



**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

By: Tim Salter, FAA Technical Center

Date: March 6-7, 2013, Renton, WA



# Previous Meeting Items

- **Sonic settings using stator and turbulator**
- **Overview of flame retention head**
- **Cargo sonic burner round robin**
- **Alternative methods of sonic burner plumbing for air supply**
  - Lowering overall height of burner
- **Thermocouple data drift and calibration**
  - To be discussed further during seat cushion oil burner presentation

# Summary for this Meeting

- **Update regarding alternate method of burner air supply plumbing**
- **Information regarding flame retention head**
- **Initial data results from testing with flame retention head**
- **Sonic cargo burner round robin update**

# Main Objective: Transition from Park Burner to Sonic Burner



# Baselining of Park Burner

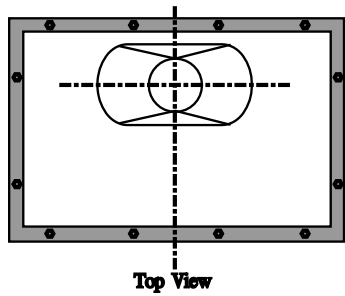
1. Generate calibration temperature results with FAATC Park burner apparatus
  - Results will be used to calibrate Sonic burner apparatus
  
2. Generate test results with FAATC Park burner apparatus
  - Results will be used to correlate sonic burner (B/T times and temp vs. time plots)
  - 3 styles of liner and 1 PAN felt have been tested
  - 2 additional materials also tested
  - **6 materials total being used for testing and comparison**

# Alternative Air Supply Plumbing

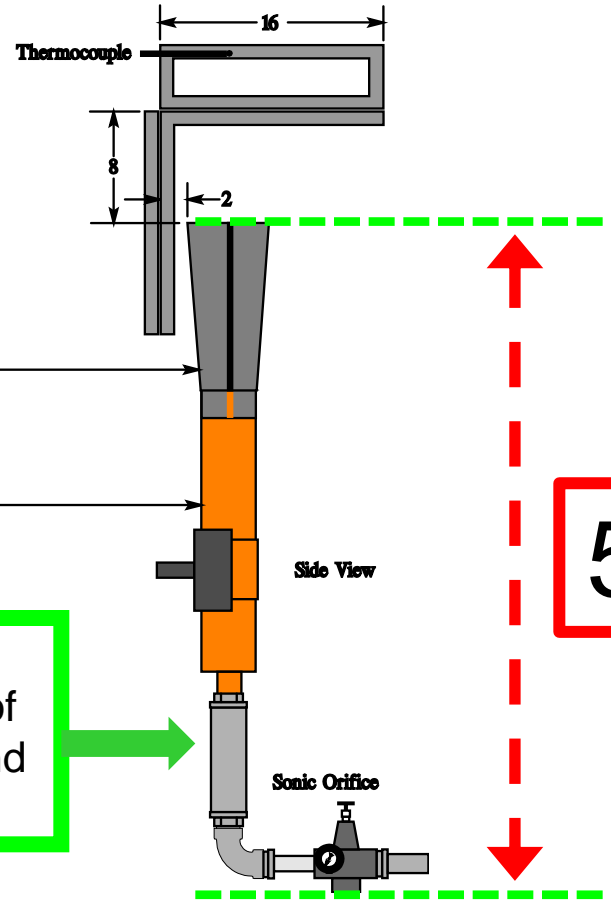
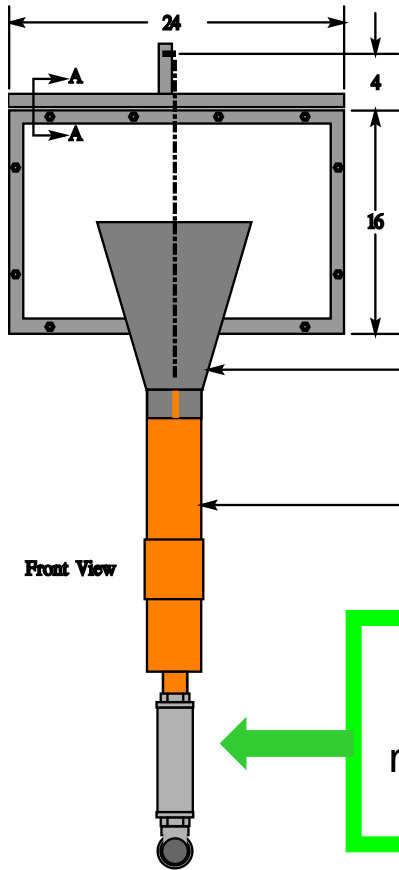
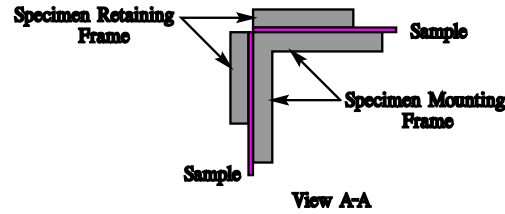
- **FAA's sonic cargo burner uses hard lines for fuel and air supply plumbing**
- **Current FAA burner arrangement limits test chamber construction/design due to burner height**
  - Difficult to see back-side of sample in some test chambers
- **FAA tested soft air/fuel supply lines which had potential to allow more flexibility with regard to burner construction**

# Alternative Air Supply Plumbing

- **Distance from test chamber floor to exit plane of burner cone**
  - FAA Park burner height: 54”
  - FAA sonic burner height: 53”
- **FAA sonic burner cone exit plane is currently 1” lower than FAA Park burner cone exit plane**
  - Sonic burner was constructed with the intent that it be no taller than the Park burner
  - Consider possible effects of air supply plumbing
  - Bends/elbows have shown to impact burner performance



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



•Current location of muffler and elbow

53"



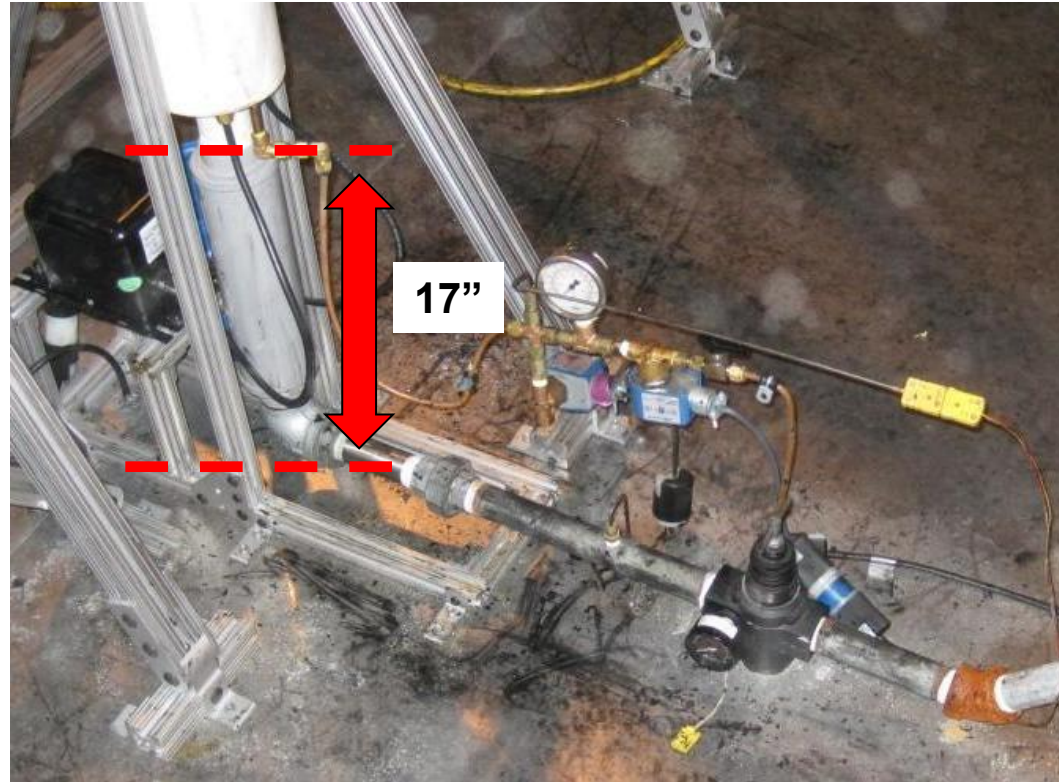
# Alternative Air Supply Plumbing

- Industry has suggested relocating muffler, elbow, and sonic choke to reduce the height of the burner cone exit plane and sample rig
- FAA burner air supply plumbing shown in picture



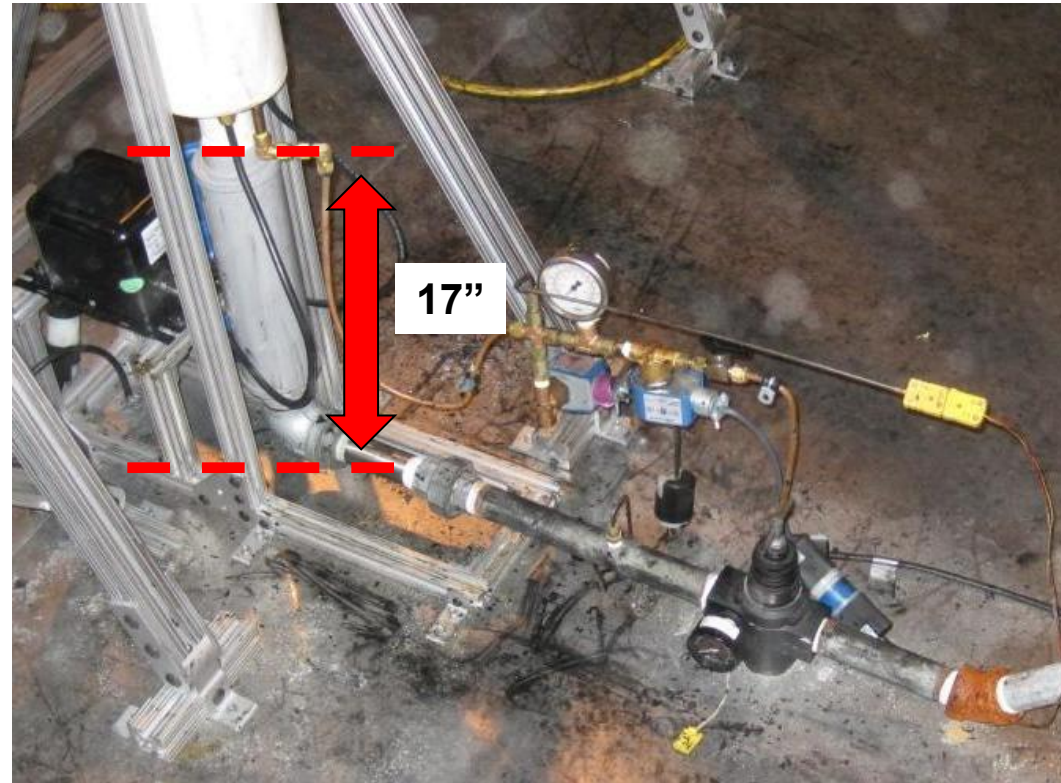
# Alternative Air Supply Plumbing

- Muffler packed with reticulated foam helps to even out the flow of the air after elbow
- Change in airflow direction due to elbow has shown to impact burner performance without use of muffler/foam
- Distance from top of muffler to test chamber floor is currently 17"



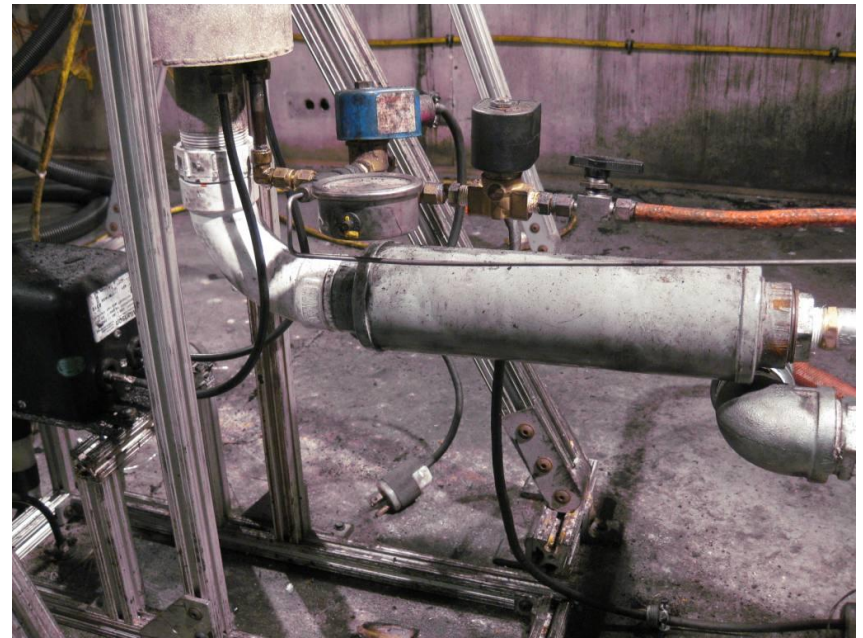
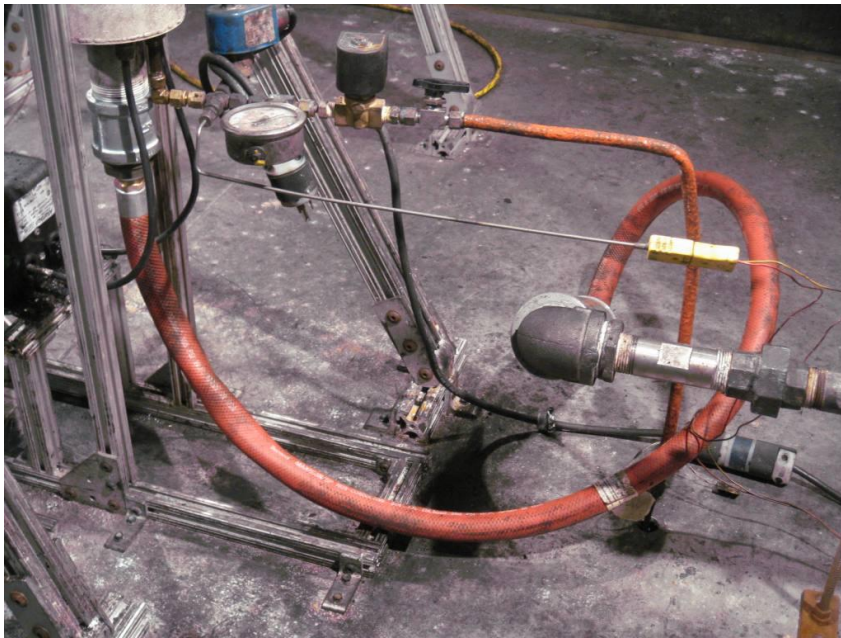
# Alternative Air Supply Plumbing

- Utilizing a  $\frac{3}{4}$ " ID rubber hose and appropriate pipe fittings, the height of the burner may be lowered 8"
- The height of the burner will depend upon the NPT fittings/adapters used, and also the bend radius of the flexible air supply hose
- Use of a swept elbow also a possibility



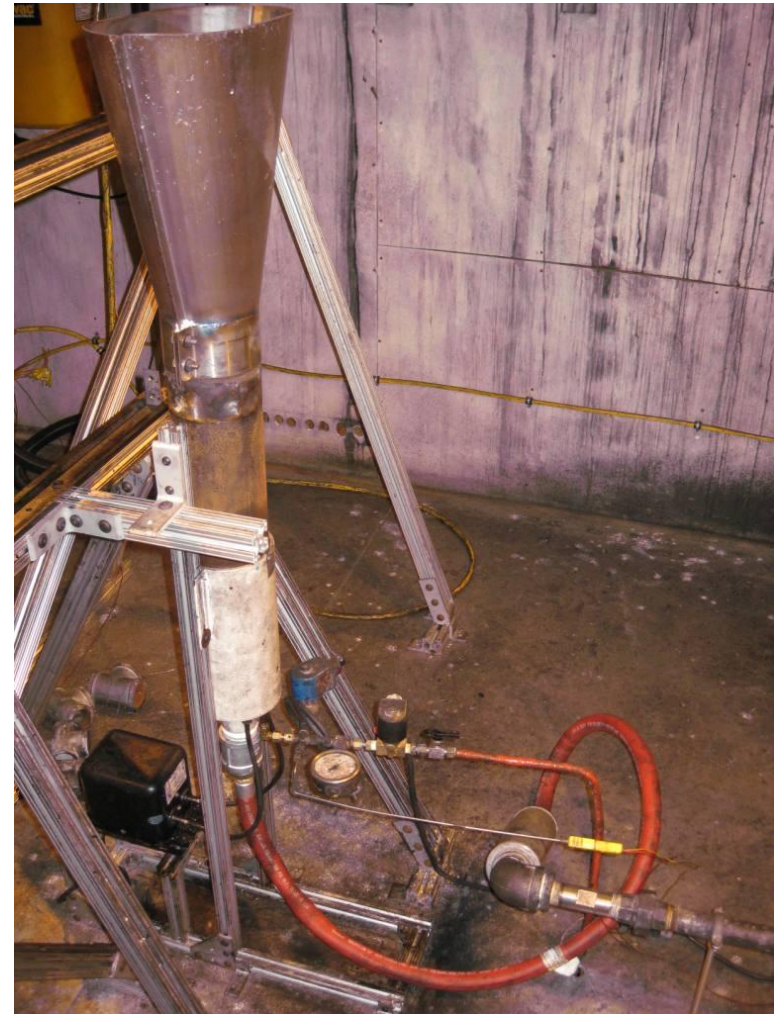
# Alternative Air Supply Plumbing

- **Two different configurations tested**
  - Flexible rubber air hose
  - Rearrange placement of muffler with swept elbow



# Alternative Air Supply Plumbing

- **Burner flame extremely sensitive to direction in which rubber hose enters the back of the burner draft tube**
- **Slight movements of the hose had a significant impact on temperatures measured during calibration**



# Alternative Air Supply Plumbing

- **Replacing muffler and hard lines resulted in highly skewed flame temperatures during calibrations**
- **Not viable options using stator/turbulator**
- **Further testing planned when running flame retention head**

•Hose entrance @ 90 degrees from burner tube

	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	AVG
Cal 1	1194	1372	1527	1623	1647	1633	1605	1514
Cal 2	1150	1308	1458	1572	1622	1631	1637	1482
Cal 3	1137	1288	1438	1558	1609	1621	1633	1469

•Hose entrance @ 180 degrees from burner tube

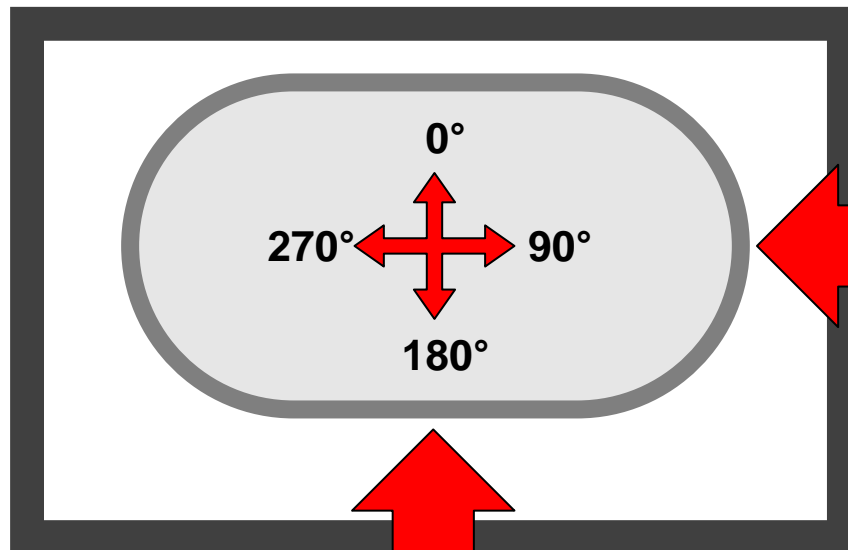
	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	AVG
Cal 1	1565	1590	1567	1562	1495	1356	1214	1479
Cal 2	1577	1618	1601	1594	1530	1398	1257	1511
Cal 3	1585	1618	1600	1598	1534	1384	1226	1506

•Swept elbow entrance @ 180 degrees from burner tube

	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	AVG
Cal 1	1620	1627	1592	1519	1332	1168	1096	1422
Cal 2	1640	1659	1640	1596	1409	1241	1196	1483
Cal 3	1638	1652	1635	1597	1402	1226	1156	1472

# Alternative Air Supply Plumbing

## Back Panel Side of Sample Rig



### •Hose entrance @ 90 degrees

TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	AVG
1194	1372	1527	1623	1647	1633	1605	1514
1150	1308	1458	1572	1622	1631	1637	1482
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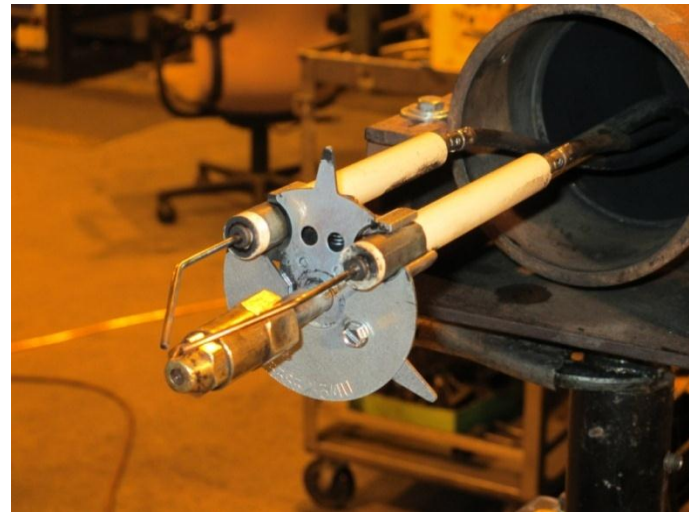
### •Hose entrance @ 180 degrees

TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	AVG
1565	1590	1567	1562	1495	1356	1214	1479
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•Diagram shows view as seen from directly above burner cone exit plane

# Flame Retention Head (FRH)

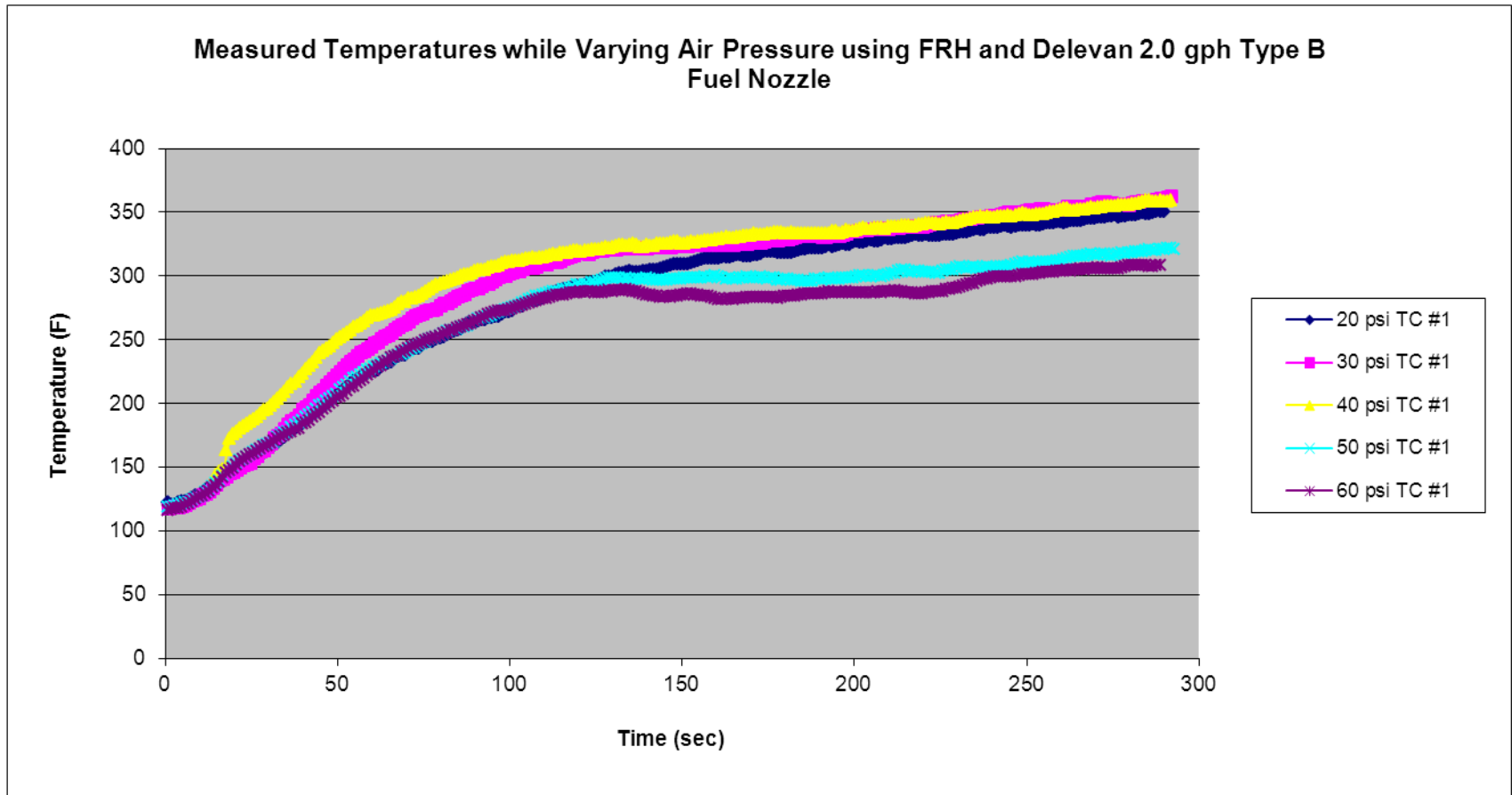
- **Eliminates the need for a stator and turbulator**
- **Fits on end of burner draft tube with minimal modification**
- **Parts purchased from local heating supply store for less than \$50**
- **Initial testing showed potential for improved test result repeatability as compared to stator and turbulator configuration**





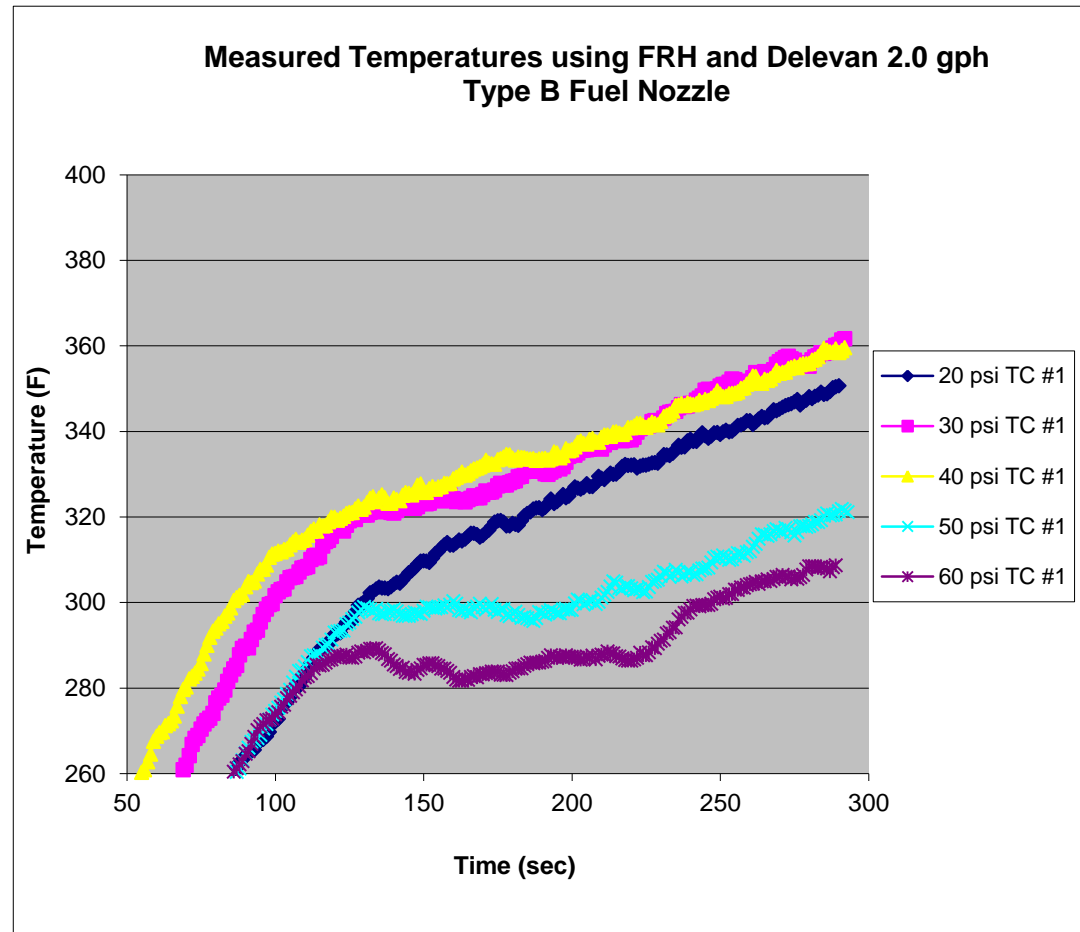
# Flame Retention Head (FRH)

- Temperatures measured 4 inches above backside of cargo liner material



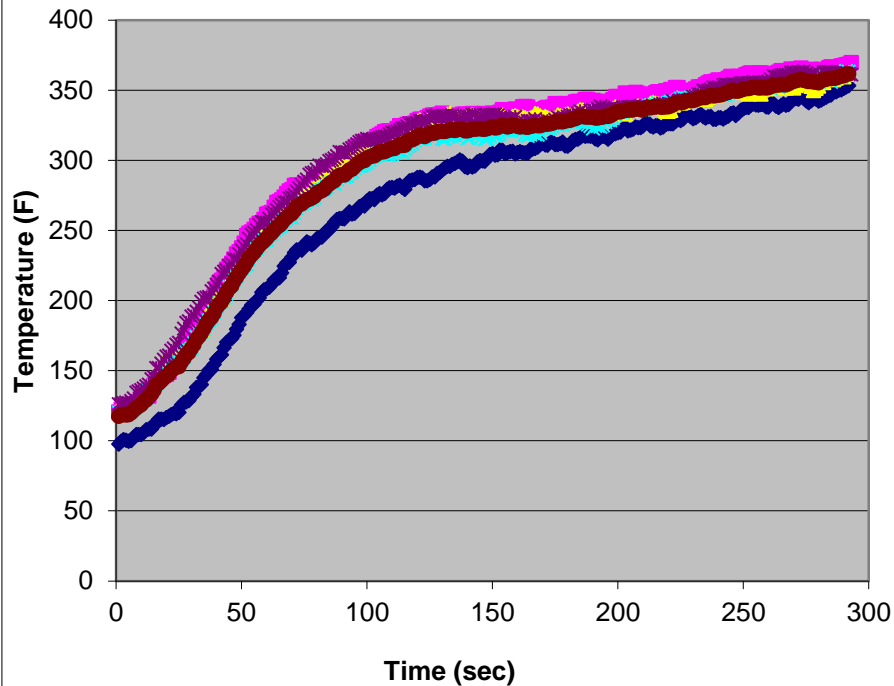
# Flame Retention Head (FRH)

- **Flame retention head (FRH) shows resistance to changes in air pressure which should lead to improved test result repeatability**
- **Burner would likely be run in the 30-40 psi range**
- **Currently testing different air pressures, fuel nozzle spray patterns, and internal burning settings**

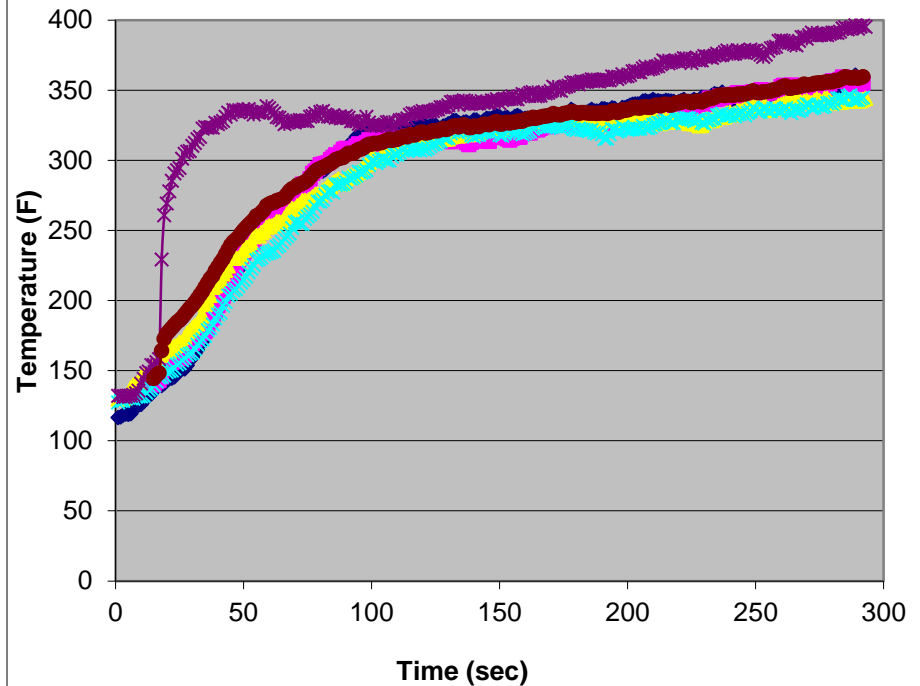


# Flame Retention Head (FRH)

Cargo Liner Temperatures with Flame Retention Head @ 30 psi Air Inlet Pressure



Cargo Liner Temperatures with Flame Retention Head @ 40 psi Air Inlet Pressure



# Cargo Sonic Burner Round Robin

- **Round robin for sonic cargo burner currently underway**
- **3 labs currently participating**
  - FAA Technical Center lab included
- **FAA has supplied each lab with a fuel nozzle, burner cone, 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 substantiate sonic burner settings developed as a replacement for the Park burner**
- **Currently looking for more labs with cargo sonic burners that are interested in participating in round robin**

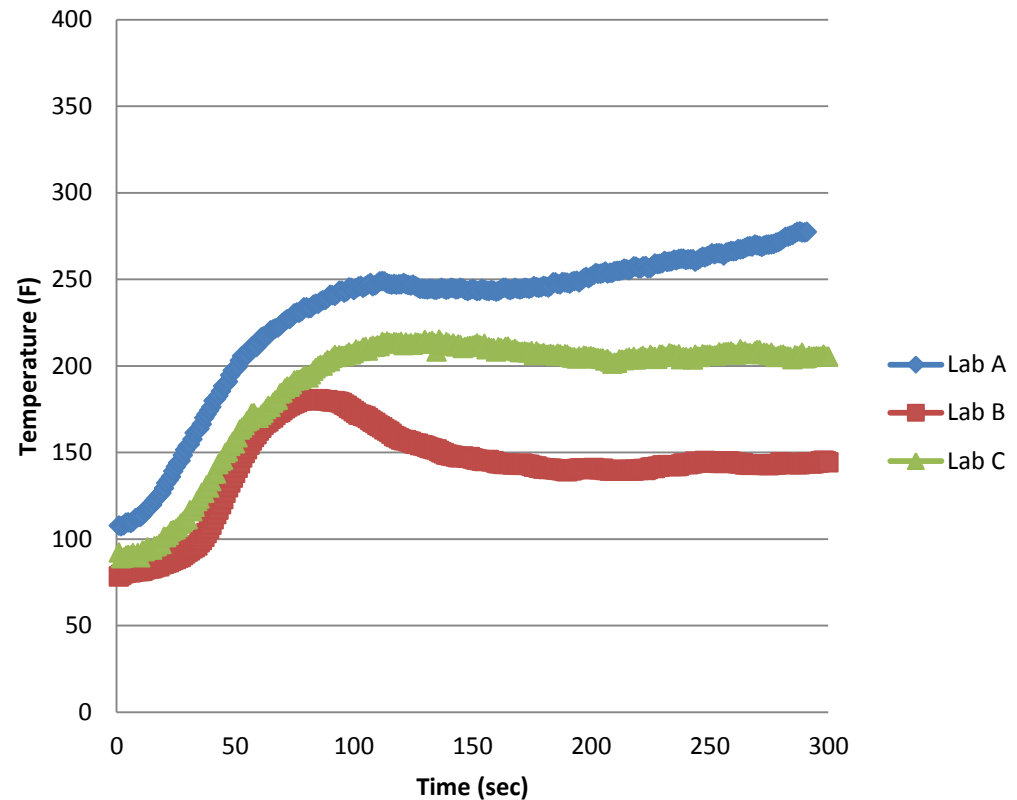
# Cargo Sonic Burner Settings

- **Sonic burner settings for use as Park burner replacement using stator and turbulator**
  - All depths are measured from the exit plane of the turbulator to the nozzle tip or front stator face
  - Recommended Nozzle: Delevan 2.0 gal/hr 80° type B
  - Nozzle Depth: 9/16”
  - Stator Depth: 3 5/16”
  - Stator Angle: 270° (centerline from vertical)
  - Turbulator: Notch will face bottom of tube (180°)
  - Air Pressure: 47.5 psi
  - Air Temperature: 40-60°F
  - Fuel Temperature: 32-52°F

# Sonic Cargo Burner Round Robin

- Initial test results show a significant difference in temperatures measured above the backside of cargo liner materials
- Burner at all labs appear to be setup identical
- Temperature differences may be due to size of lab test area, ventilation, or other reasons not a result of the burner itself

Average Temperatures Measured 4 Inches above Backside of Cargo Liner Material



# Cargo Sonic Burner Round Robin

- **Measured time to burn through for Textech felt material was relatively consistent and similar among labs**
- **Percent standard deviation is below 10% for all labs**

	Lab A	Lab B	Lab C
	Time (sec)	Time (sec)	Time (sec)
	393	334	387
	351	363	353
	386	380	342
	378	403	
	342	408	
avg	370	378	361
stdev	22.33	30.37	23.46
%stdev	6.03	8.04	6.50



# Planned Activities

- **Research effects of test area size as well as type of air ventilation**
- **Continue FRH development and testing**
- **Complete current round robin using stator and turbulator configuration**
- **Plan for future round robin using FRH**
- **Conduct testing of various cargo design features to support development of advisory material**

# Questions?

