Federal Aviation Administration

7th Triennial Conference on Cabin and Fire Safety

Flame Retention Head for use on the Sonic Oil Burner

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Introduction

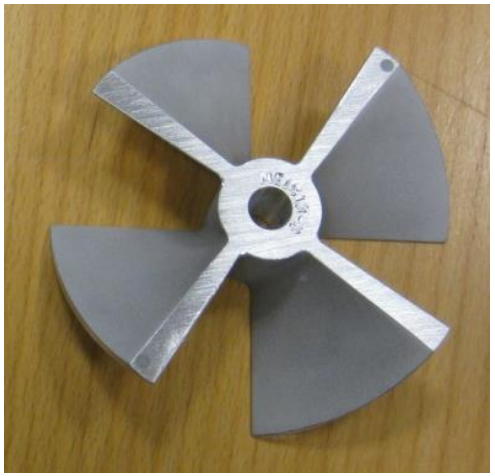
- **Previous interlab studies had shown the NexGen burner test results to be less repeatable than originally thought**
- **In the case of the Park burner, the stator and turbulator inside the burner draft tube could be adjusted to compensate for any irregularities in burner performance which might impact 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**

Revised Stator

- **Original Stator Design (Top)**
  - Incorporated mounting holes for clamping igniters in place which results in an asymmetrical design
  - Igniters and ignition wires in air stream possibly forcing the air to exit the burner to the left or right side

- **New Stator Design (Bottom)**
  - A symmetric design should generate a more even airflow
  - The igniters and ignition wires are eliminated from inside the burner draft tube
  - Burner flame must be ignited externally

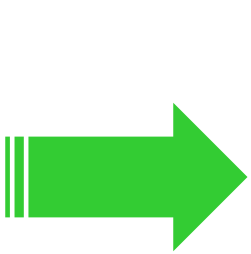
- **Results of Testing**
  - The NexGen burner was tested using the new stator design, but no noticeable improvements were found
  - In some case, test results worsened, and showed less resemblance to Park burner results
  - New stator design was abandoned



Old Vs. New Burner Internals

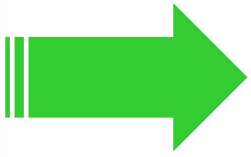
- **The original concept was to retain the same internals from the Park burner for use in the NexGen burner in order to keep burner performance similar**
- **After trialing the igniterless stator design with no success, other options were considered**
- **Oil burners on the market today no longer use 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

Function of the Flame Retention Head

- **The flame retention head (FRH) mounts to the end of the burner draft tube and generates a swirling motion in the flow of air exiting the burner which, combined with the fuel spray, creates a highly combustible mixture**
- **The design of the head also produces a flame that burns closer to the burner tube compared to the stator/turbulator configuration**
- **This results in a more efficient combustion of the air and fuel mixture as compared to the stator/turbulator, and a more uniform, repeatable flame**

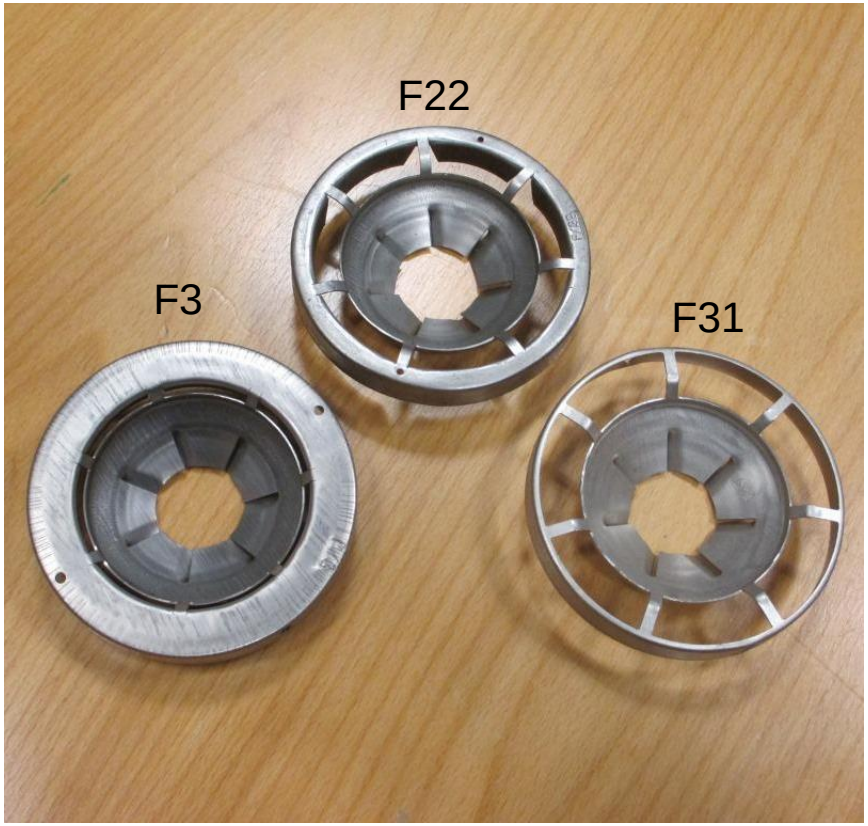
FRH vs. Stator and Turbulator

Flame Retention Head

Stator and Turbulator

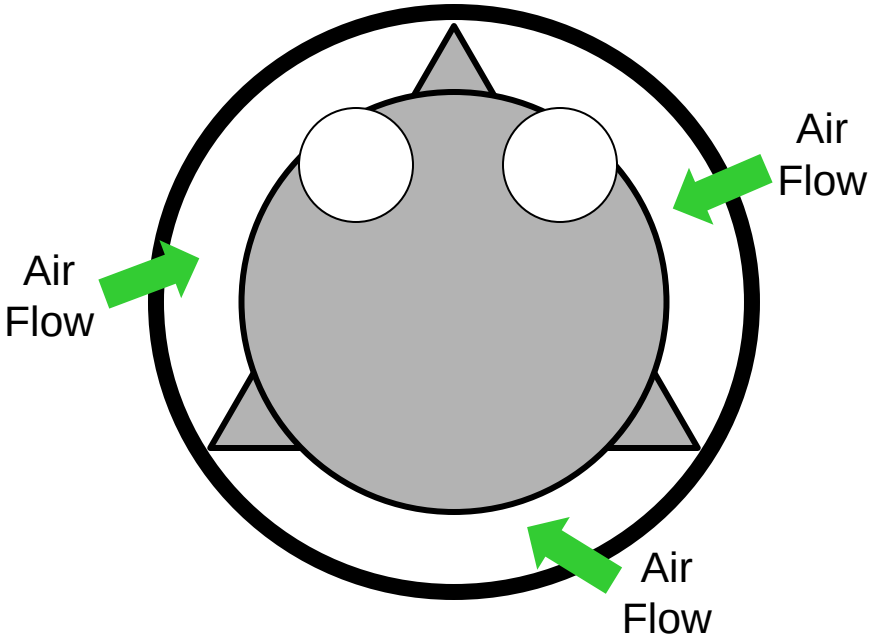
Performance of Different Retention Heads

- **Smaller holes increase combustion air velocity and make for a more concentrated, torch-like flame**
- **Larger holes reduce combustion air velocity and produce a lazier, fuller looking flame**
- **The NexGen burner currently uses the larger hole FRH (F31) for both the cargo liner and seat cushion tests**

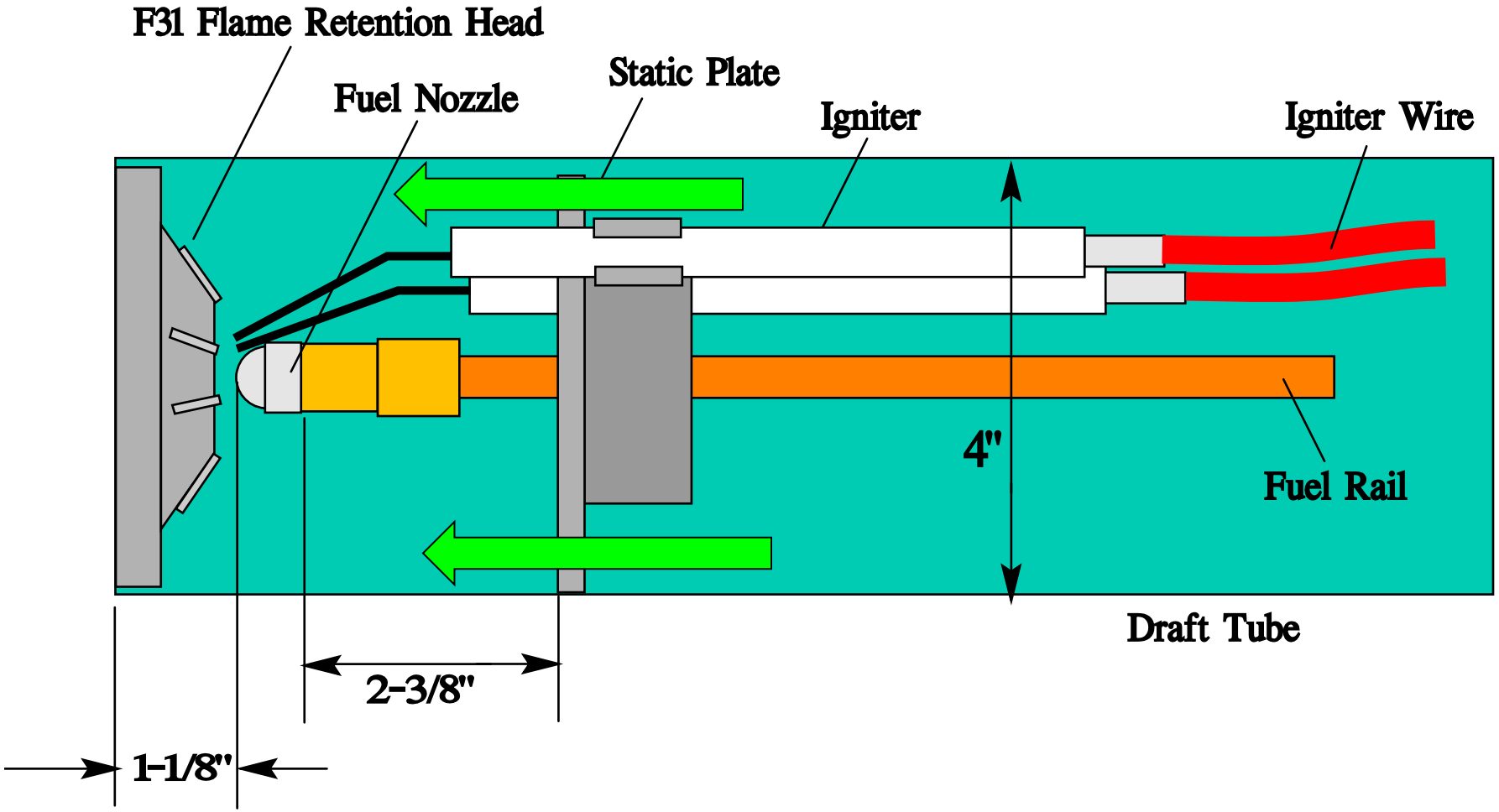


Static Plate

- **The static plate is upstream of the flame retention head inside the burner draft tube**
- **Air flow is channeled around the outer perimeter of the plate which increases combustion air flow uniformity through the draft tube**
- **This work to keep the flame even as it exits the burner cone**
- **Igniters are also held in place by the plate**



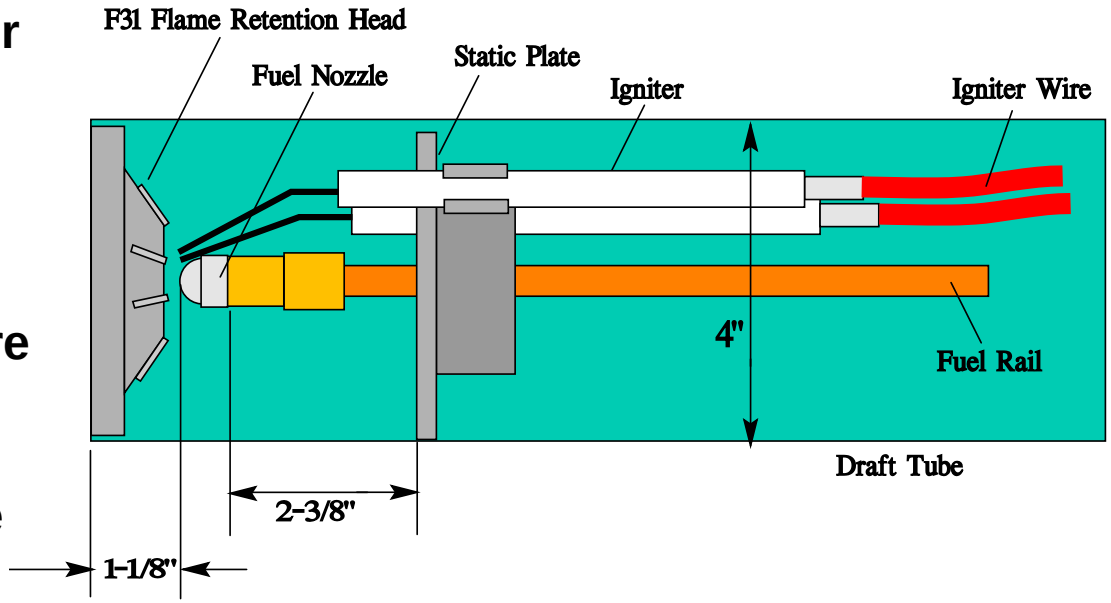
FRH and Static Plate in Draft Tube



FRH and Static Plate in Draft Tube

- **As with the stator and turbulator burner internals, the parts inside the burner draft tube must be positioned to specified locations**

- **The dimensions shown are nearly identical to those specified by the original manufacturer of the flame retention head**

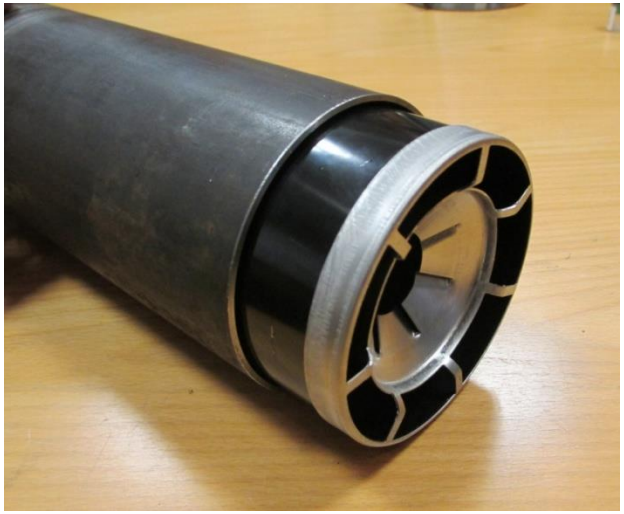


Draft Tube Assembly

- **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**
- **Spacer tube must be cut to the same length as draft tube (15 inches)**

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**



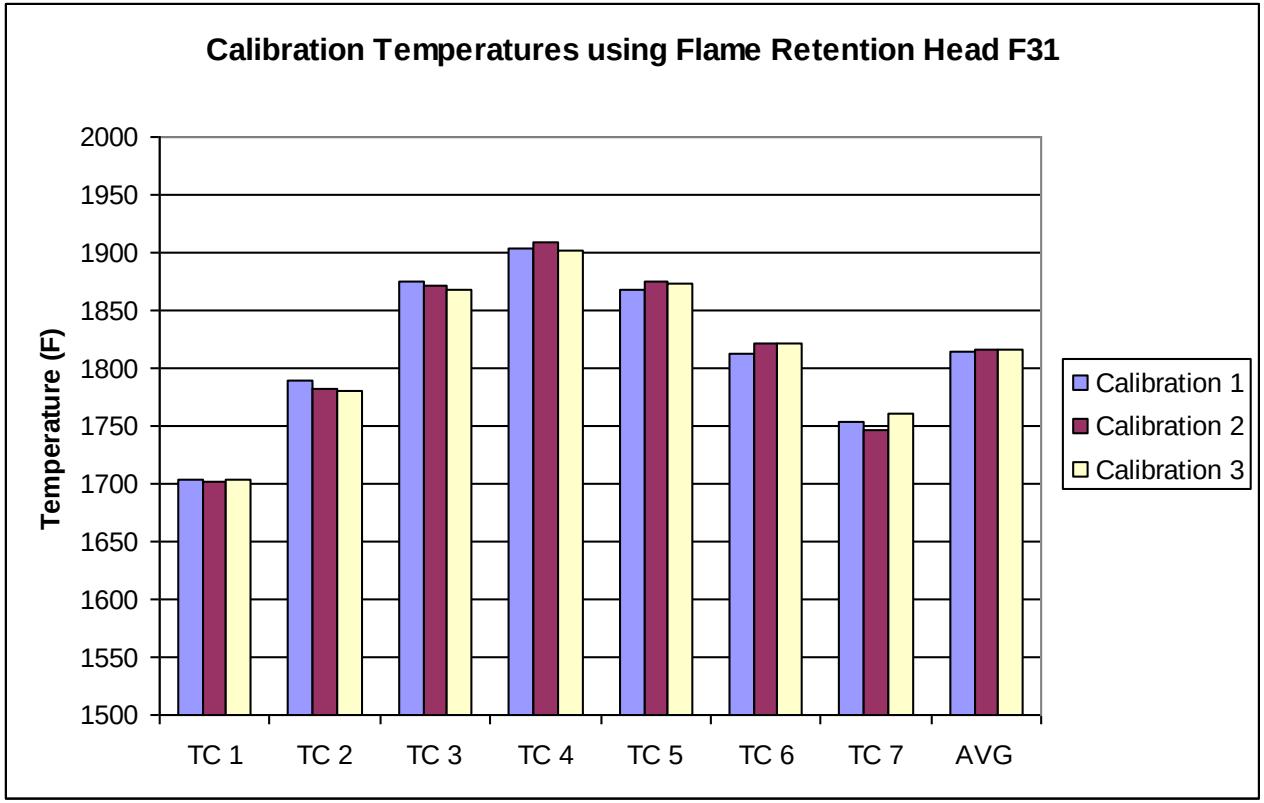
Burner Settings

- **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**

Development of Burner Settings

- **Began with manufacturer's recommend settings for placement of static plate and igniters**
- **Air pressure**
  - 20, 30, 40, 50, 60 psi tested
  - 45 psi chosen based on cargo liner test results
  - Same air pressure used on seat burner with FRH
  - Results appear to be consistent and similar to Park results
- **Nozzles**
  - Delavan B (solid spray pattern)
  - Delavan A (hollow spray pattern)
  - Delavan W (all purpose spray pattern)
  - W nozzle selected based on cargo and seat burner test results

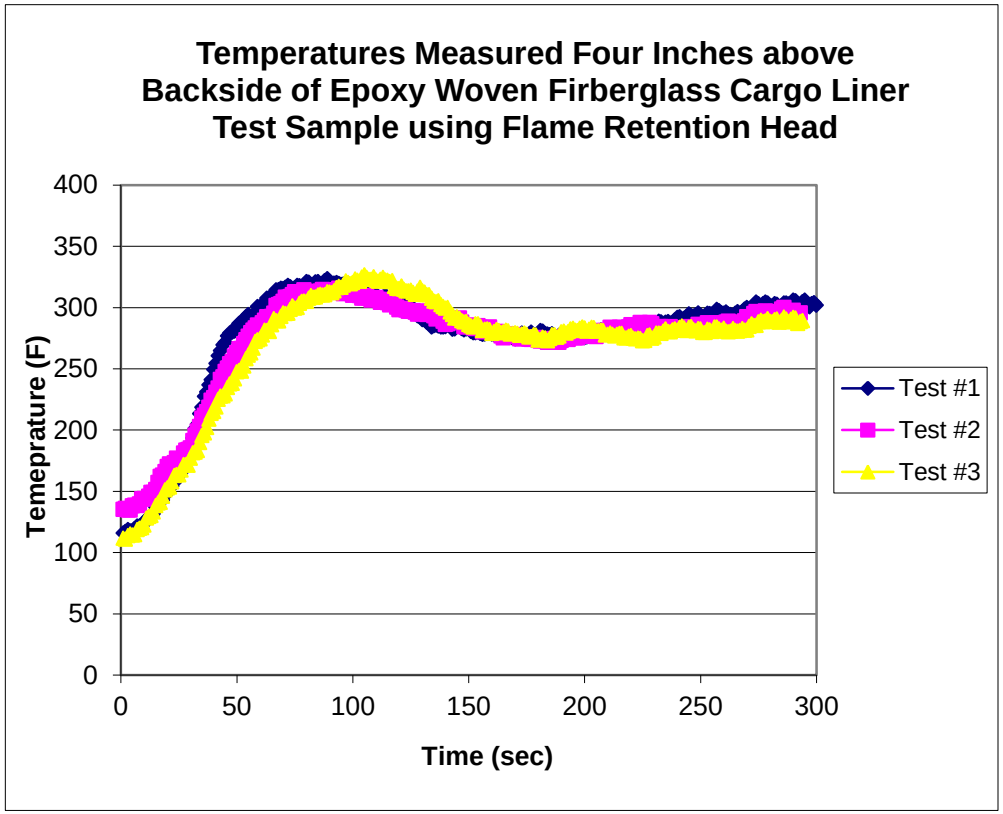
Flame Retention Head (FRH)



- **Extremely low variation of temperature**
- **Less than 1°F variation of averaged temperatures**

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

2013 Cargo Sonic Burner w/FRH Round Robin

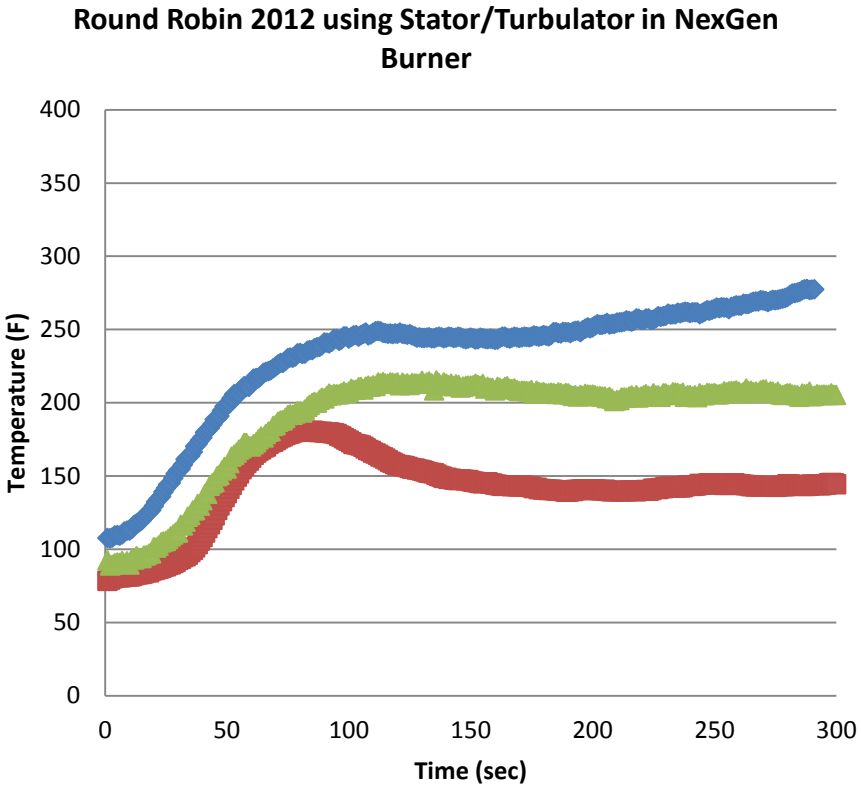
- **2013 round robin for sonic cargo burner currently underway**
- **5 labs currently participating, including FAA lab**
- **FAA has supplied each lab with a fuel nozzle, burner cone, modified draft tube, spacer tube, flame retention head, static plate, and test samples**
- **3 types of samples provided**
  - Heavy, woven fiberglass/epoxy liner (5 pieces)
  - Light, semi-rigid liner (3 pieces)
  - Polyacrylonitrile (PAN) felt (5 pieces)

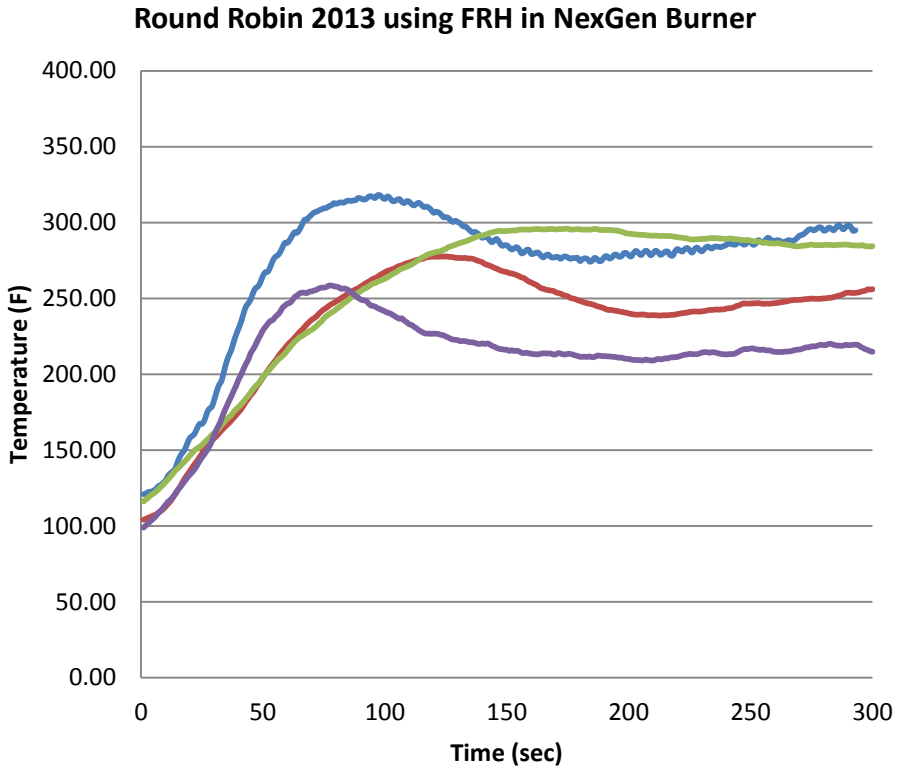
Cargo Sonic Burner Round Robin

- **Different sample materials will burn through at different rates, or show different temperature profiles measured 4 inches from the back-side of the sample**
- **Results should further reinforce the advantages of using the flame retention head in the sonic burner as an improvement over the stator and turbulator**
- **RR results from participating labs should demonstrate that FRH is a suitable replacement for the stator/turbulator setup**
- **Need RR results in order to finalize burner settings and design**
  - RR to be competed by next meeting in March 2014

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**





Questions?