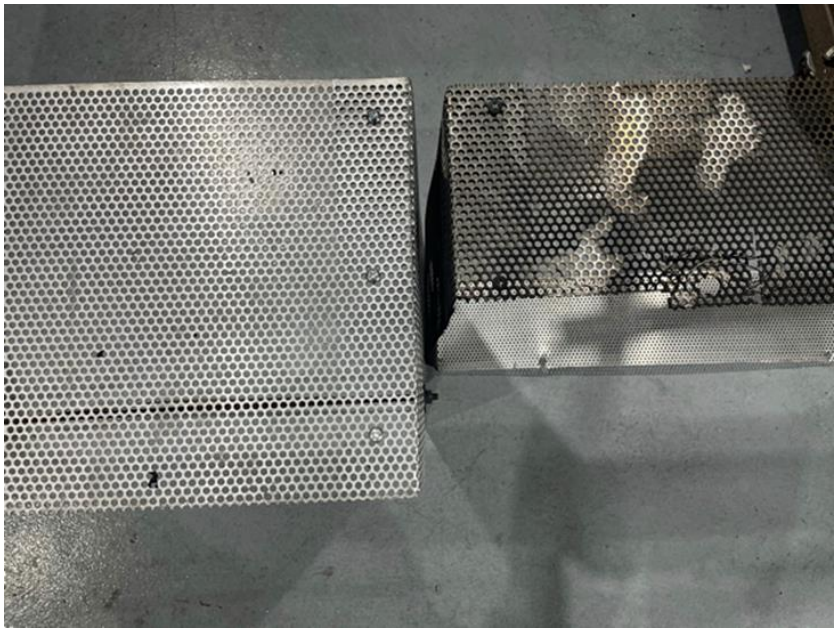
‘Sample B’ Test Results



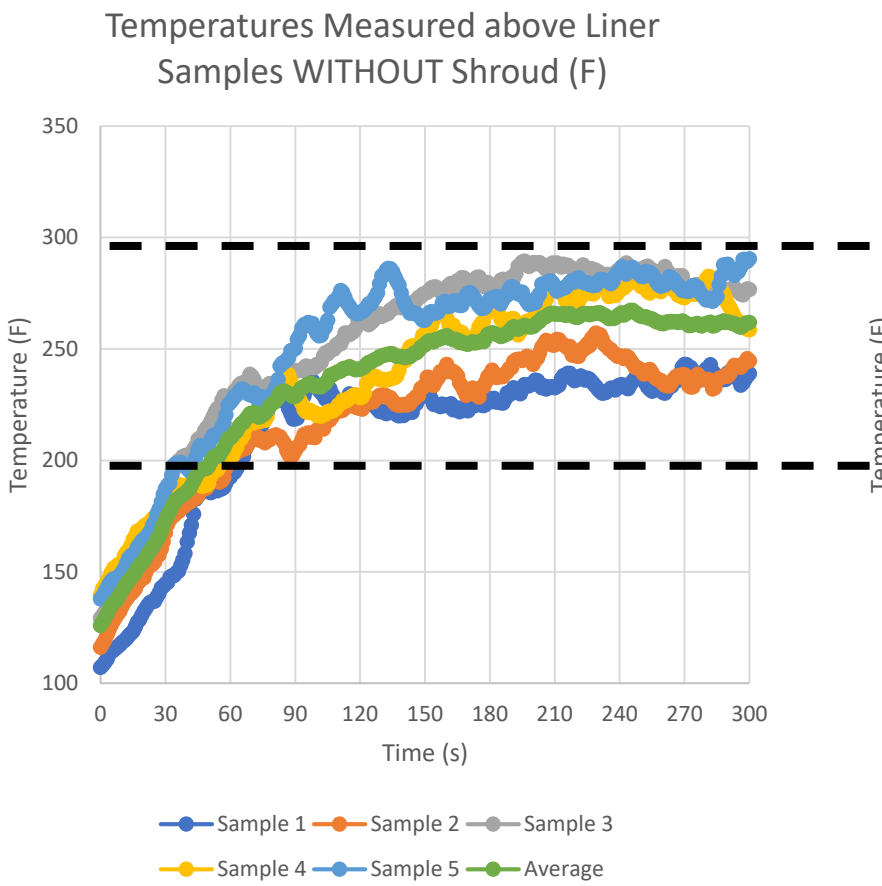


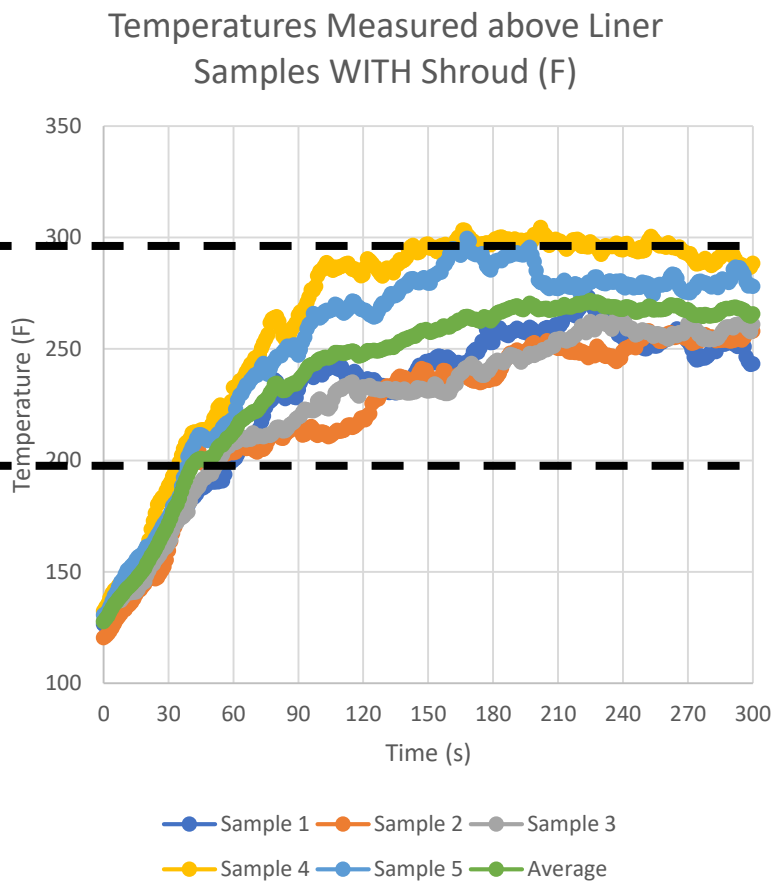
Cargo Shroud Study: Phase 2

- **Repeat testing as in Phase 1 using modified shroud design**
- **Samples and shroud supplied to study participants**
- **Tighter control in Phase 2**
  - Greater detail for equipment used, ambient conditions, etc.
- **More consistent results with supplied test sample type-A**
  - 2 different liner types were used in phase 1 due to low stock of sample material type-A

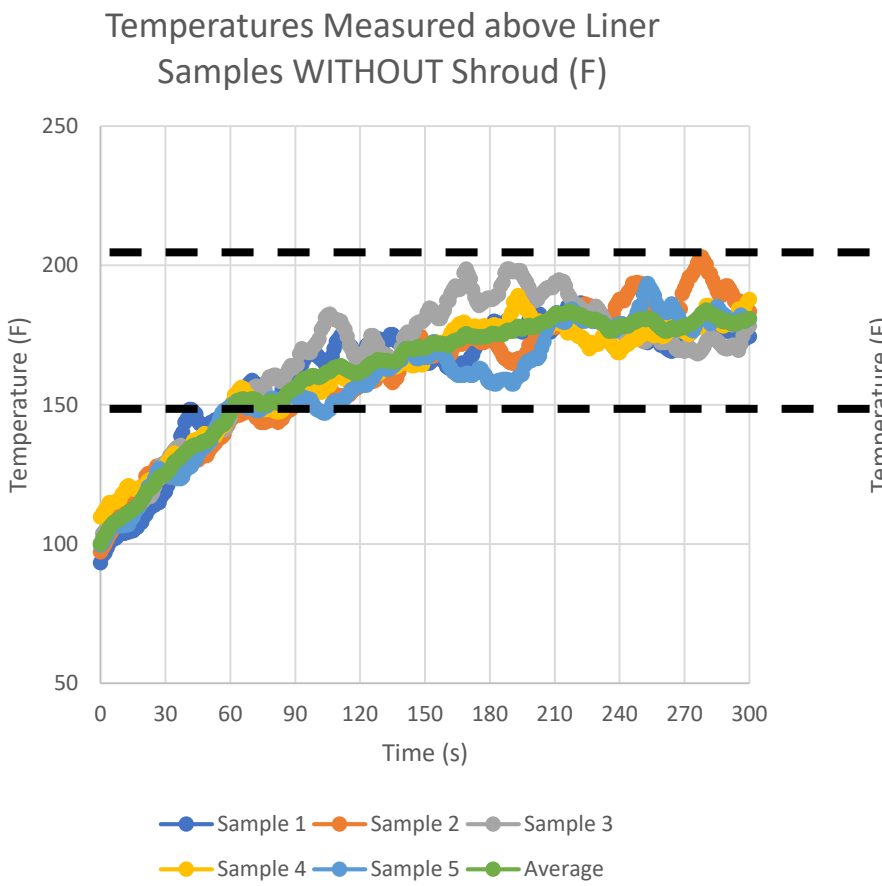


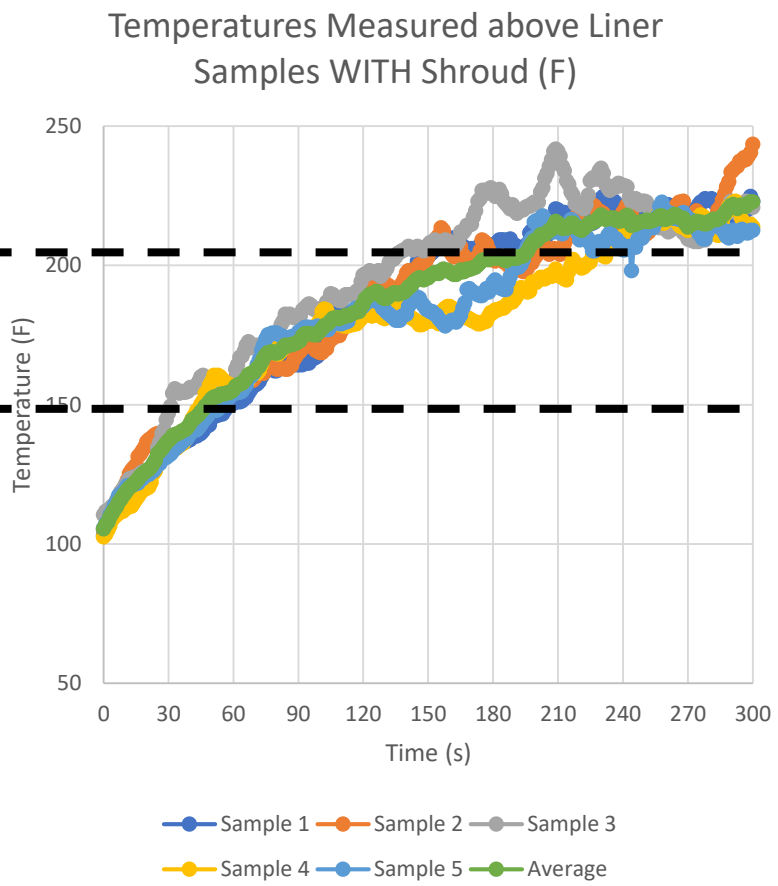
Phase 2 Results – Lab A



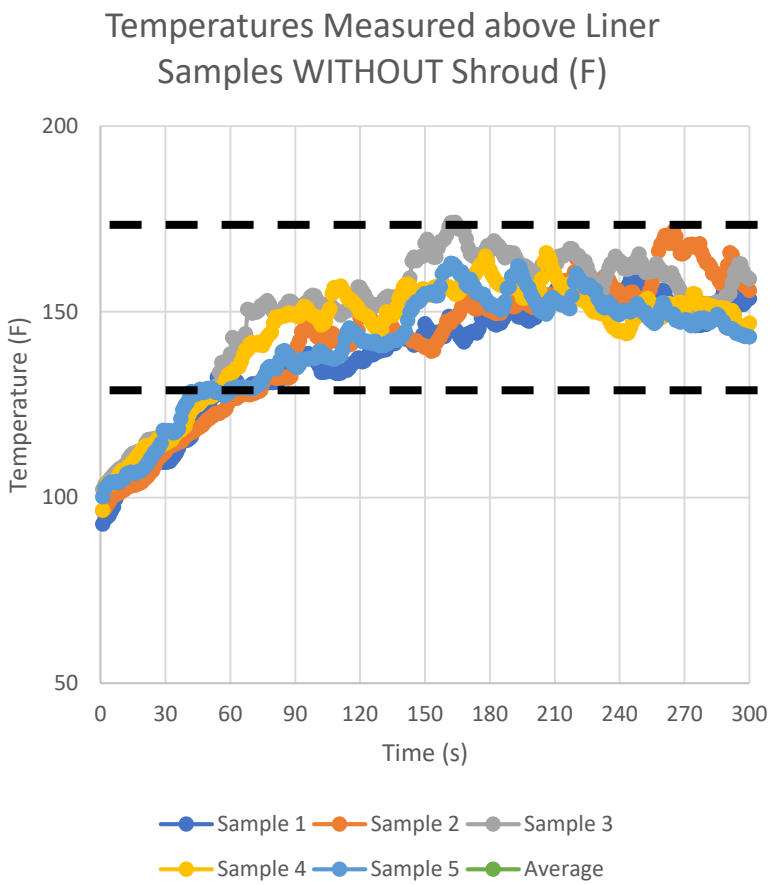


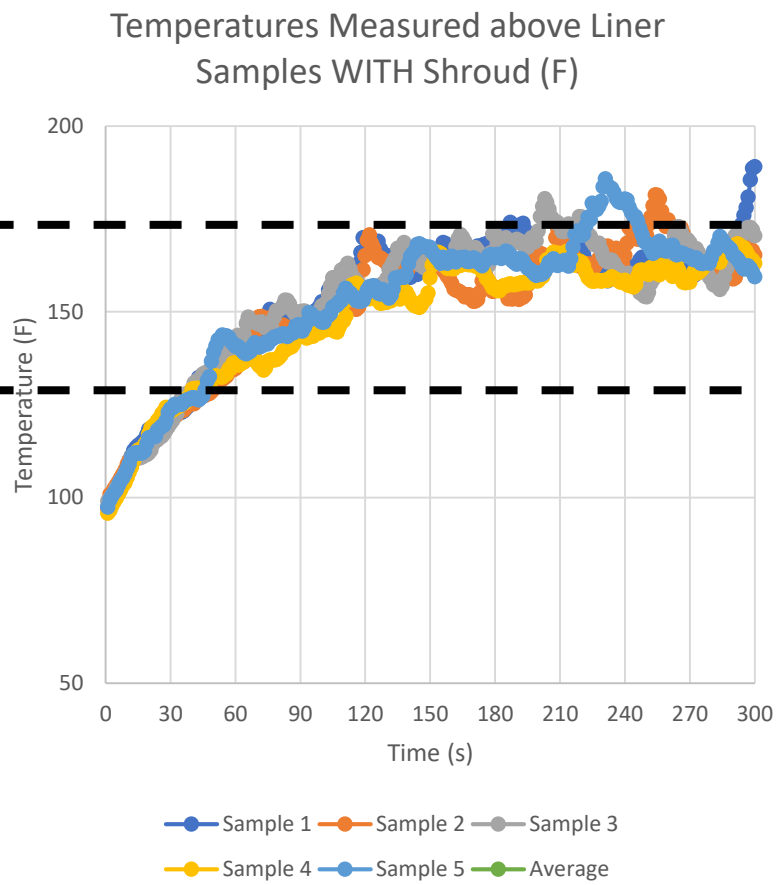
Phase 2 Results – Lab B



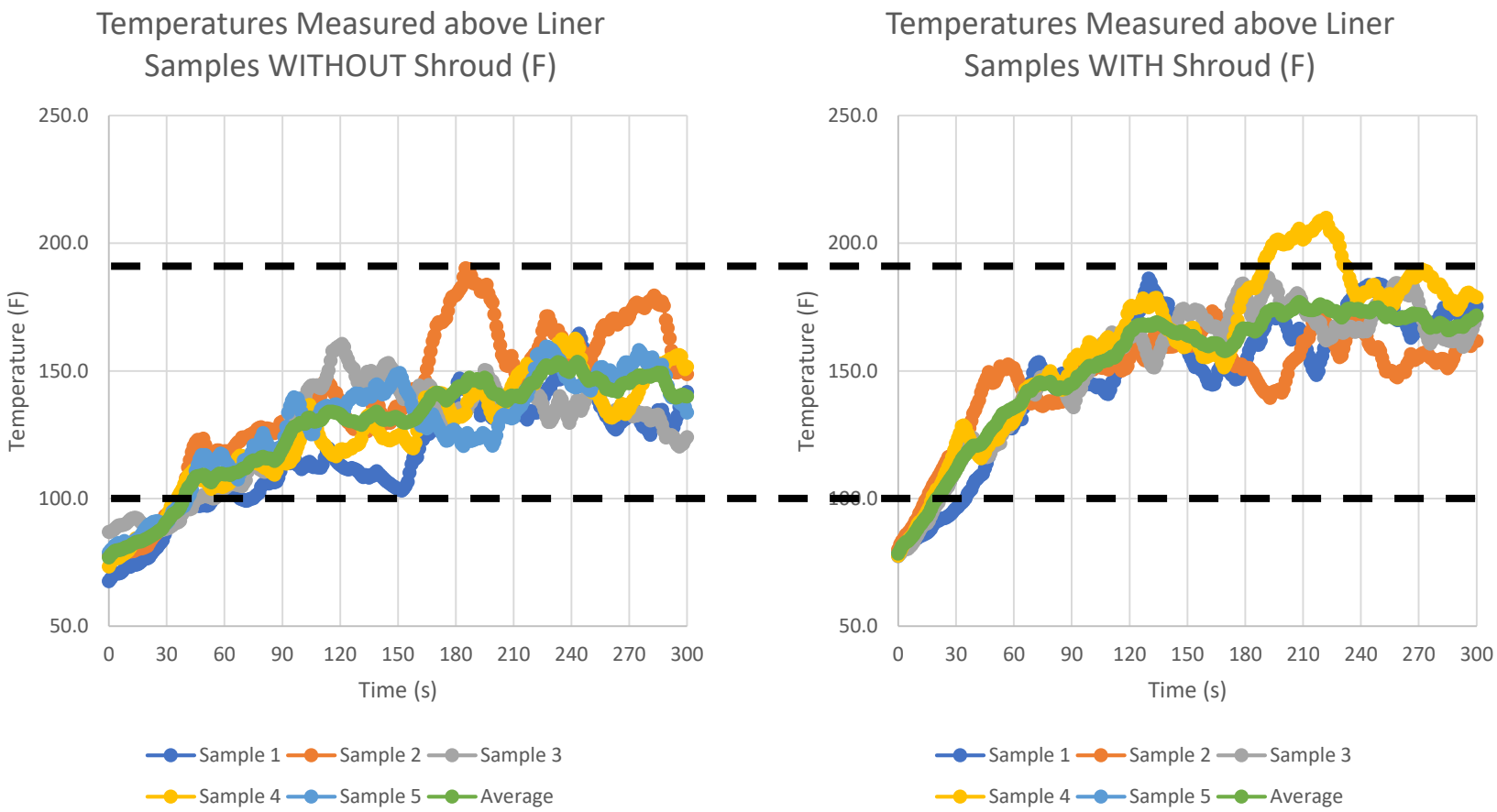


Phase 2 Results – Lab C



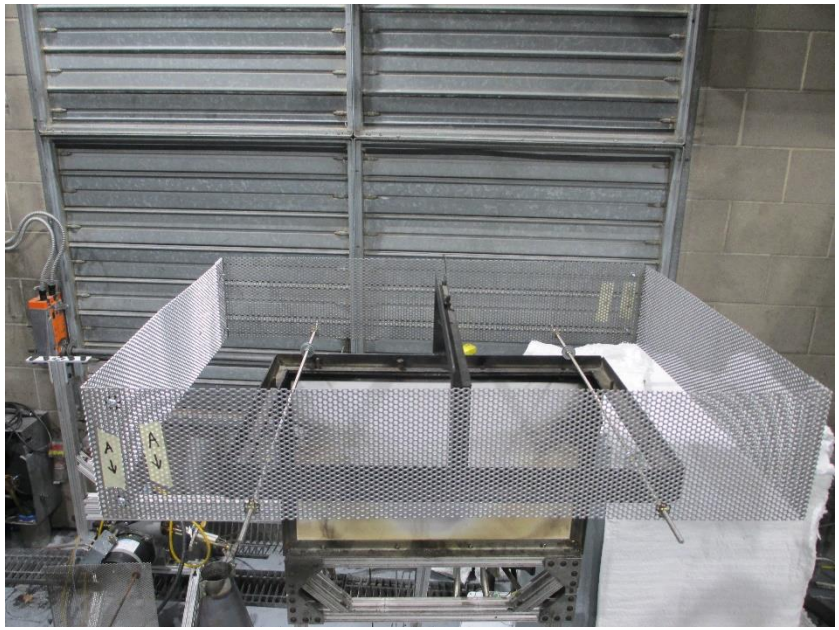


Phase 2 Results – Lab D



Phase 2 Conclusions

- **Test results at the FAA lab showed better repeatability without raised peak temperatures**
- **Outside labs saw a slight increase in peak temperature, but little to no improvement in repeatability**
- **Need to take a step back and reassess the use of the shroud in the cargo liner test**



Sonic Burner Seat Cushion Test: Air Shroud Update

Seat Cushion Shroud Study

- **Adapted cargo liner air shroud to fit seat cushion test method**
- **Interlab study had been delayed due to low supply of test materials and fewer lab workers due to Covid**

Seat Cushion Shroud Study

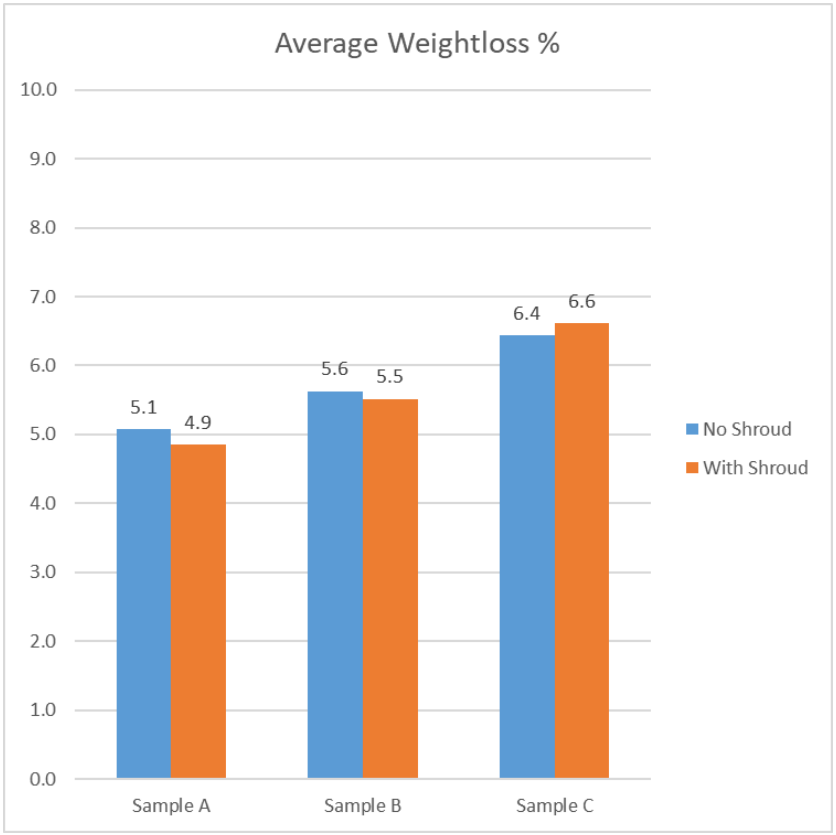
- **Same purpose as cargo shroud**
  - Reduced influence of localized air currents
- **Modified cargo shroud design**
  - Shrouded on three sides
  - Open on flame side
  - Does not interfere with sample mounting
  - No frame modifications

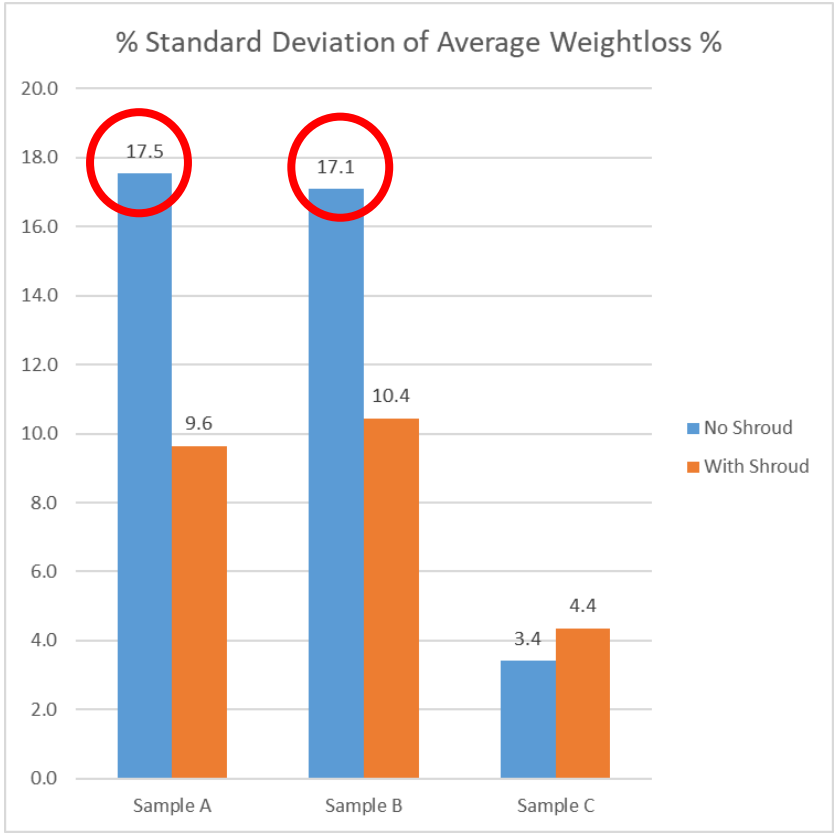
Seat Cushion Samples Tested

- **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

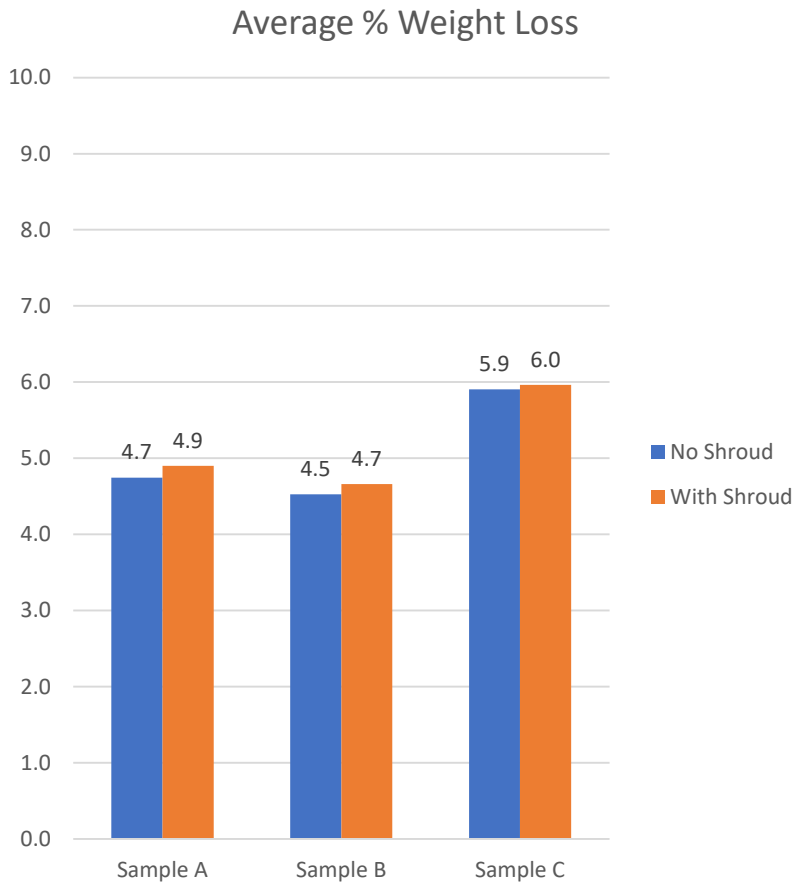


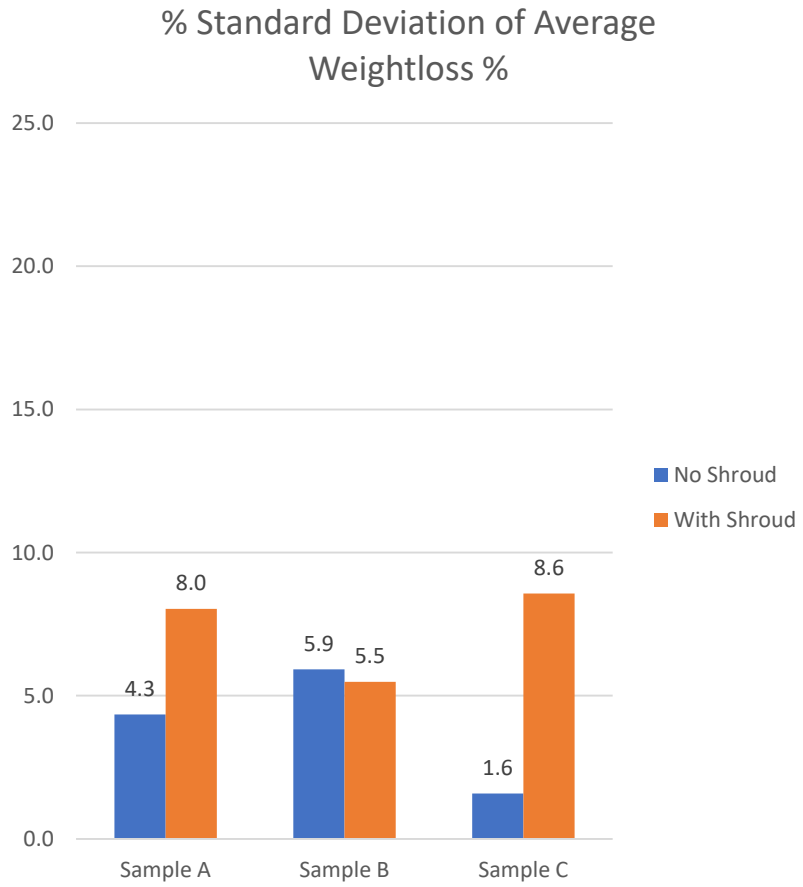


Seat Air Shroud

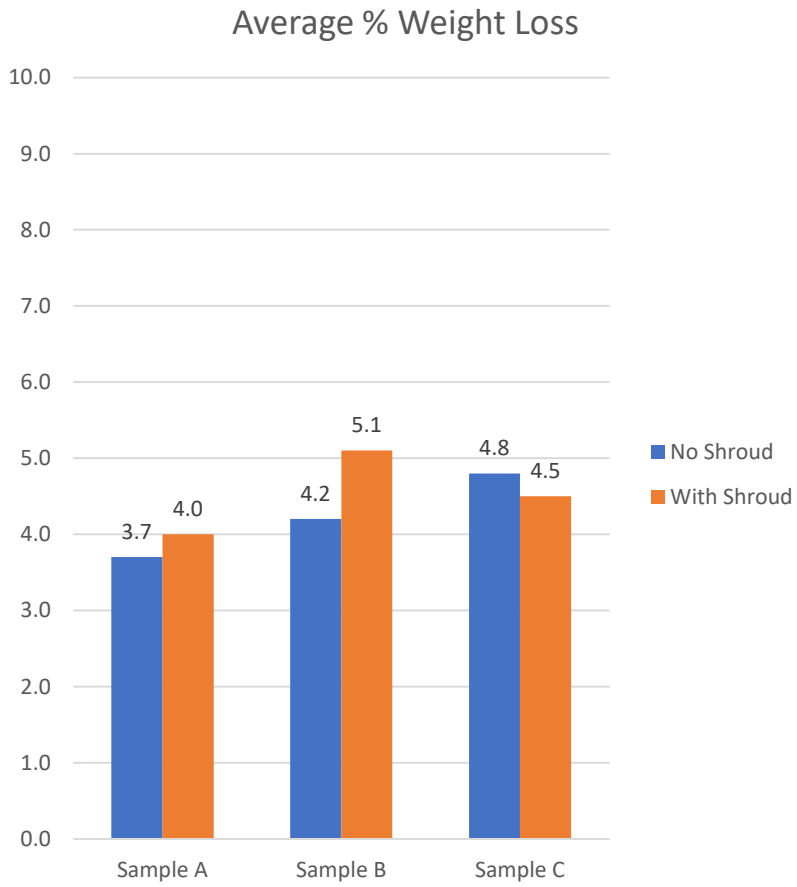
- **Interlab Study**
  - 3 sample foam sample types with 3 of each foam sample type provided to each participating lab
  - Same dress covers for all samples
  - Shroud provided with assembly and sample fire test instructions
  - No modifications to seat test frame are needed

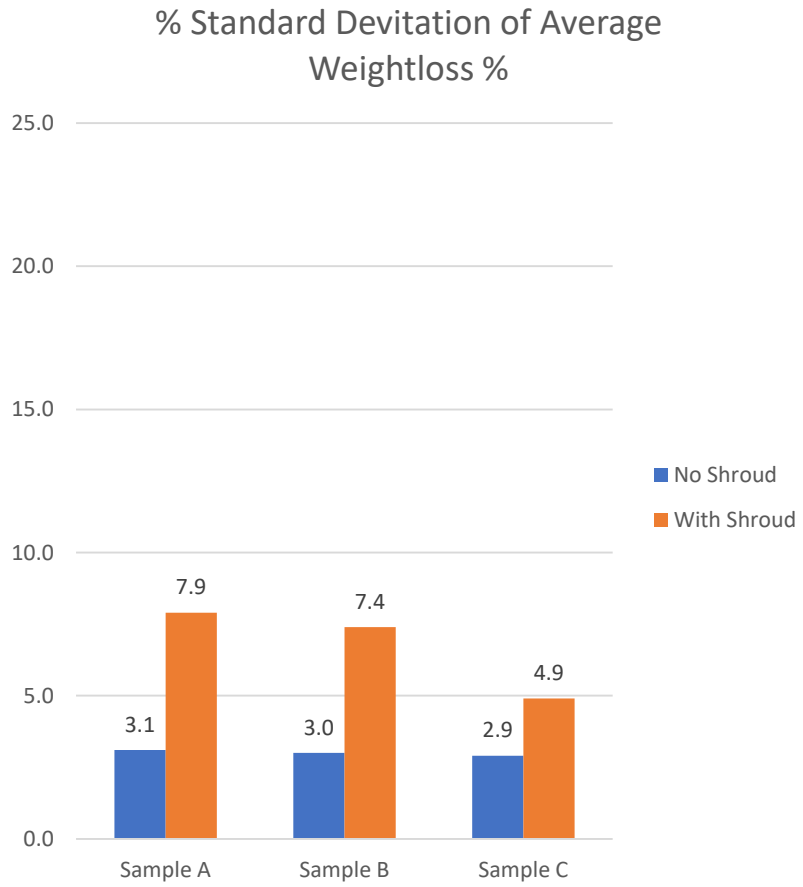
Study Results – Lab A



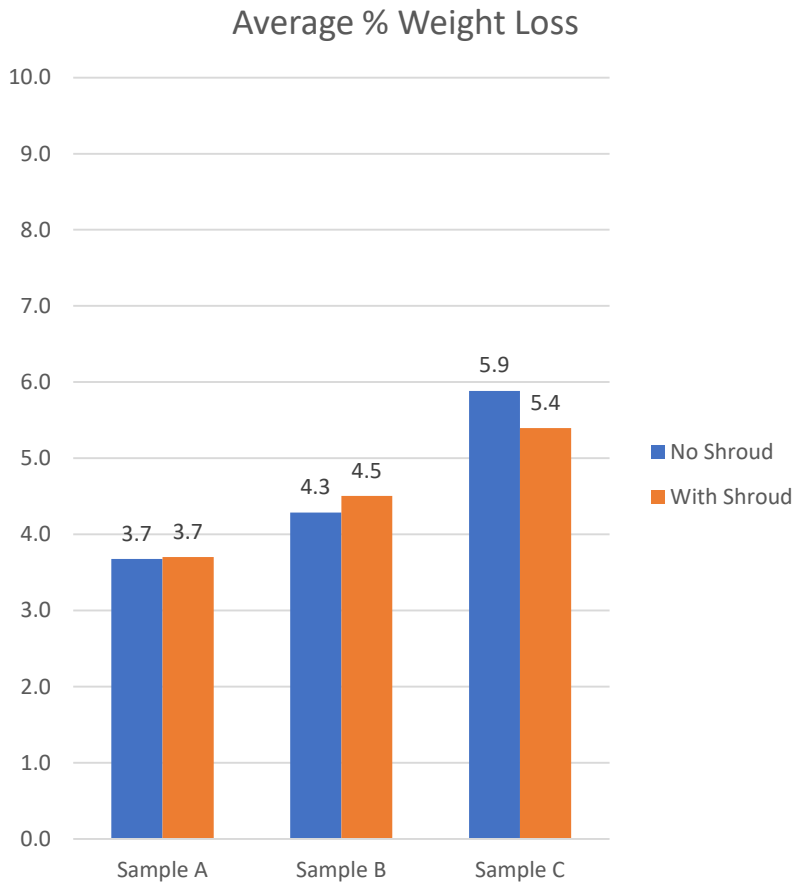


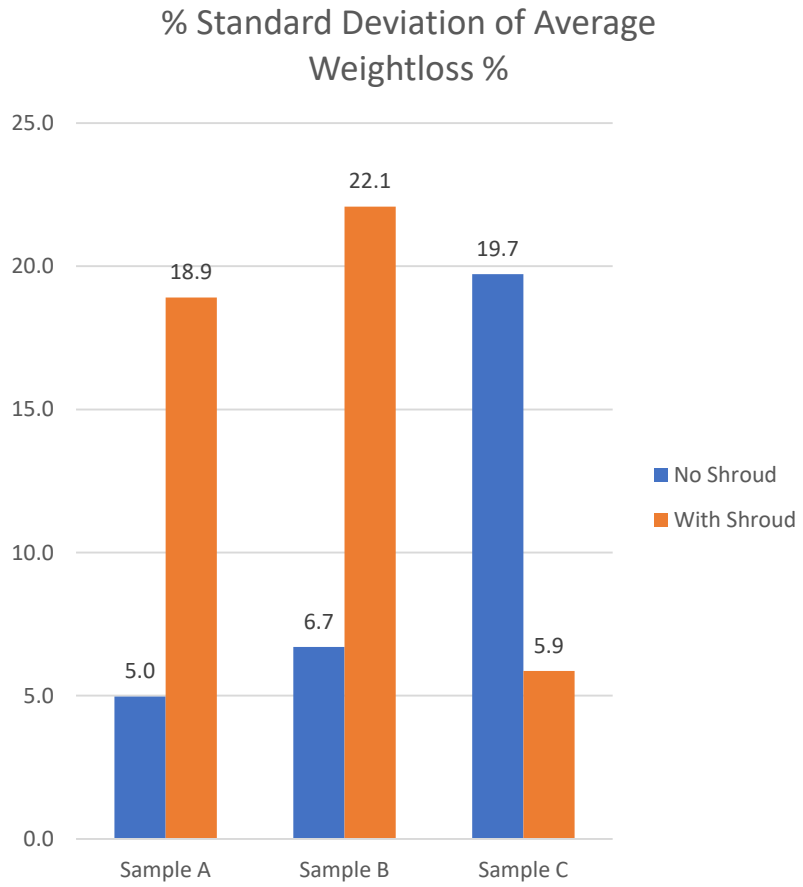
Study Results – Lab B





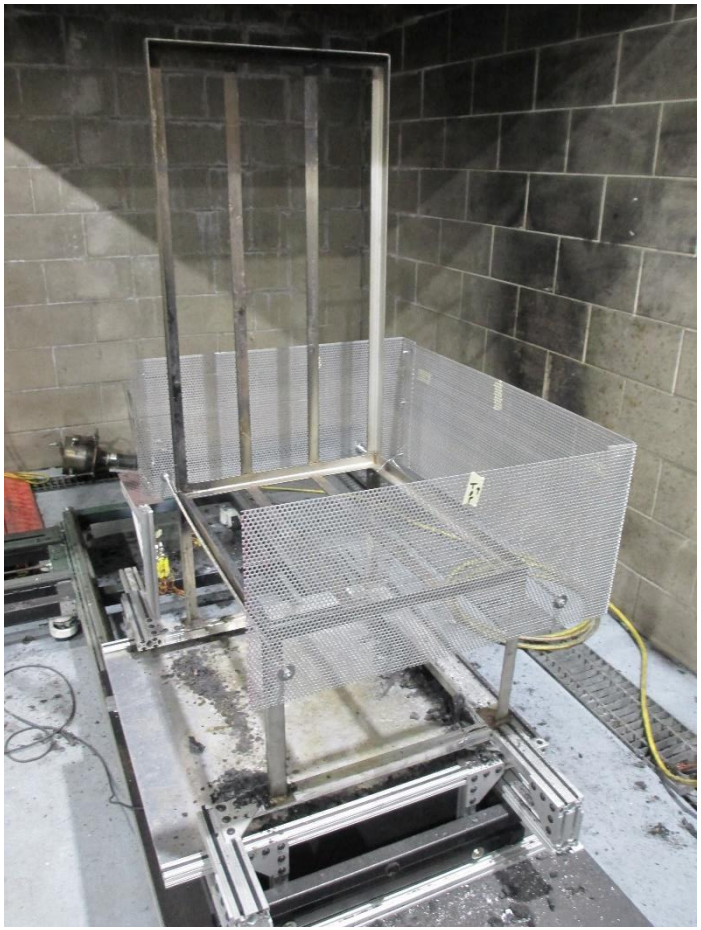
Study Results – Lab C





Study Result Conclusions

- **Test results at the FAA lab showed better repeatability without increased weight loss percent with shroud**
- **Outside labs saw little to no difference in weight loss percent, but no clear indication of improved repeatability with shroud**
- **Need reassess the design and use of the shroud in the seat cushion test**



Questions?

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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 economic practicality**
- **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 should experience less temperature drift than K-type TCs**

Background

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

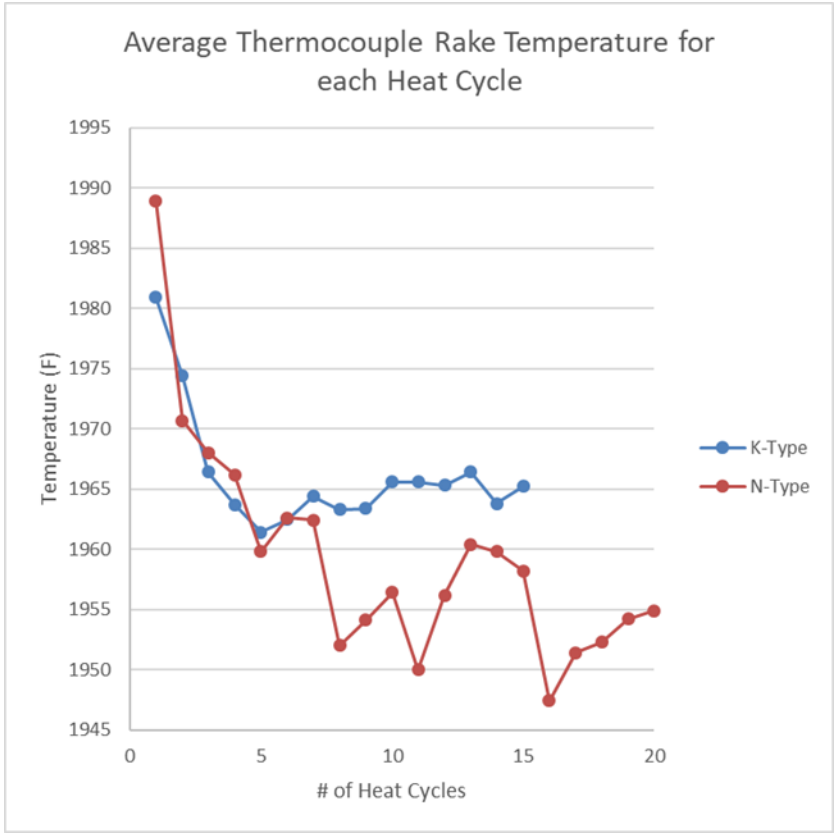
Thermocouple Comparison

- **K-type thermocouples**
  - 7 count
  - 1/8” diameter
  - 18” length
  - Pyrosil sheathed
  - (rated for ~1900F)

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

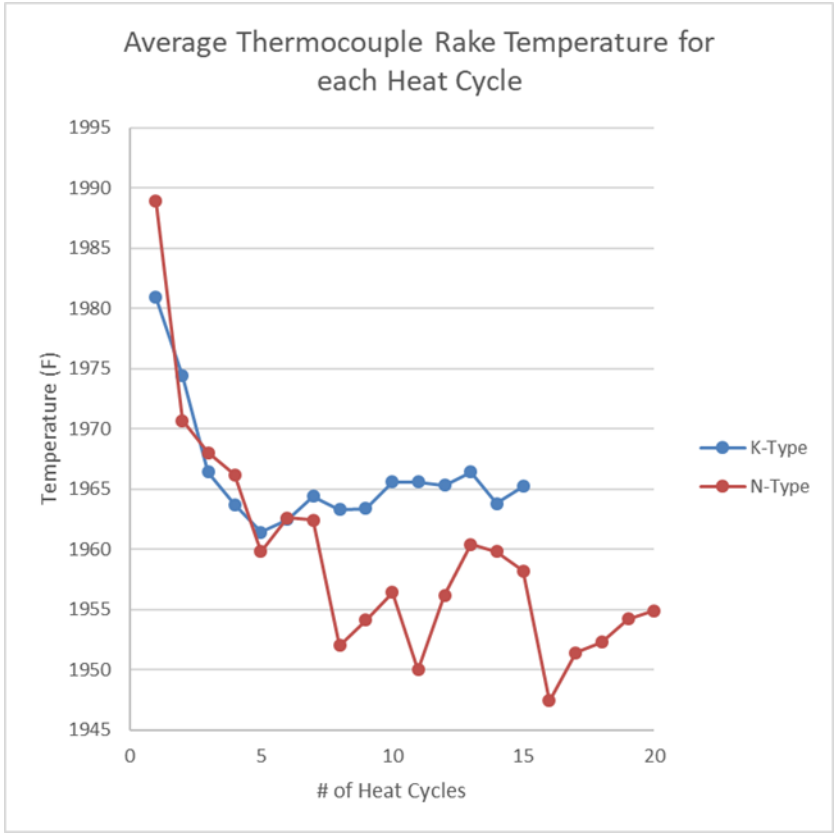
K-Type Test Results

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



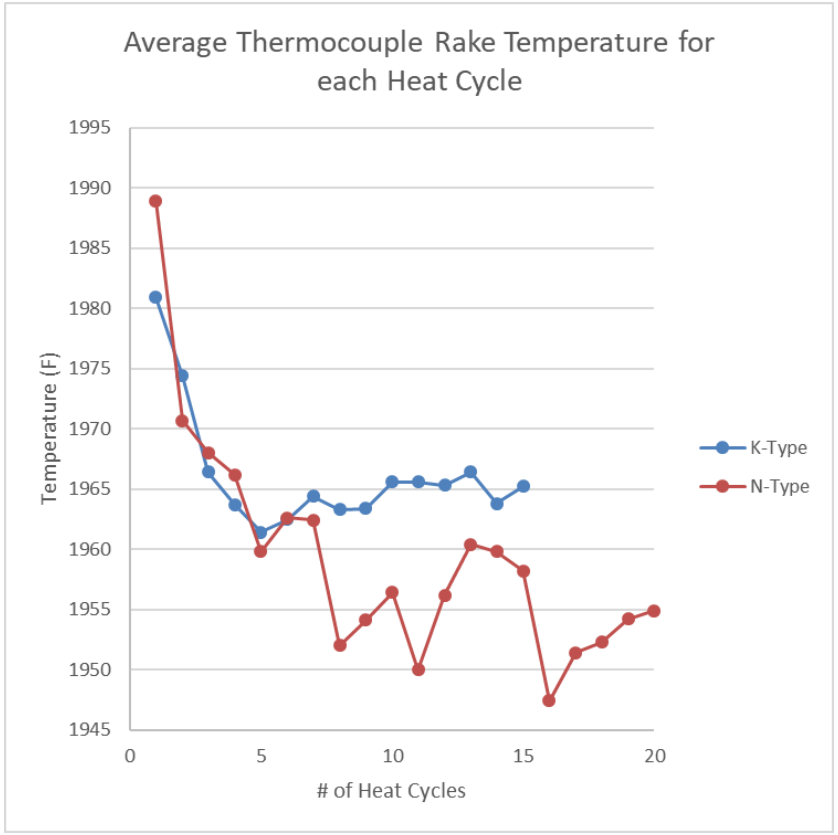
N-Type Test Results

- **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**



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