International Aircraft Materials Fire Test Working Group Meeting

Task Group Session on Revised Cargo Liner Test

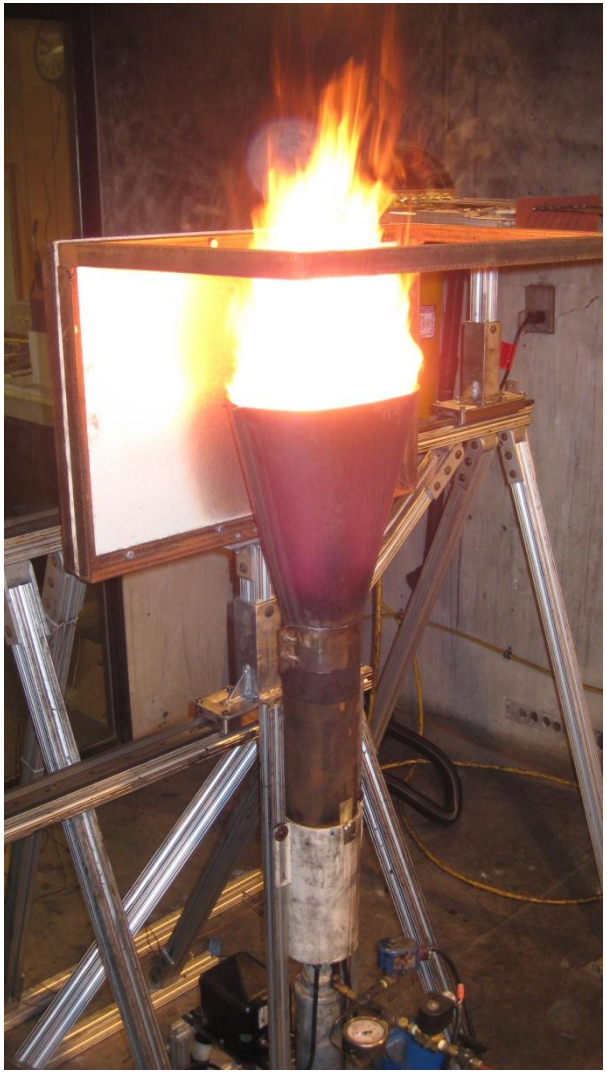
Presented to: International Aircraft Materials Fire Test Working Group, Indianapolis, Indiana

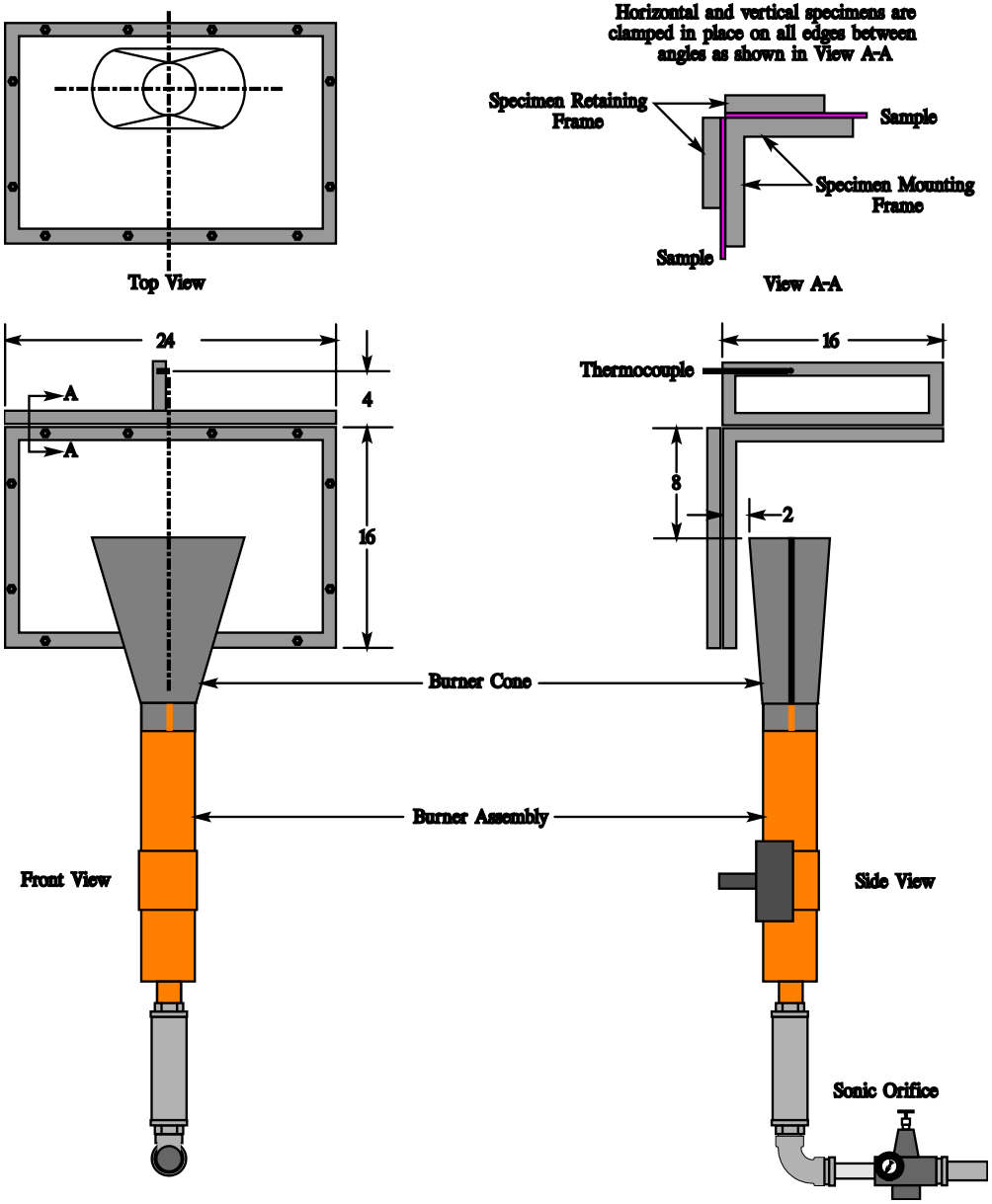
By: Tim Salter, FAA Technical Center

Date: October 16-17, 2012

Federal Aviation Administration

Main Objective: Transition from Park Burner to Sonic Burner



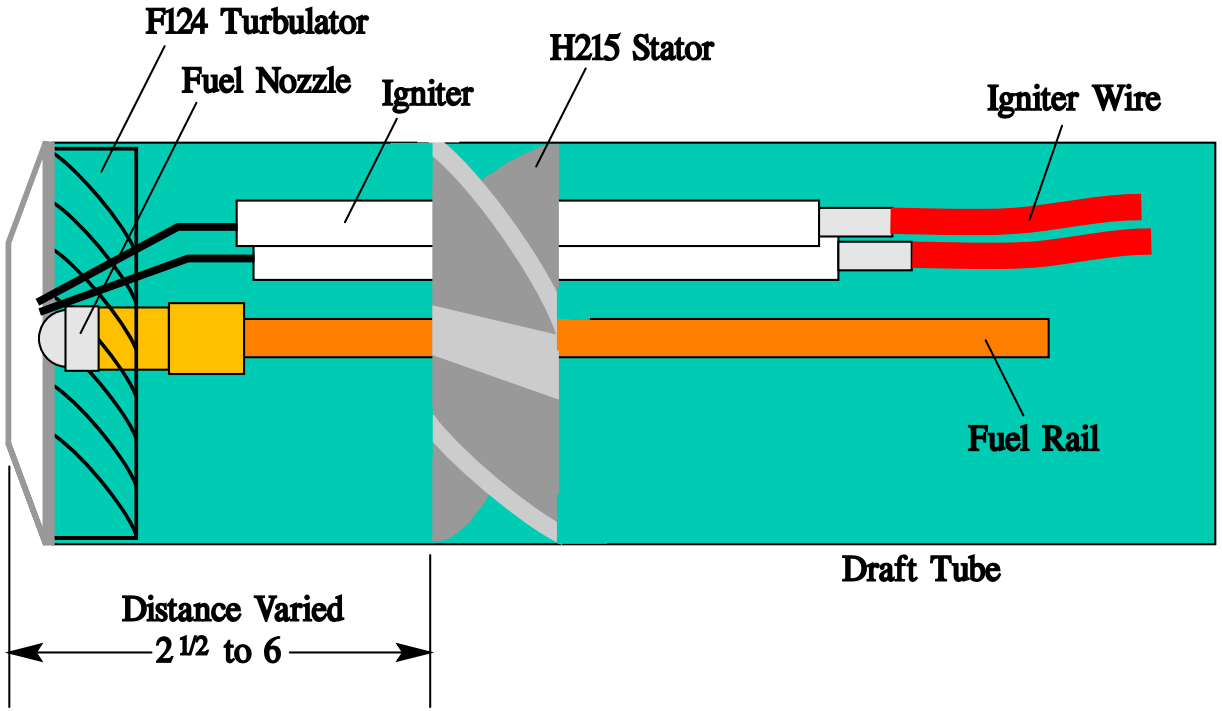

Horizontal and vertical specimens are clamped in place on all edges between angles as shown in View A-A
Specimen Retaining Frame
Sample
Specimen Mounting Frame
Sample
Top View
View A-A
24
4
16
A
A
16
Thermocouple
8
2
Burner Cone
Burner Assembly
Front View
Side View
Sonic Orifice

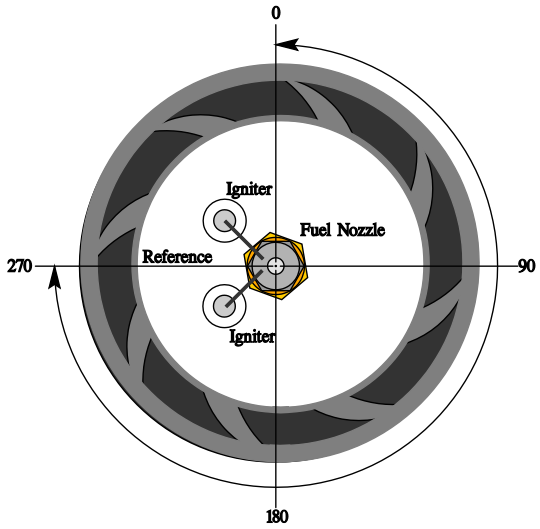
Baselining of Park Burner

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

Initial Sonic Burner Settings and Calibration





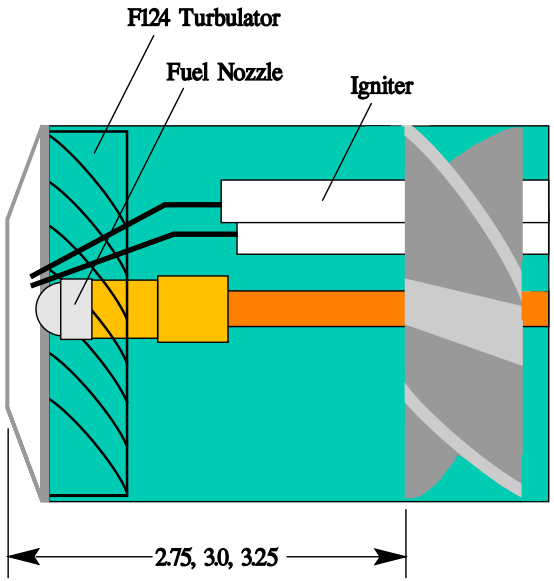
8 Positions (2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0) X 4 Angles (0º, 90º, 180º, 270º)

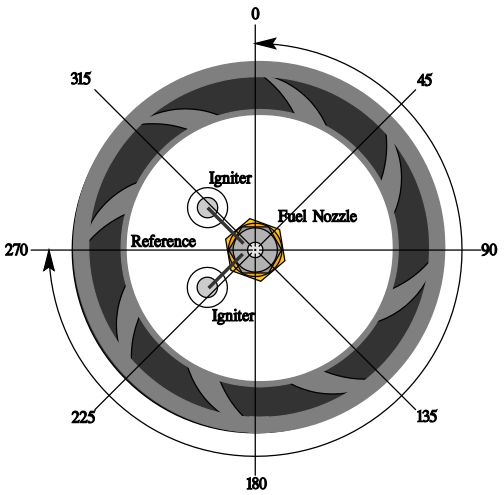
= 32 Combinations

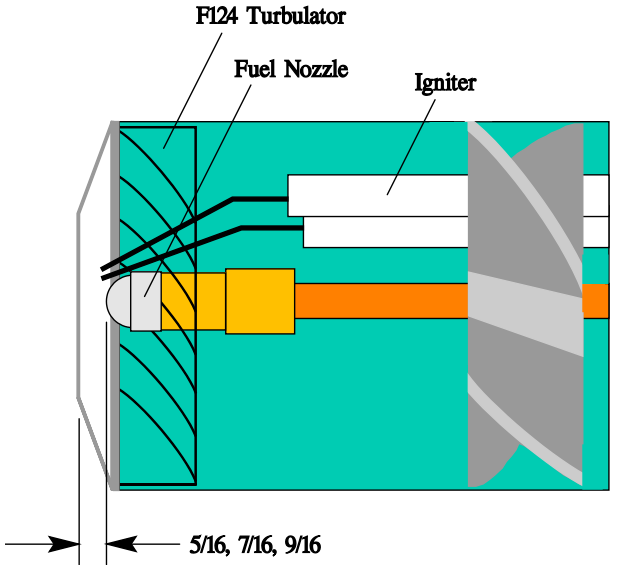
Refining Sonic Burner Settings

- **Burner then tested using a number of smaller adjustments**
- **Adjustments made in positions where burner showed adequate performance**
- **Stator face to turbulator exit plane varied:**
  - 2.75, 3.0, and 3.25 inches (3 positions)
- **Stator rotational position on fuel rod**
  - 0-360° in increments of 45° (8 positions)
- **Nozzle depth from turbulator exit plane**
  - 5/16, 7/16, and 9/16 inches (3 positions)
- **Total of 72 unique combinations tested**

Refining Sonic Burner Settings







3 Positions X 8 Angles X 3 Depths

= 72 Combinations

= LOTS OF DATA

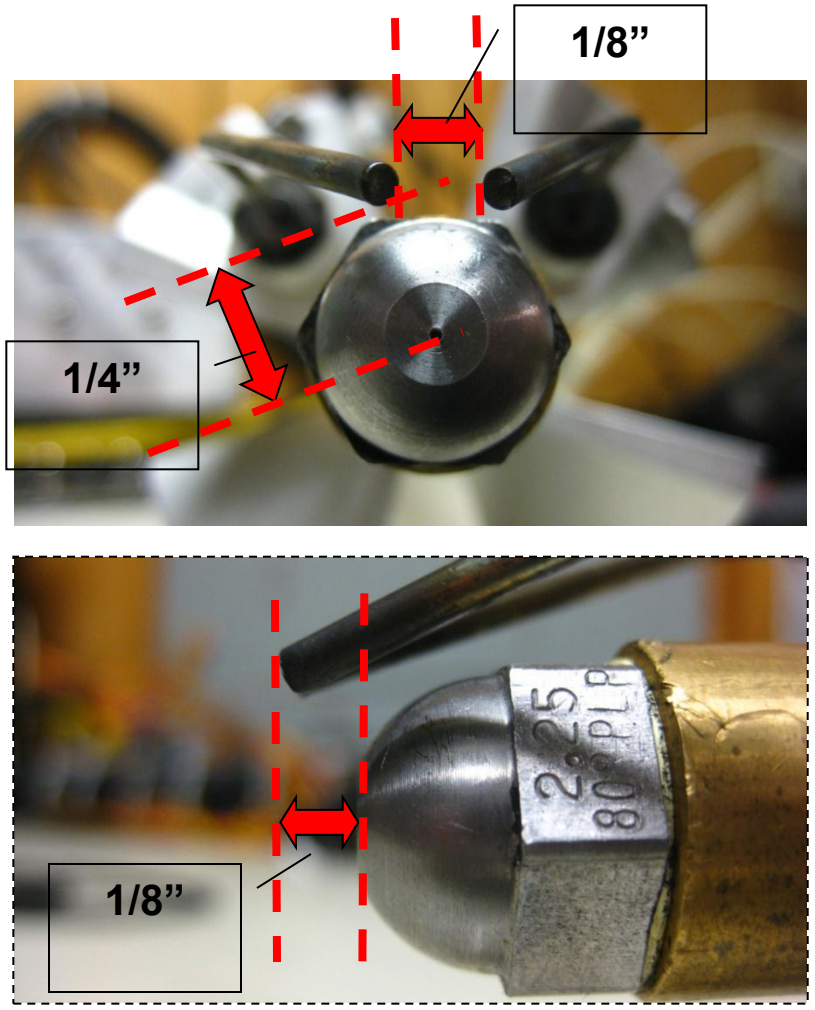
Cargo Sonic Burner Settings

- **Sonic burner settings for use as Park burner replacement**
  - 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 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

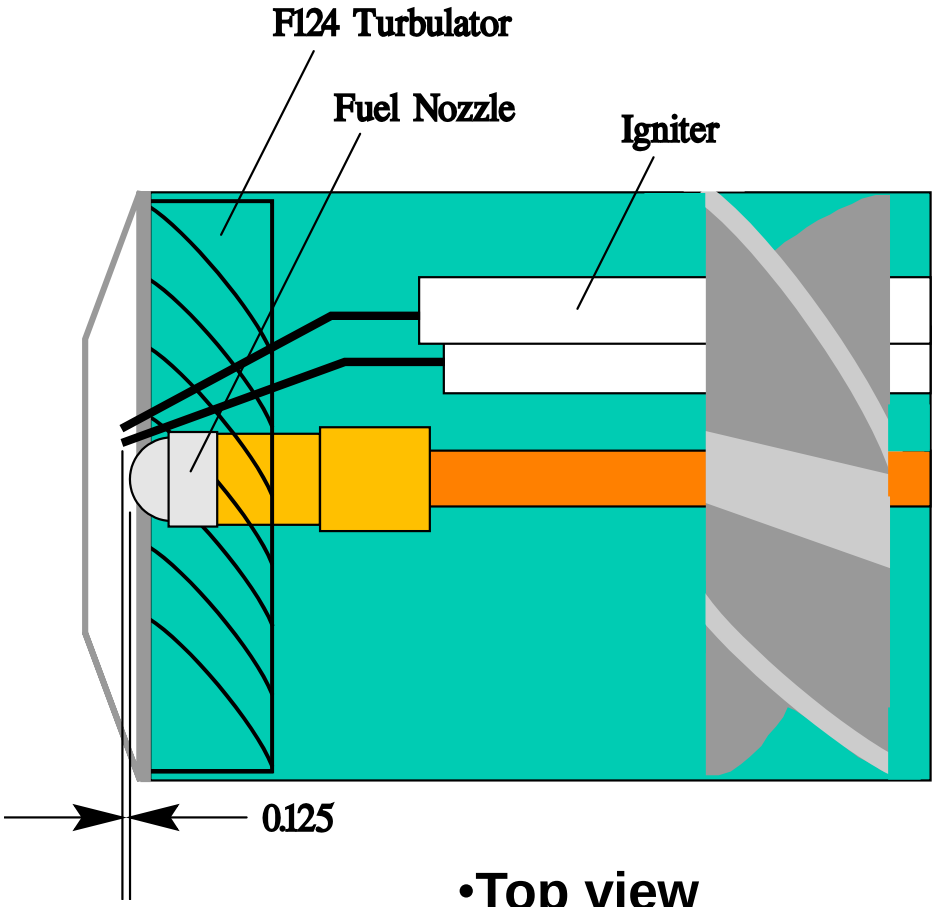
New Standardized Igniter Positions

- **Gap between igniters**
  - 1/8”
- **Nozzle center to igniter**
  - ¼”
- **Nozzle face to igniter**
  - 1/8”

*Diagrams shown only for igniter tip spacing

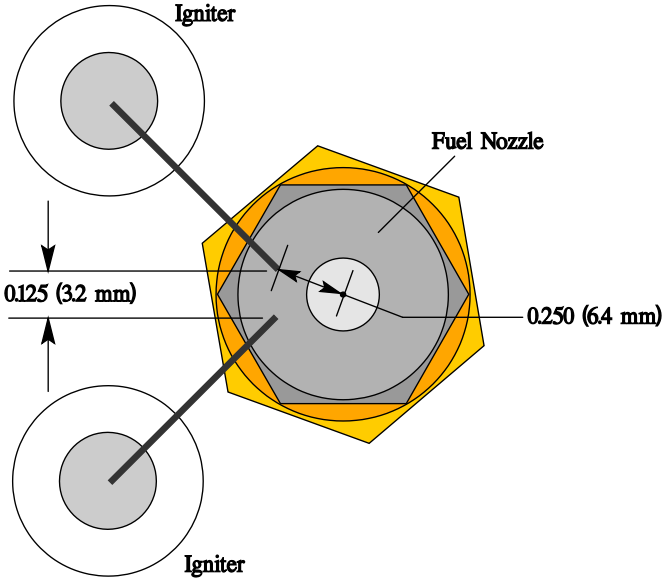


Igniter Positions



•Top view

(side facing sample wall on test rig)

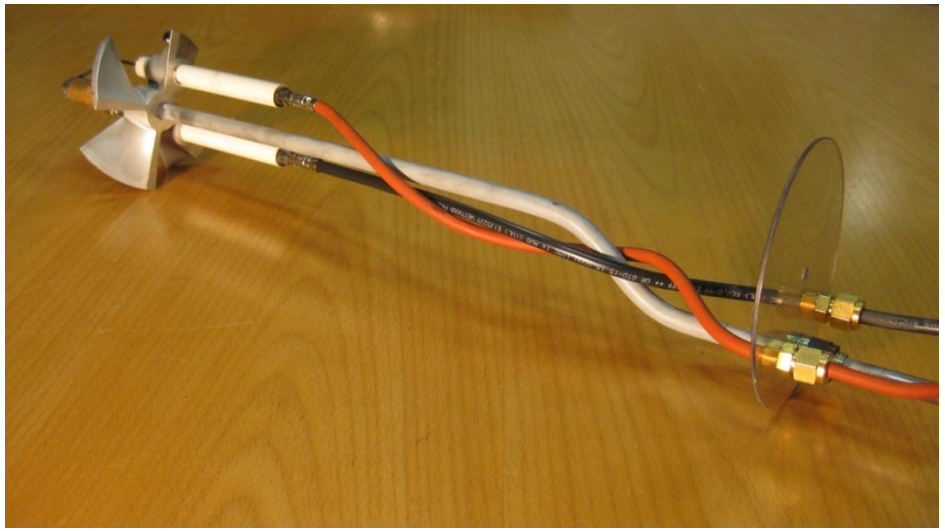


•Front view

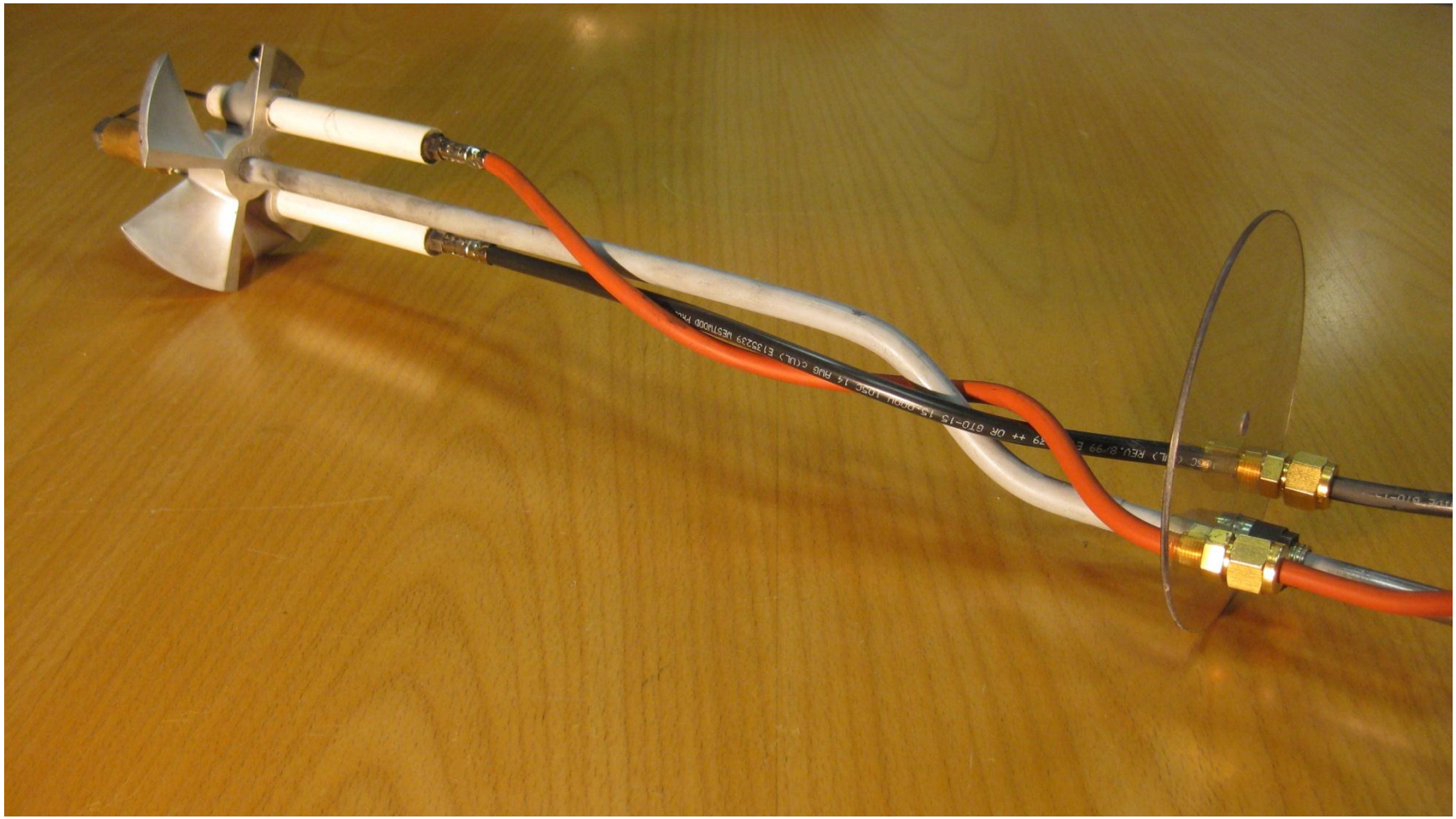
(looking into cone)

Ignition Wires

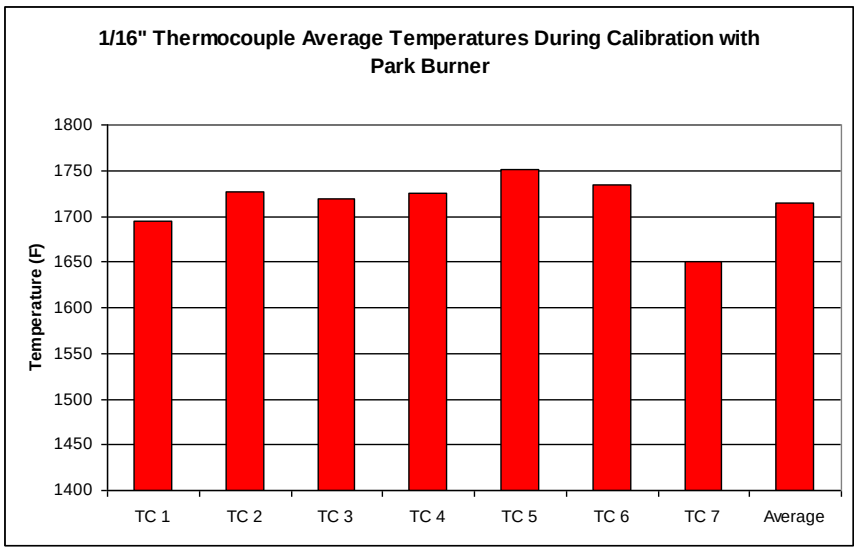
- New wire length and routing scheme minimize airflow disturbance
- Wires should be positioned exactly as shown in picture
- It is important to ensure each wire crosses over or under the other wire or fuel rod as shown
- There should be no slack or excess wire length
- Wire lengths (tip of metal wire terminal to rear of draft tube)
  - Red: 13.75”
  - Black: 13.5”

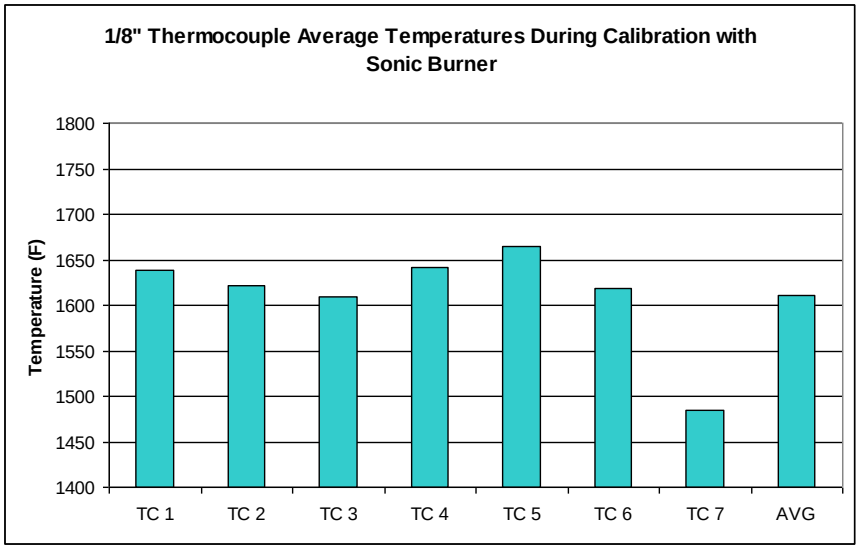


New Ignition Wire Routing Method



Final Sonic Settings: Calibration



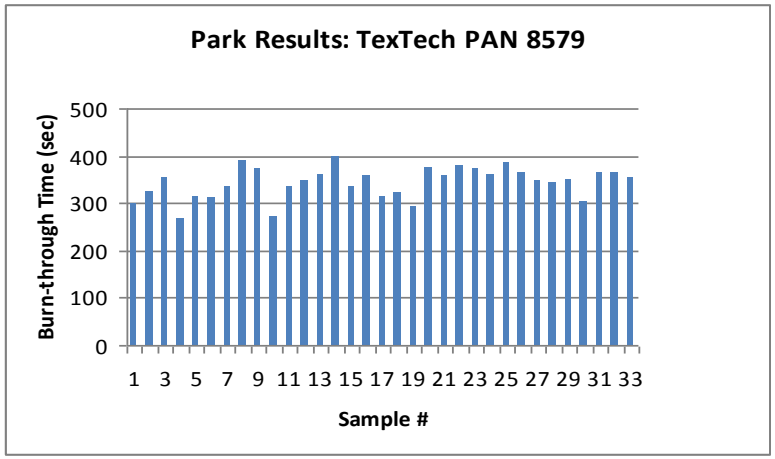


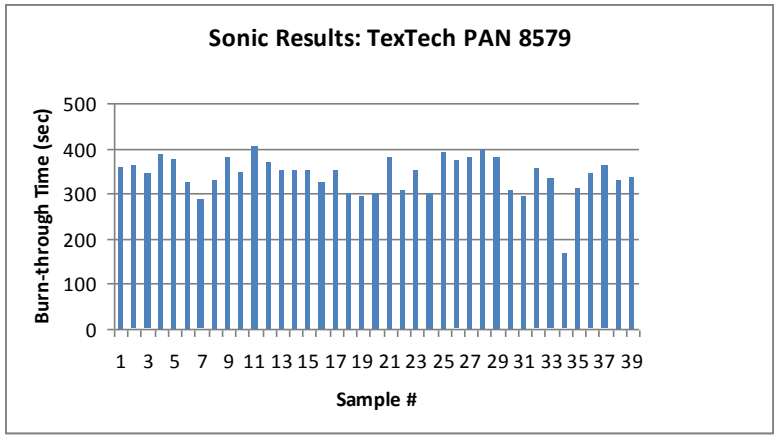
- **All thermocouples must read at or above 1600°F**
- **It is likely that the sonic burner shows lower temperatures due to using 1/8” thermocouples**
- **Sonic test results still show higher temperatures**

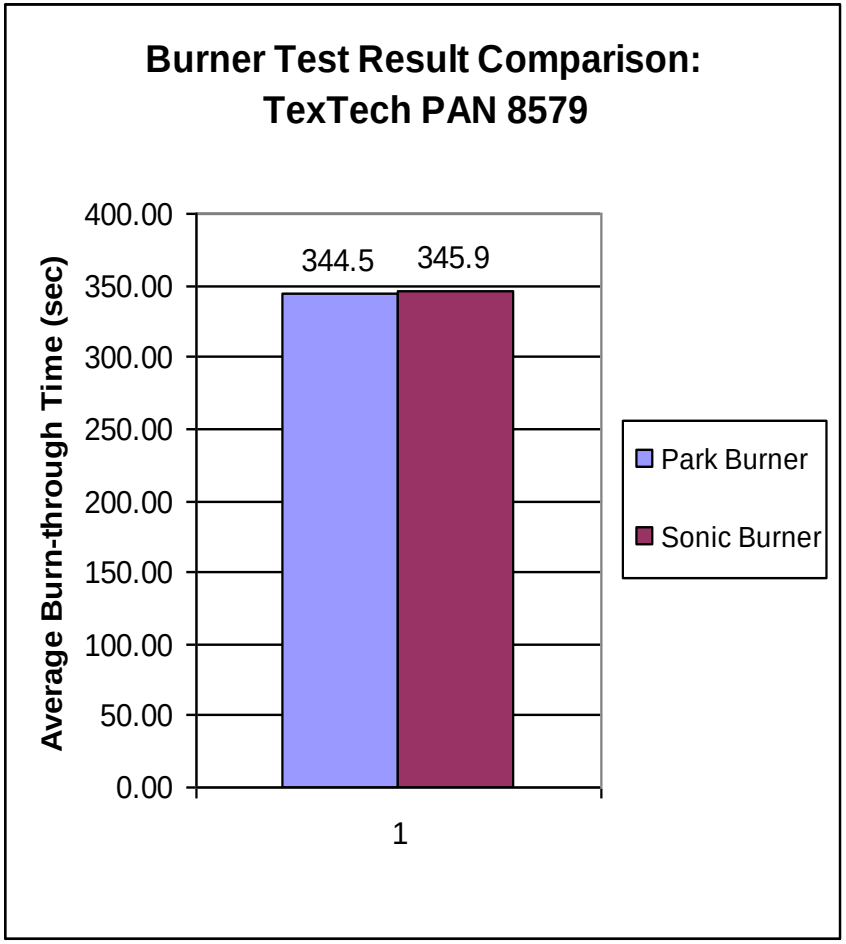
Final Sonic Settings: Testing

- **TexTech PAN 8579**
  - Park Burner: 33 samples tested
  - Sonic Burner: 39 samples tested
- **Thick Cargo Liner**
  - Park Burner: 10 samples tested
  - Sonic Burner: 12 samples tested

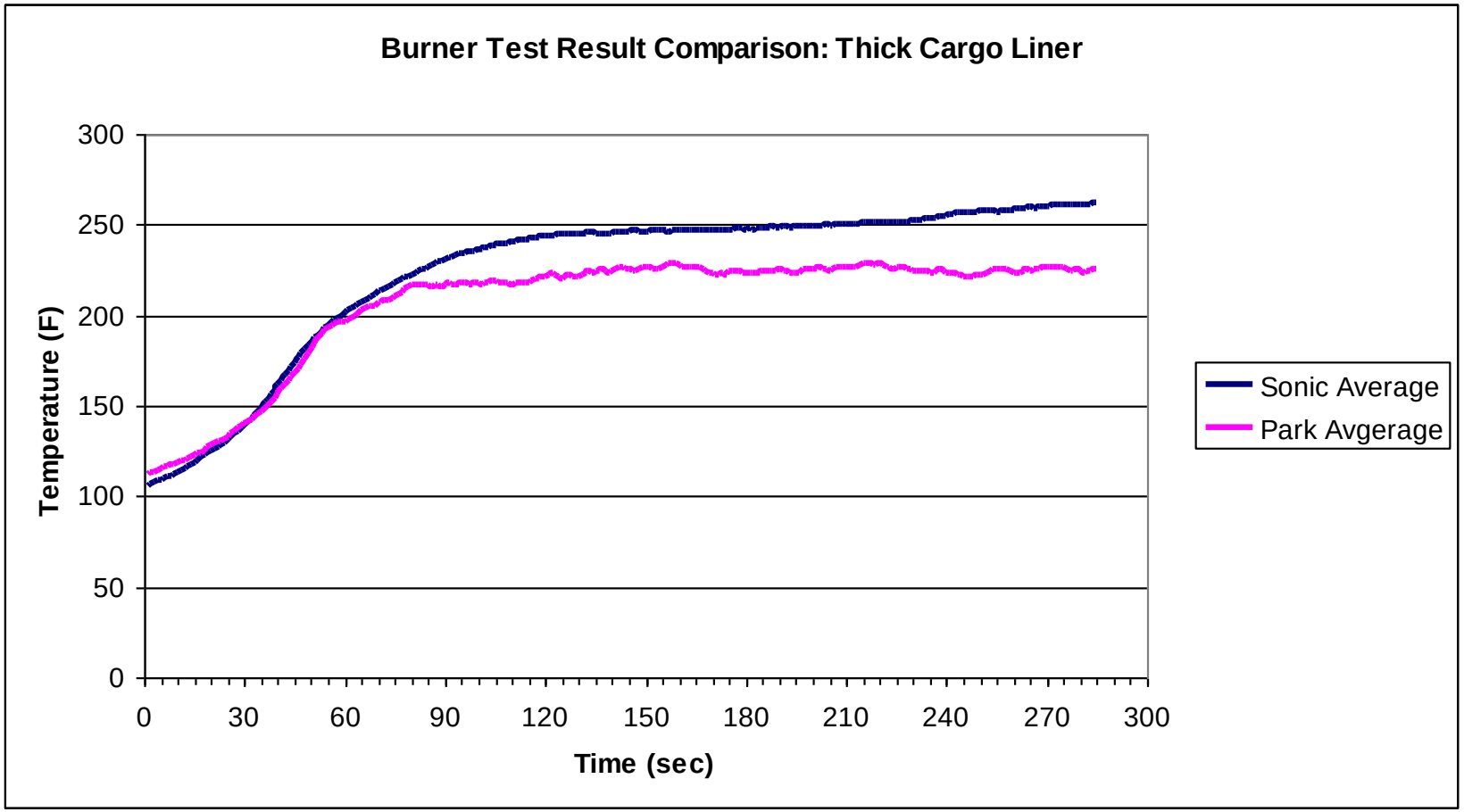
Final Sonic Settings: Test Results







Final Sonic Settings: Test Results

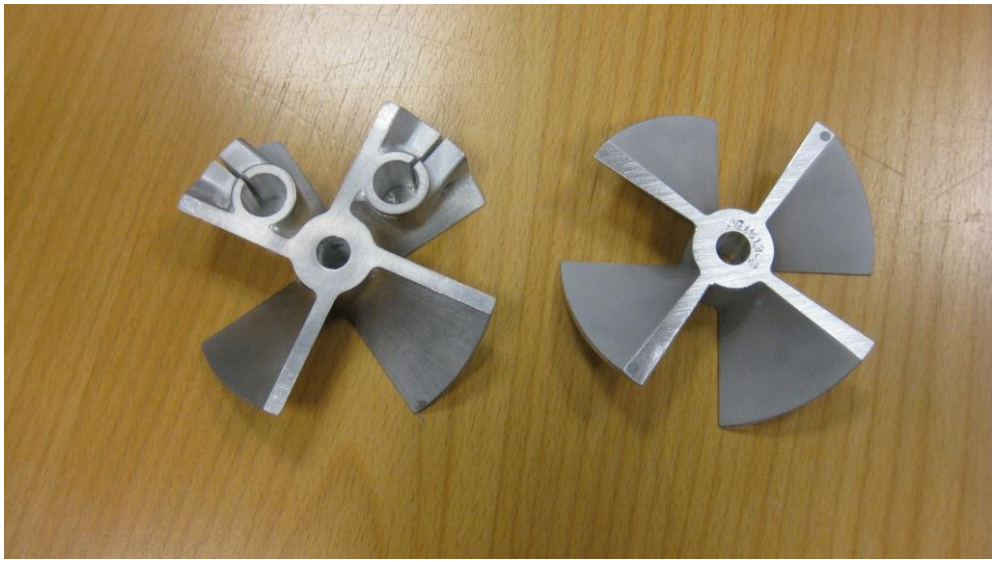


Final Sonic Settings: Conclusion

- **Calibration temperatures are lower than Park calibration temperatures**
- **Temperature readings during cargo liner testing show slightly elevated sample back-face temperatures using sonic burner versus Park burner**
- **Test results show that these settings will allow the sonic burner to perform well as a suitable replacement for the Park burner**

Revised Stator

- New stator eliminates igniters and ignition wires in draft tube
- Intended to simplify burner settings
- No noticeable improvement compared to original stator design
- Revised stator had a negative effect on test results compared to Park burner results



Flame Retention Head

- Eliminates the need for a stator or turbulator
- Fits on end of burner draft tube
- Initial testing shows good potential
- Plans for future testing

Thermocouple Calibration

- **Looking further into TC degradation and changing temperature readings**
- **Calibration unit has been delivered to FAA Technical Center**
- **Begin testing and calibration of 1/8” thermocouples**
- **Determine effect of extreme heat cycling on thermocouples**
  - Possibly predict changes in temperature readings based on number of heat cycles

Cargo Sonic Burner Round Robin

- **Round robin for sonic cargo burner currently underway**
- **3 labs currently participating**
- **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**

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 testing soft lines which may allow more flexibility with regard to burner construction**

Alternative Air Supply Plumbing

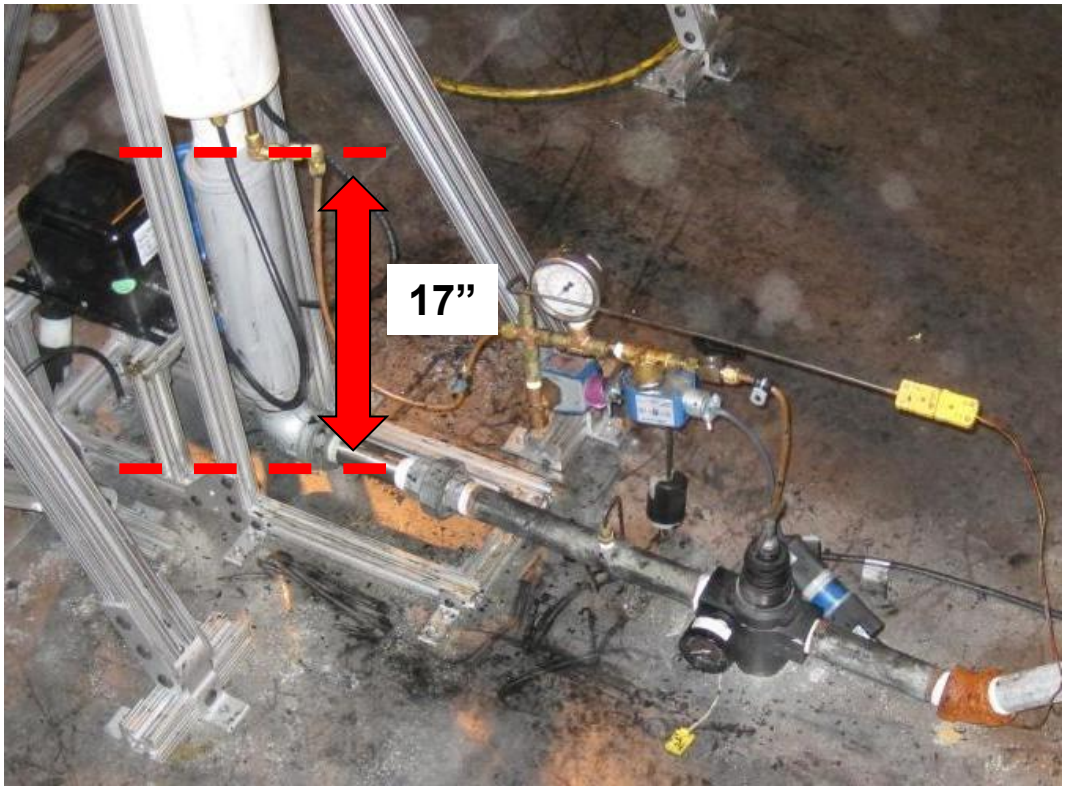
- **Distance from test chamber floor to exit plane of burner cone**
  - FAA Park burner height: 54”
  - FAA sonic burner height: 53”
- **FAA sonic burner cone exit plane is currently 1” lower than FAA Park burner cone exit plane**
  - Sonic burner was constructed with the intent that it be no taller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

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**

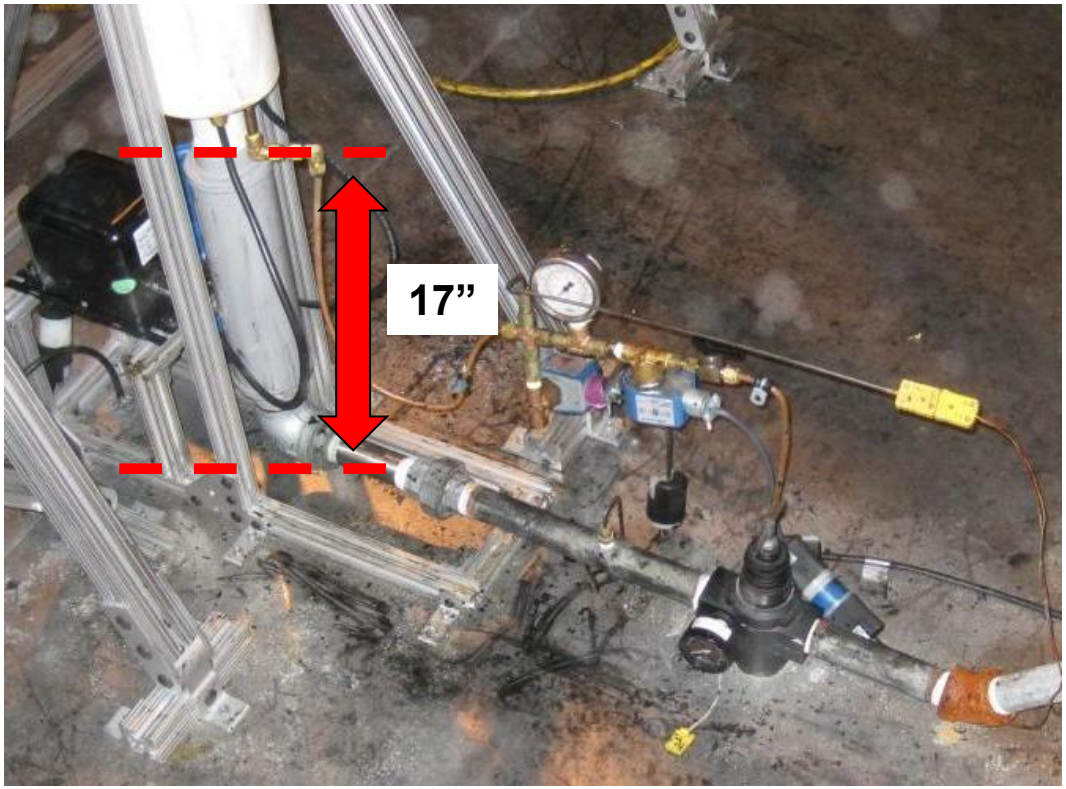
Alternative Air Supply Plumbing

- **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 ¾” 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**



Alternative Air Supply Plumbing

- **Tests previously performed using the FAA's seat sonic burner have shown that burner performance is sensitive to changes in air supply plumbing**
- **Cargo burner performance may be impacted by changing current plumbing arrangement**
- **In the process of testing alternative plumbing arrangements**
  - Flexible air supply hose
  - Relocating muffler and sonic choke

Planned Activities

Finalize burner settings by conducting temperature calibrations ✓

Complete testing of samples to ensure sonic equivalency to Park ✓

Begin round robin for sonic cargo burner ✓

Begin burner testing using flexible air supply line ✓

Continue development/testing of flame retention head

Continue investigation of thermocouple degradation using calibration device

Conduct testing of various cargo design features to support development of advisory material

Questions?