



**Federal Aviation
Administration**

International Aircraft Materials Fire Test Working Group Meeting

Task Group Session on Revised Cargo Liner Test

Presented to: International Aircraft Materials Fire Test
Working Group

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Date: March 4-5, 2014, Savannah, Georgia



Summary for this Meeting

- **Completion of the 2013 NexGen sonic burner cargo liner round robin and final test results**
 - Prove the worthiness of the flame retention head
 - Is the FRH an improvement over the stator/turbulator setup?
 - Test results
- **Final settings for the NexGen sonic burner for use in the cargo liner test method**
 - Design and burner assembly
 - Final Settings

Cargo Liner Round Robin Studies

- **2012 Cargo Liner Round Robin**
 - Develop settings at the FAA Technical Center for the NexGen sonic burner using the original stator/turbulator configuration
 - Provide settings and instructions to participating labs
 - Review data and determine if burner settings will produce consistent test data similar to data generated by the Park burner
 - Results show large variations in temperature among labs
- **2013 Cargo Liner Round Robin**
 - Can the cargo liner test method and sonic burner be improved through the use of the flame retention head?
 - Develop settings and provide instruction to participating labs
 - Compare results to those of the 2012 round robin
 - Should the NexGen sonic burner be configured using the flame retention head or the stator/turbulator configuration?

Background

- **The 2012 round robin had shown the NexGen burner test results to be less repeatable than originally thought**
- **In the case of the Park burner, the stator and turbulator inside the burner draft tube could be adjusted to compensate for any irregularities in burner performance which might impact test results**
- **The NexGen burner was designed to be setup in a standardized configuration, meaning that there are no adjustments to be made in order to simplify NexGen burner test rig setup**
- **Flames coming from the NexGen burner cone were often bias to the left or right side, rather than exiting evenly from the cone**
- **It was thought that redesigning the internal components of the NexGen burner may help reduce flame bias and increase test repeatability**



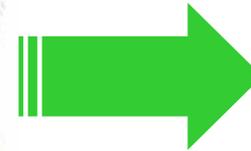
Old Vs. New Burner Internals

- The original concept was to retain the same internals from the Park burner for use in the NexGen burner in order to keep burner performance similar
- After trialing the igniterless stator design with no success, other options were considered
- Oil burners on the market today no longer use stators and turbulators to direct the flow of air through the burner
- Flame retentions heads (FRH) are now used in their place
 - Generate a more efficient and complete combustion
 - Simpler in design
 - Relatively easier to produce

Turbulator



Flame Retention Head



Stator



Static Plate

FRH vs. Stator and Turbulator

Flame Retention Head



Stator and Turbulator



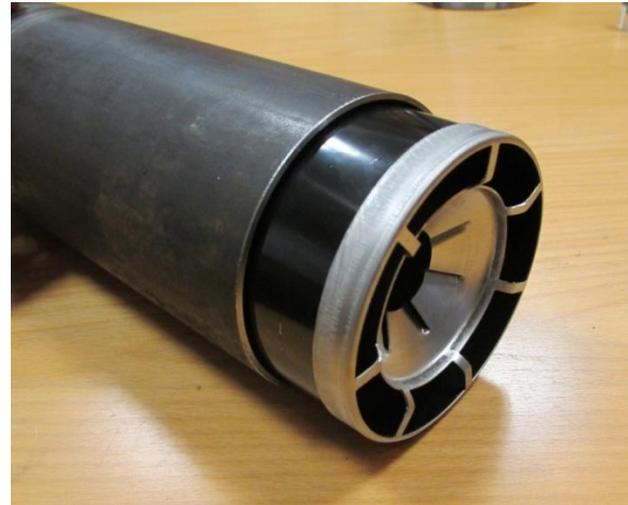
Modified Draft Tube Assembly

- **Top: Modified draft tube with machined groove (left), to allow for spacer sleeve and FRH**
- **Bottom: Spacer sleeve fits into draft tube to ensure static plate and fuel rod are centered in draft tube**
- **Sleeve manufactured by the Beckett company, purchased from local HVAC supplier**



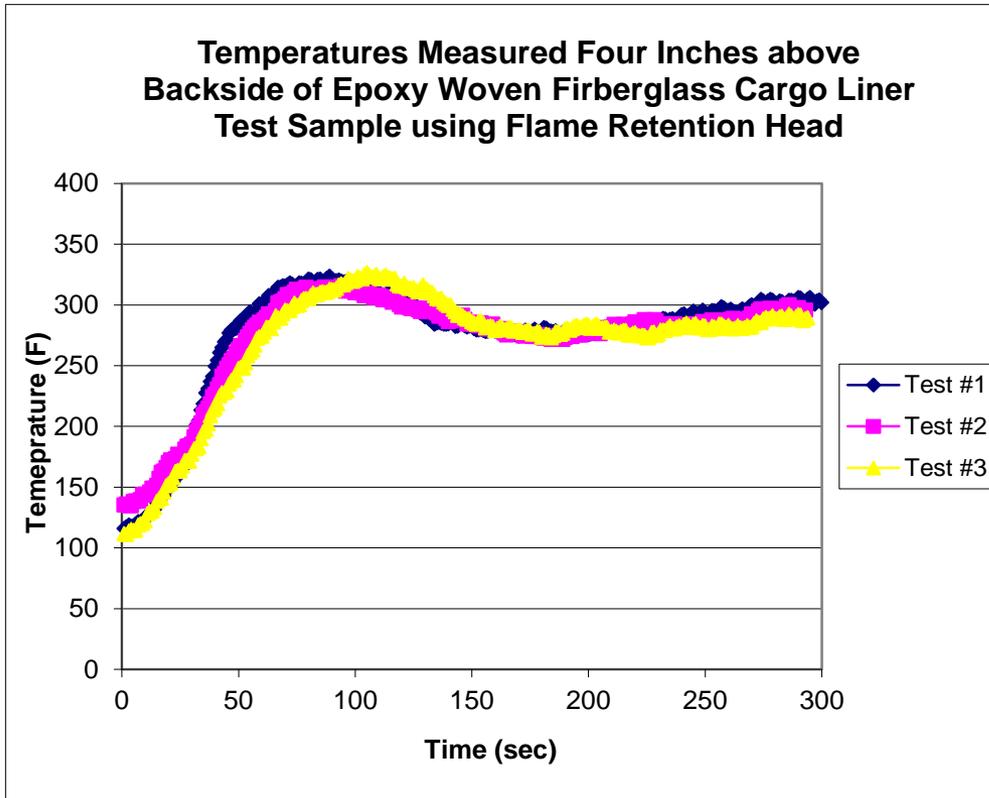
Modified Draft Tube Assembly

- **Top: FRH is press fit onto the spacer sleeve**
- **Bottom: The FRH and spacer sleeve assembly is pressed into the burner draft tube until the face of the FRH and end of the draft tube are flush**



Repeatability of the FRH for Cargo Burner

Cargo Liner Temperature Test



PAN Felt Burnthrough Test

- 3 samples tested first using stator/turbulator in the NexGen burner, and 3 more samples tested using FRH
- Material exposed to flame until visible penetration of the material occurs
- Stdev and %Stdev improved for FRH compared to tests using stator and turbulator

	Stator	FRH
Stdev (sec)	22.3	19.4
%stdev	6.0	4.73

NexGen Burner Settings for 2013 Cargo Liner Round Robin

- **Face of FRH to nozzle tip: 1-1/8"**
- **Fuel nozzle adapter to static plate: 2-3/8"**
- **Static Plate Angle: centerline of igniters at 0°**
 - Looking into the cone of the burner, the centerline between the igniters will be at 0° on the burner reference
- **Fuel pressure: 108 psi (+/- 4 psi)**
 - This pressure is to be used as a starting point when flow checking the fuel flow rate
- **Air pressure: 45 psi**
- **Air Temperature: 40-60°F**
- **Fuel Temperature: 32-52°F**

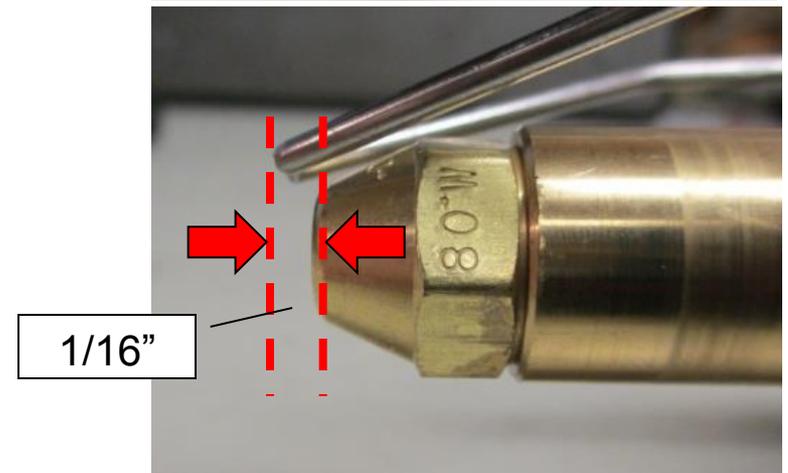
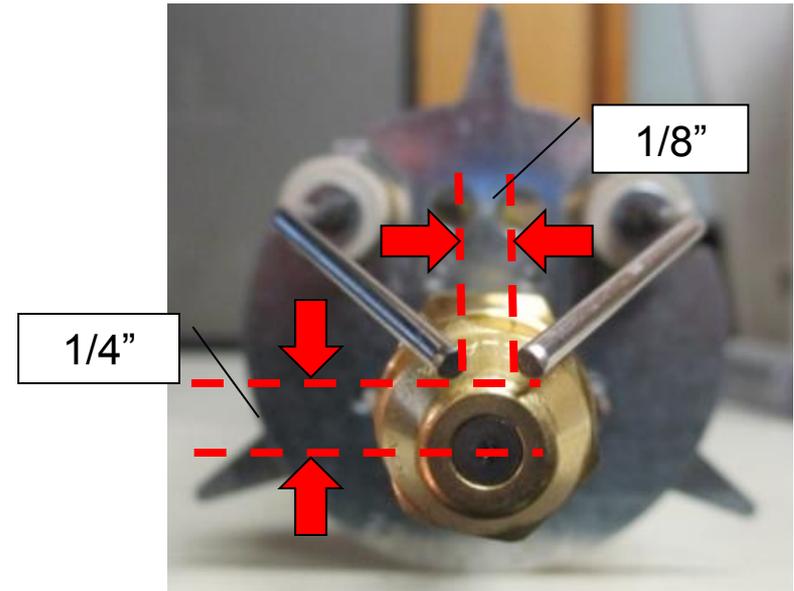
Ignition Wires

- **Wires should be wrapped tightly around fuel rod as shown in picture in order to minimize possible disruptions of airflow inside burner tube**
- **Wire lengths (tip of metal wire terminal to rear of draft tube)**
 - **Red: 12.5"**
 - **Black: 12.5"**

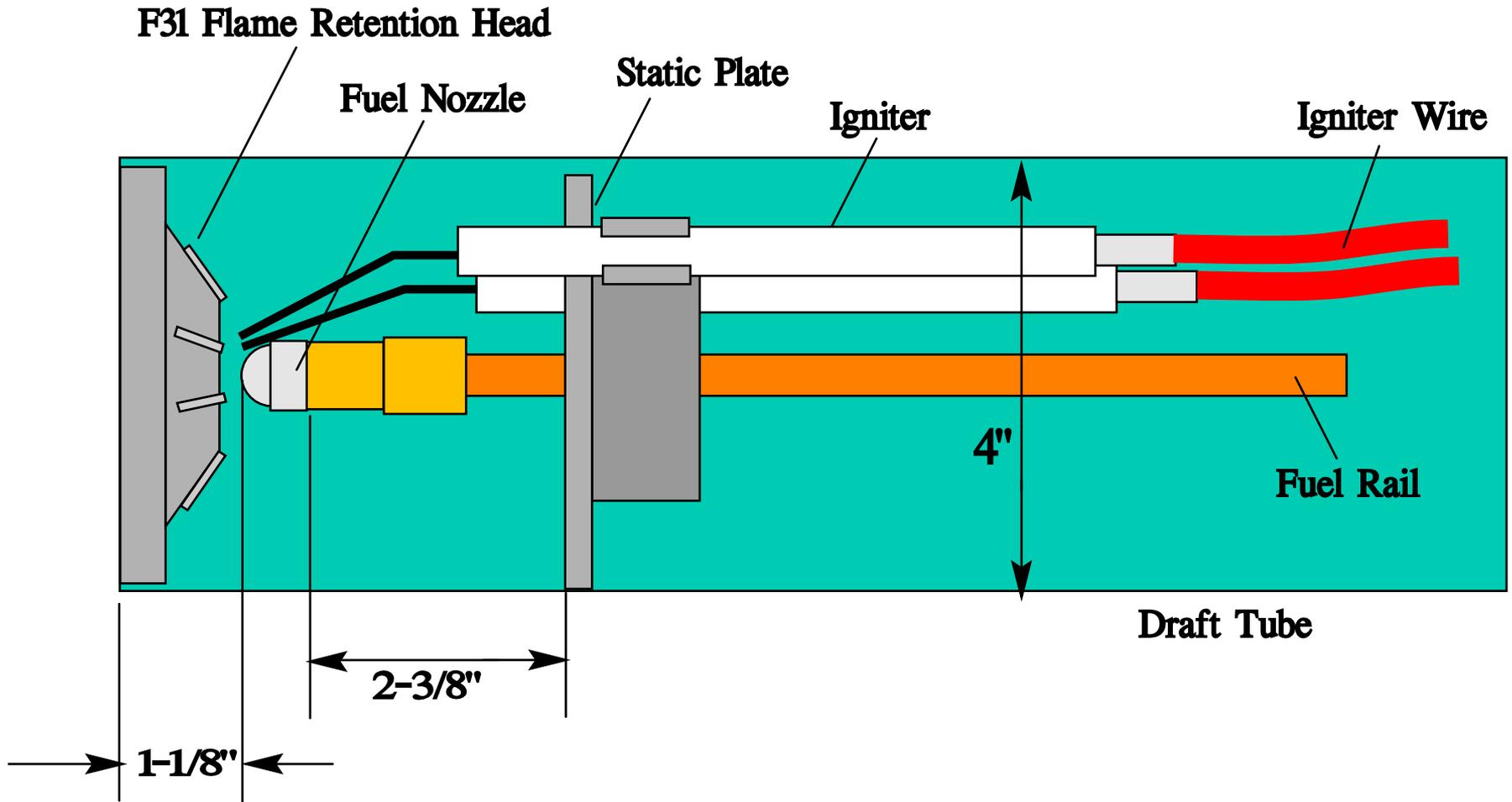


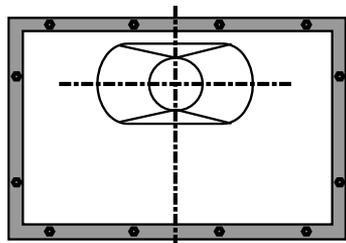
Standardized Igniter Position

- **Gap between igniters**
 - 1/8"
- **Nozzle center to igniters**
 - 1/4"
- **Nozzle face to igniter tips**
 - 1/16"



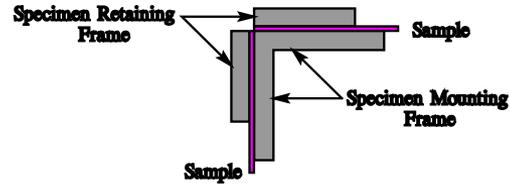
Burner Settings



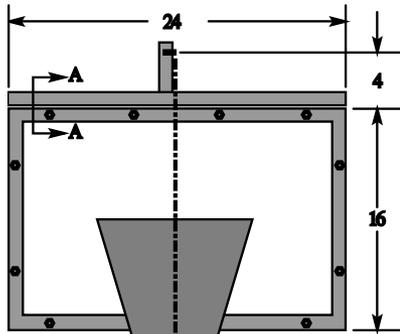


Top View

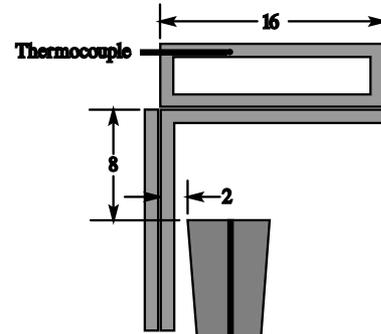
Horizontal and vertical specimens are clamped in place on all edges between angles as shown in View A-A



View A-A



Front View



Side View

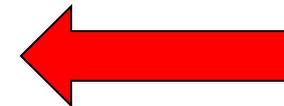
Burner Cone

Burner Assembly

Thermocouple

Sonic Orifice

Air Supply Entering Burner



NexGen Burner 2013 Cargo Liner Round Robin

- **2013 round robin for sonic cargo burner currently underway**
 - Began approximately June 2013
 - Completed March 2014
- **7 labs participated, including FAA lab**
 - FAA supplied each lab with a fuel nozzle, burner cone, modified draft tube, spacer tube, flame retention head, static plate, and test samples
 - 5 labs out of 7 completed testing and returned results
- **3 types of samples provided**
 - Polyacrylonitrile (PAN) felt (5 pieces)
 - Light, semi-rigid liner (3 pieces)
 - Heavy, woven fiberglass/epoxy liner (5 pieces)

Provided Burner Parts

- **Modified draft tube**
- **6" Spacer tube**
- **Static plate**
- **Beckett model F31 flame retention head (FRH)**
- **Delavan 2.0 gal/hr 80° W style fuel nozzle**
- **Burner cone**
 - Included for labs who have not previously participated in a round robin where cones were provided



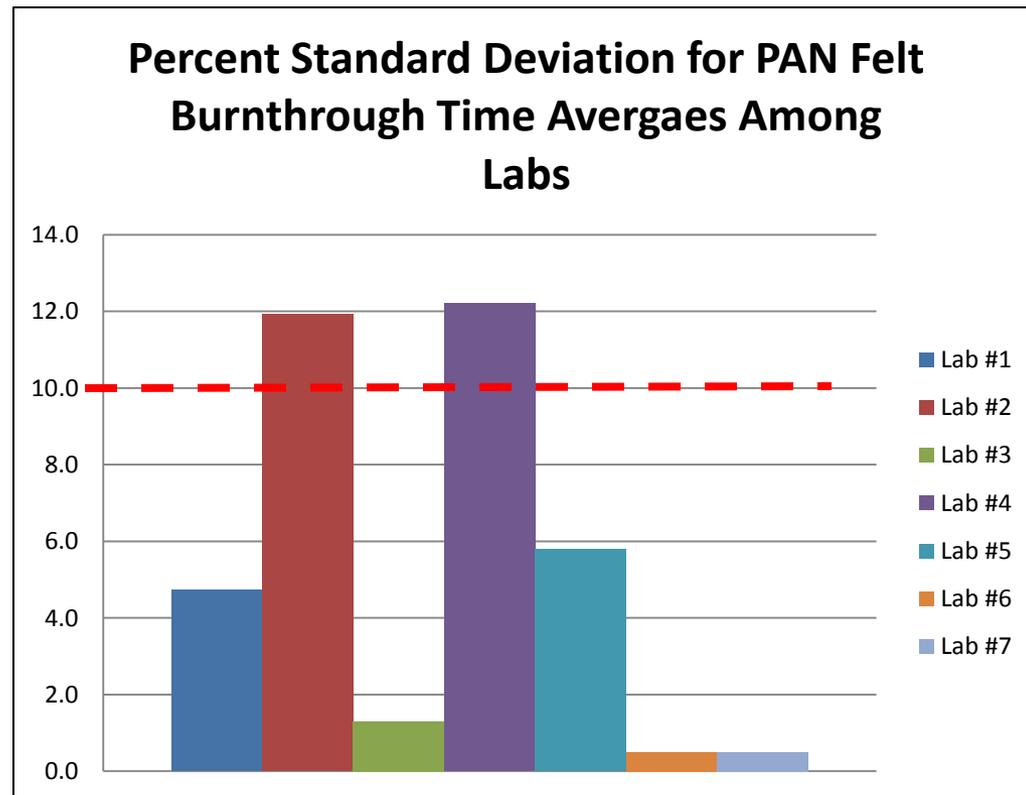
Changes since beginning of RR

- Round robin participants were originally provided with a 6 inch long spacer sleeve
- For future testing, the 6 inch sleeve should be replaced using a Beckett 16 inch sleeve (or similar) cut down to 15 inches so as to match the length of the burner draft tube



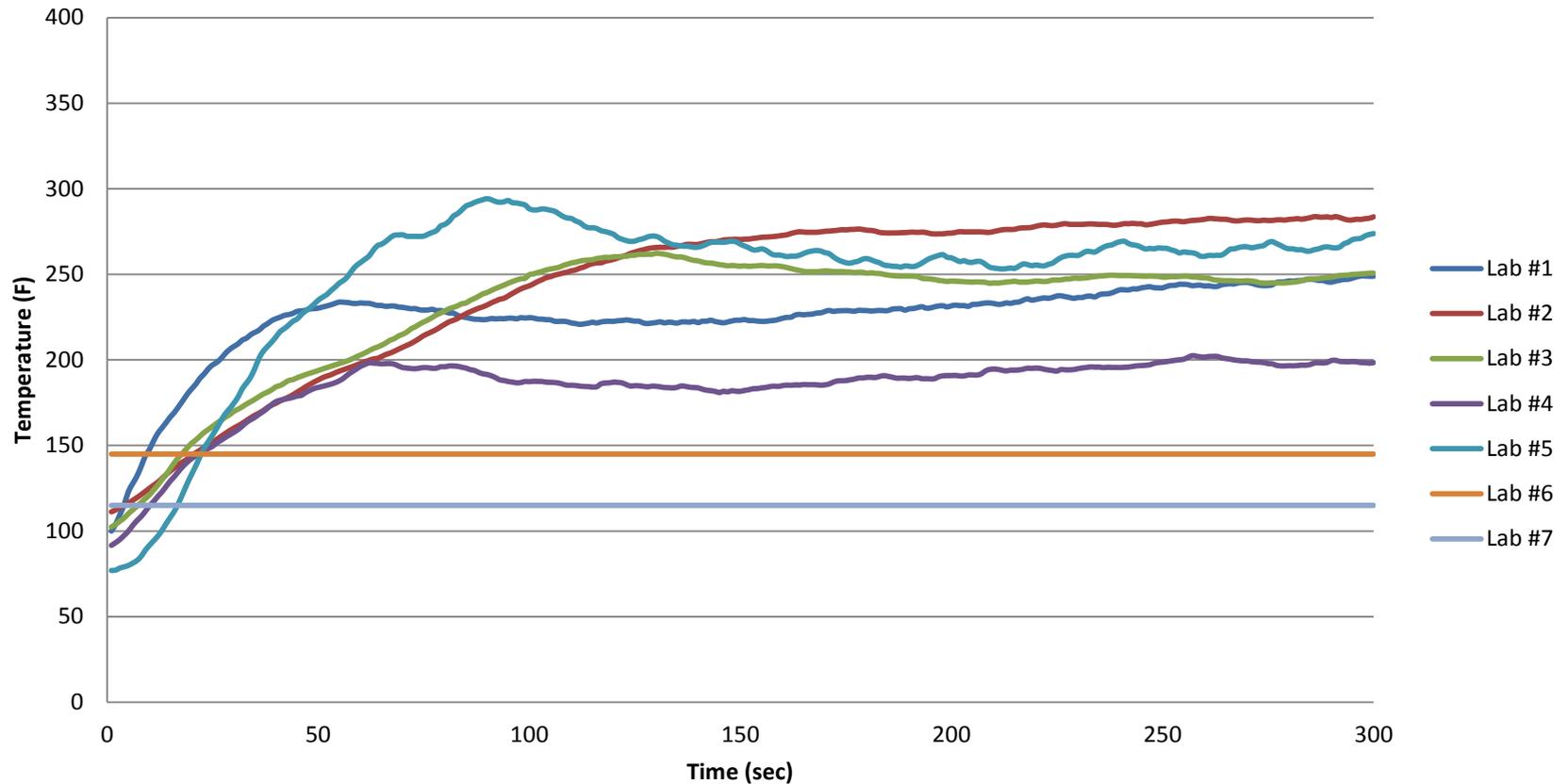
PAN Burnthrough Test Results

	Average #1	Average #2	Average #3	Average #4	Average #5	Average #6	Average #7
#1	427	422	587	389	331		
#2	389	511	592	388	380		
#3	415	435	598	344	380		
#4	-	560	580	433	359		
#5	-	514	582	474	377		
avg	410	488	588	406	365.4		
stdev	19.4	58.2	7.4	49.5	21.1		
%stdev	4.7	11.9	1.3	12.2	5.8		



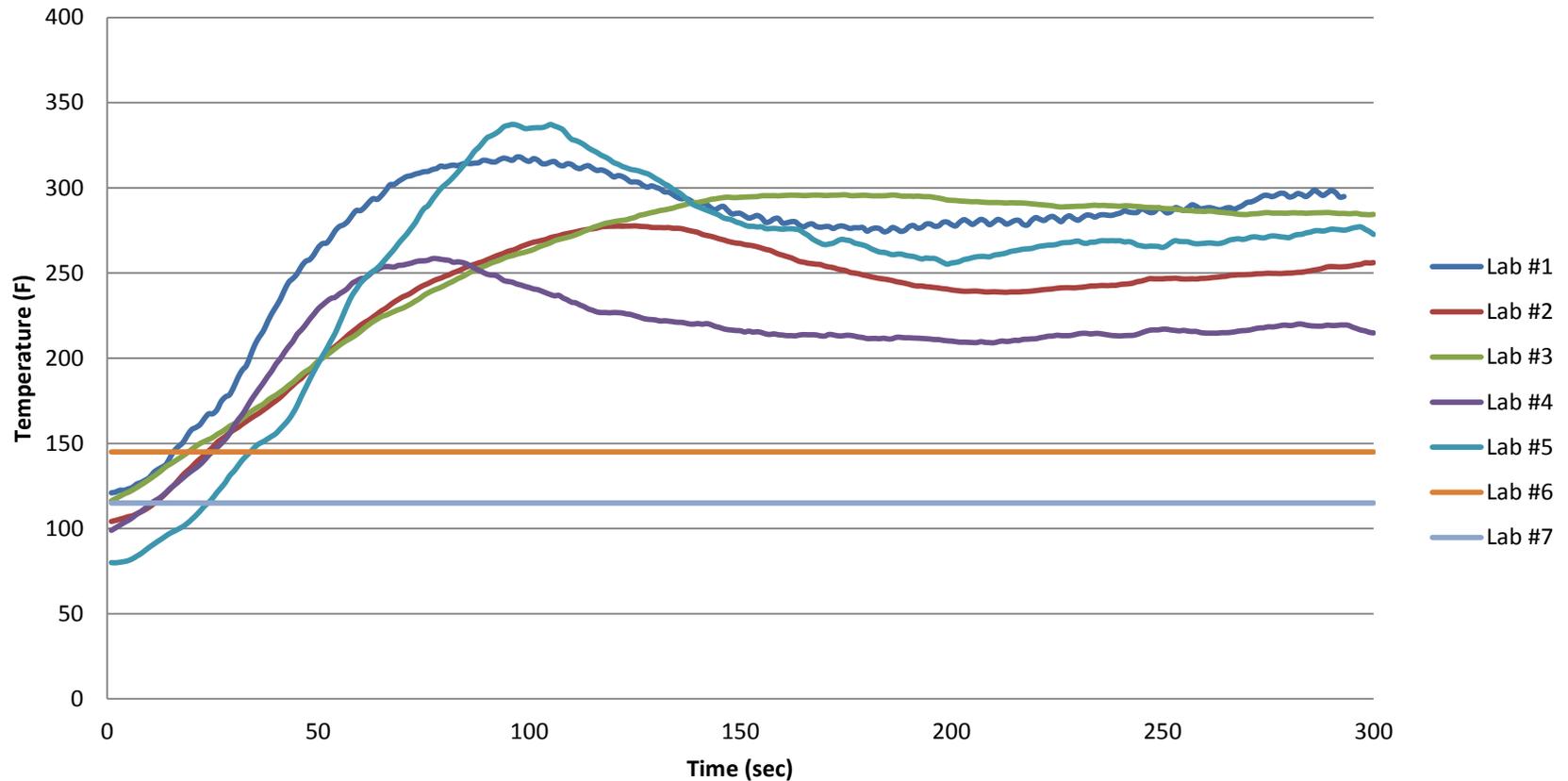
Light Semi-Rigid White/Tan Cargo Liner Test Results

Temperatures Measured Four Inches above Semi-rigid White/Tan Cargo Liner



Heavy Woven Fiberglass/Epoxy Cargo Liner Test Results

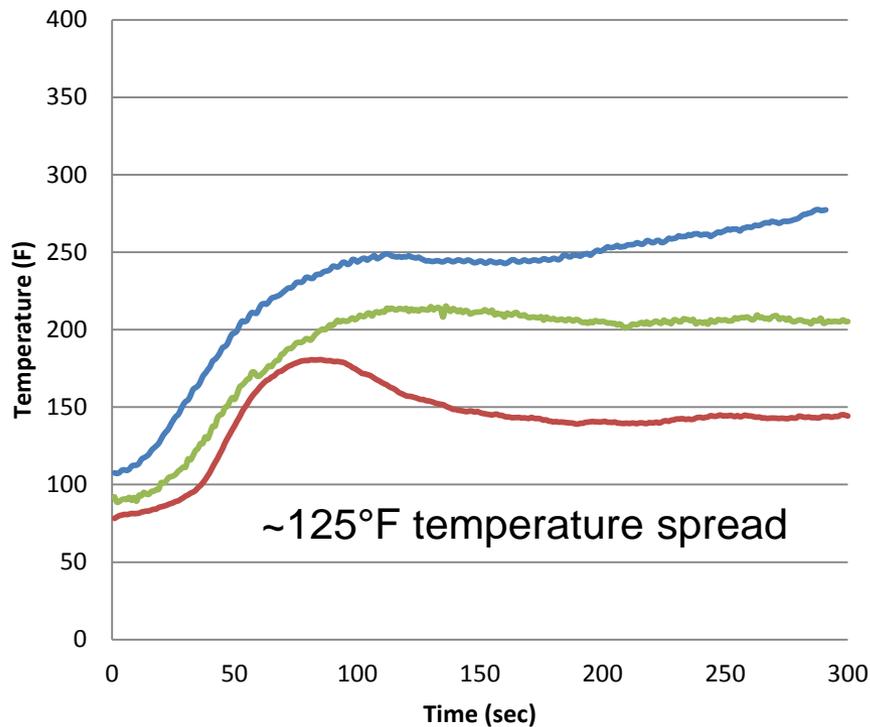
Temperatures Measured Four Inches above Heavy Woven Fiberglass/Epoxy Cargo Liner Samples



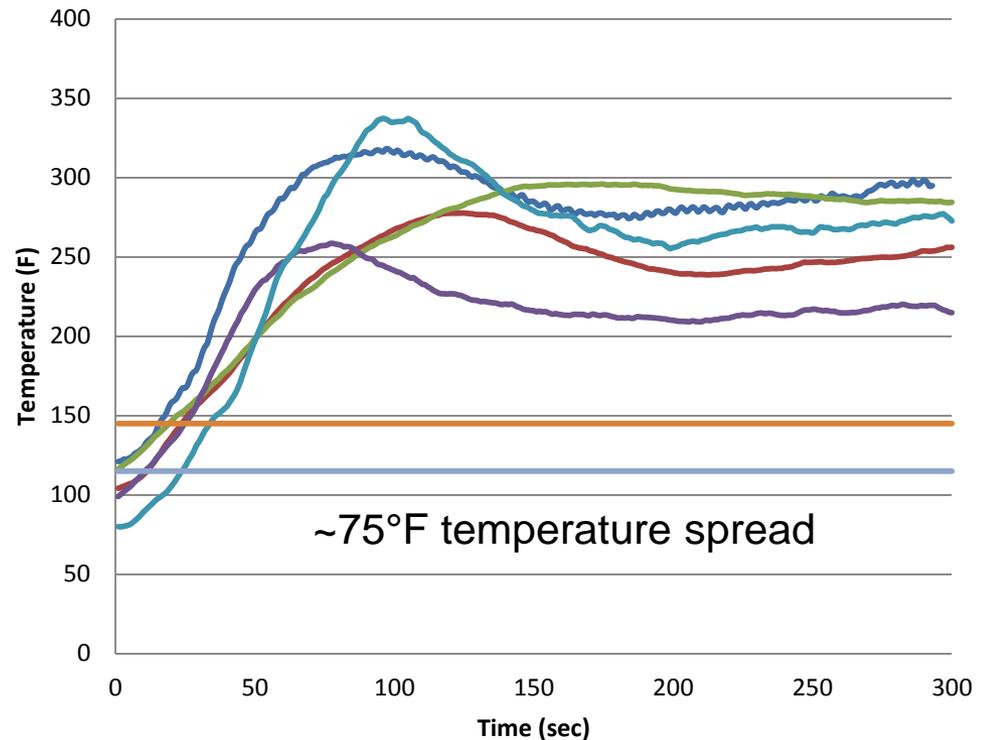
Stator/Turbulator Vs. FRH Results

- Data results shown are average material temperatures measured above the cargo liner test samples among participating round robin test labs
- Each color represents the average results of a participating test lab

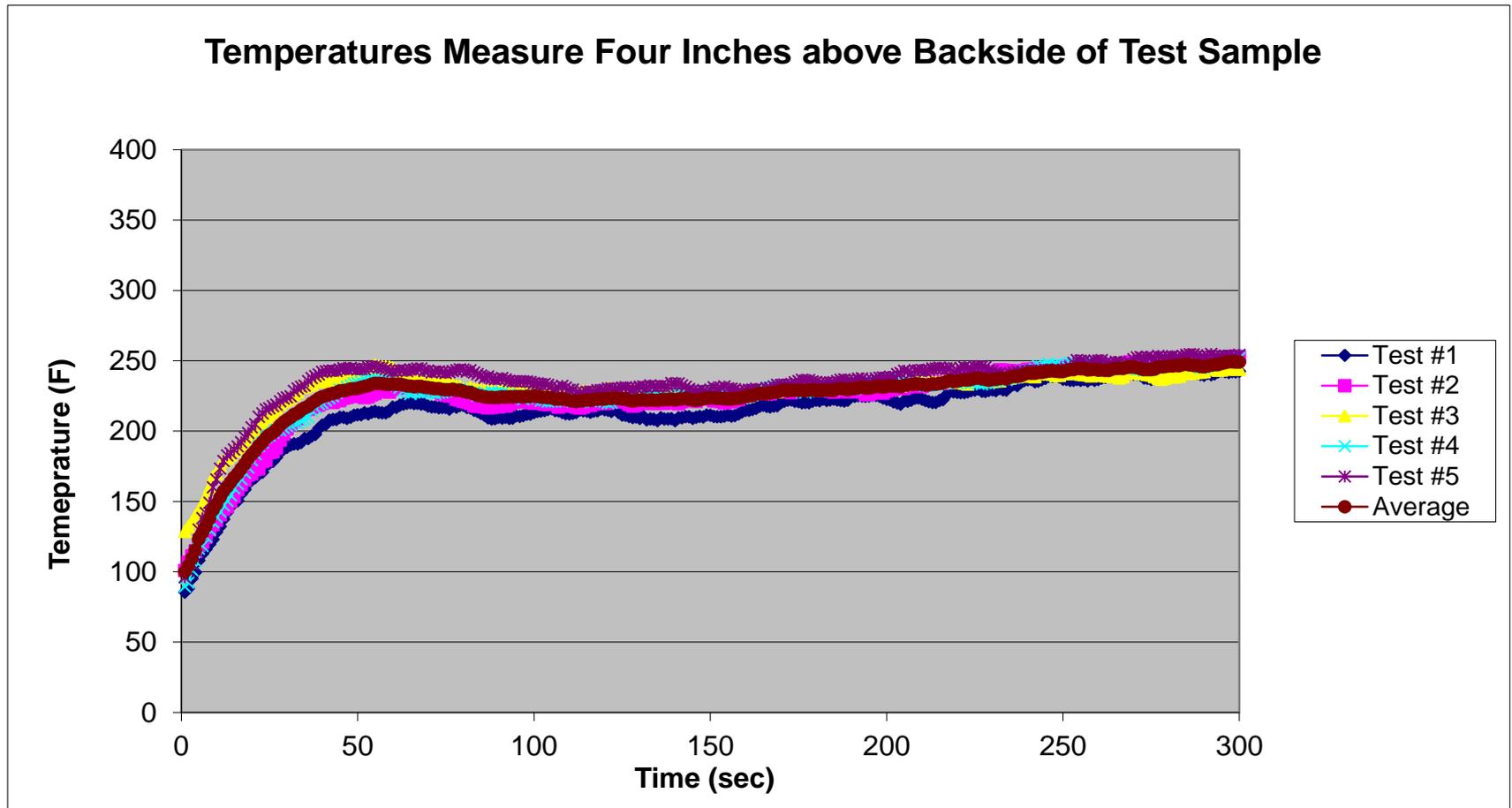
Round Robin 2012 using Stator/Turbulator



Round Robin 2013 using Flame Retention Head



Inside FAA Lab Results



Conclusion of 2013 Cargo Liner Round Robin

Turbulator



Stator

Flame Retention Head



Static Plate

Questions?

