# International Aircraft Materials Fire Test Working Group Meeting

# Seat Cushion Test Method Update

Presented to: International Aircraft Materials Fire Test Working Group

By: Tim Salter, FAA Technical Center

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

Federal Aviation Administration

# Previous Meeting Items

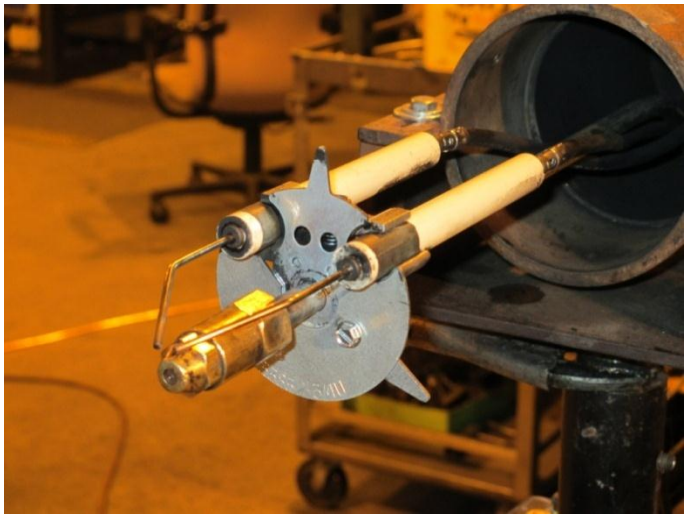
- **Completed stator and turbulator settings for seat cushion sonic burner**
- **Test results of stator with no igniters**
- **Introduction to flame retention head (FRH)**
- **Proposed standardized methods of leather seat cushion restraints**
- **Sonic burner seat cushion RR update**

# Summary for this Meeting

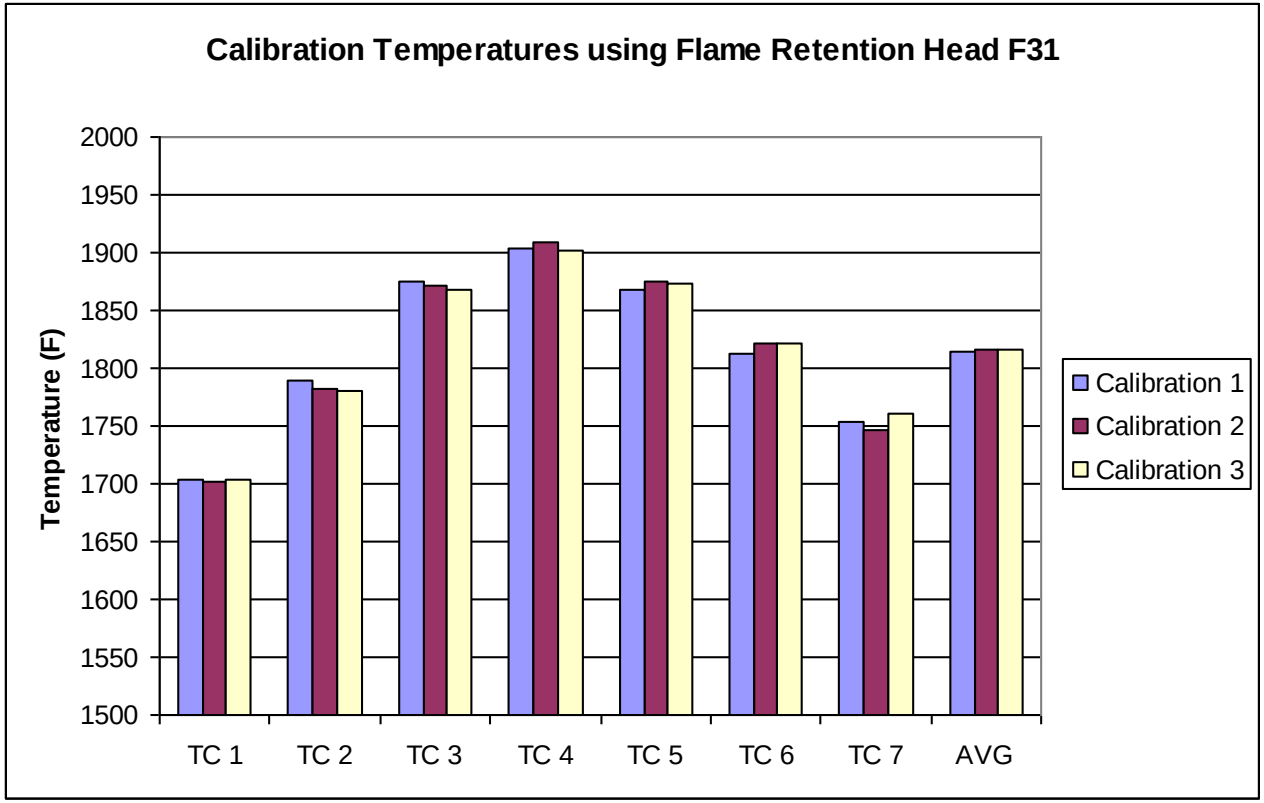
- **Information regarding flame retention head and overview of initial test data**
- **Status of leather seat cushion restraints**
- **Sonic burner seat cushion round robin**
- **Initial test results of TC readings using sonic burner compared to TC calibration unit results**

# 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

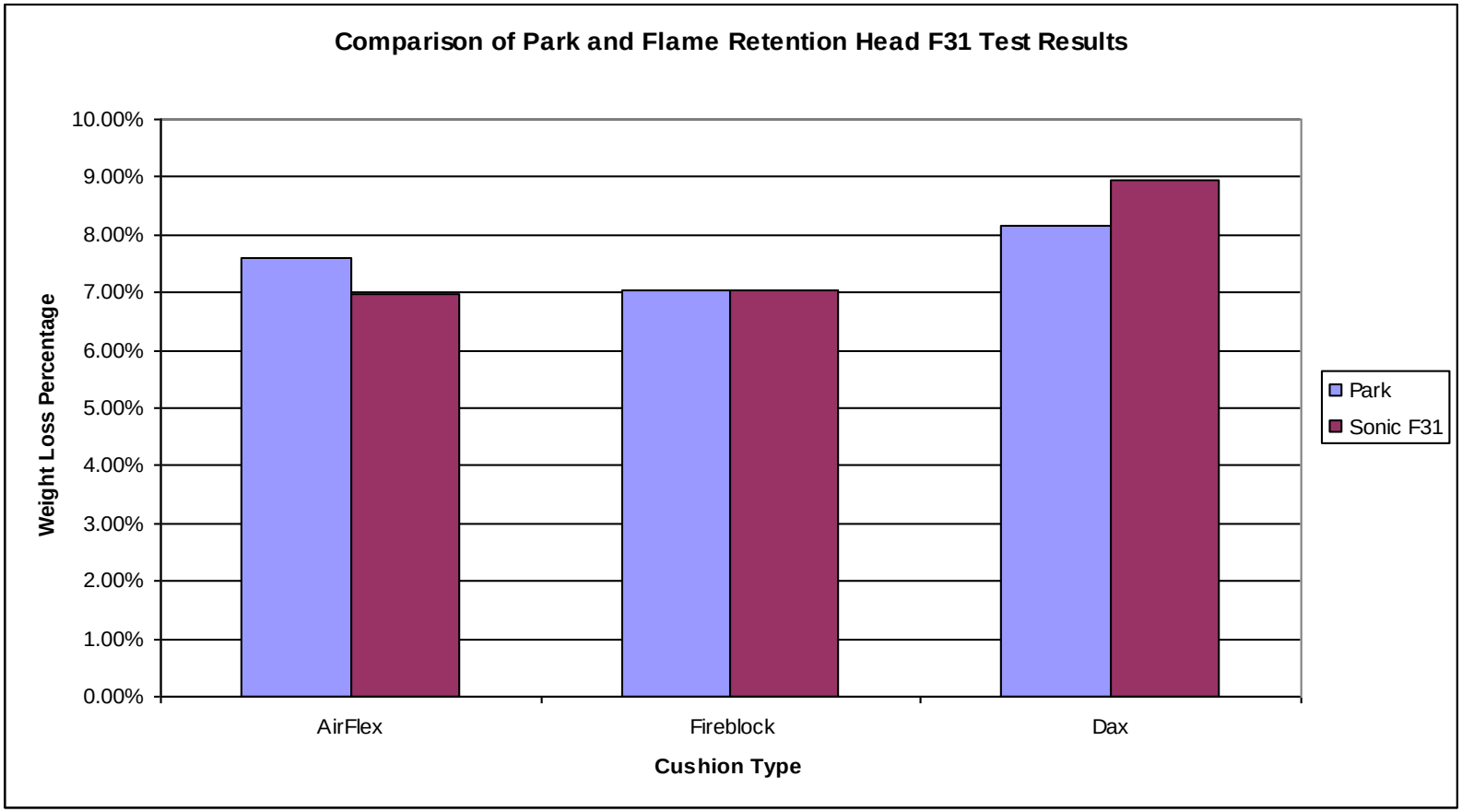


# Flame Retention Head (FRH)




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

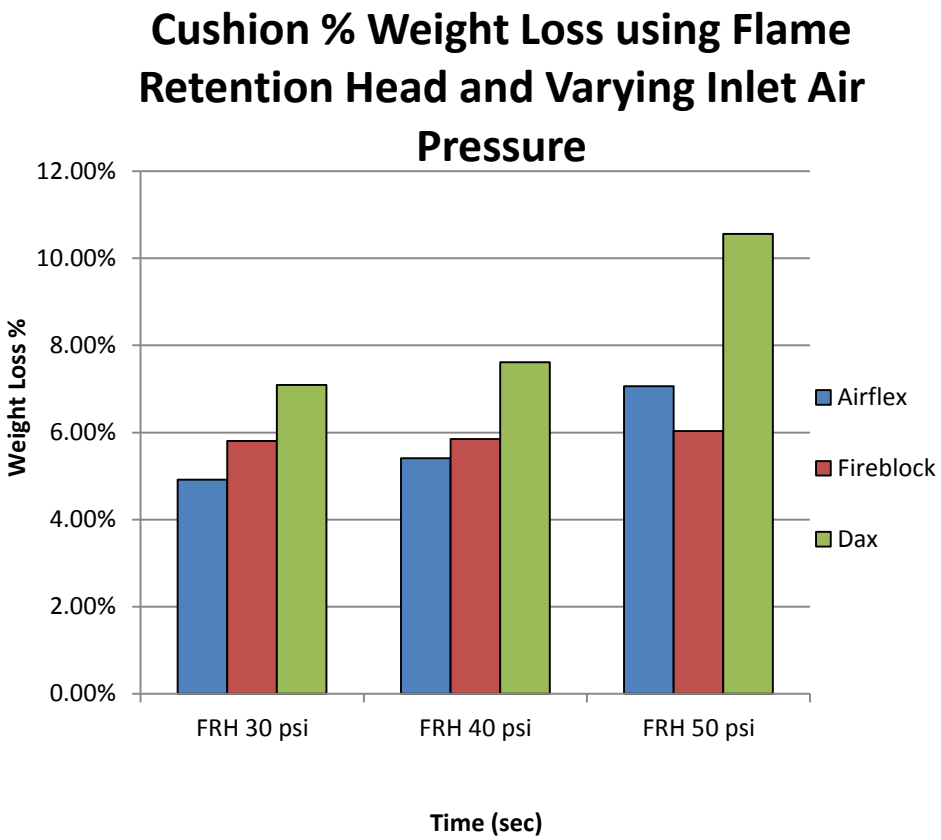
# Flame Retention Head (FRH)




- Results from first tests using flame retention head

# Flame Retention Head (FRH)

- **Initial tests show that increasing air inlet pressure tends to increase percent weight loss**
- **Currently testing different air pressures, fuel nozzle spray patterns, and internal burner settings**
- **Further testing is required to fine tune the burner and FRH before any conclusions can be made regarding the FRH's suitability as part of the seat cushion oil burner test**



# Leather Cushion Restraints

- **Industry has asked that a standardized method of restraining leather seats to the test frame be developed**
- **Work had been performed in the past, but no final conclusions were made**
- **Data has shown that there is not necessarily a correct or incorrect method of restraining leather cushions**
  - However, restraints should not impede the flame
- **A standardized restraint method used by all labs should increase test result repeatability**

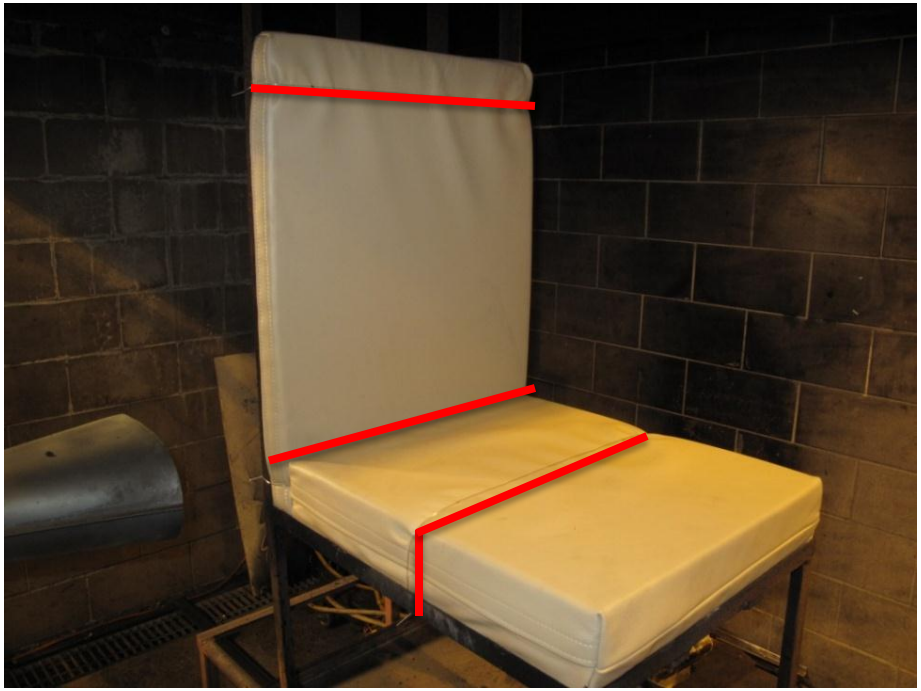
# Leather Cushion Restraints

- **Items to consider**
  - Number of restraints
  - Spacing of restraints
  - Type of restraint (safety wire, hook and loop, etc.)
- **Goal**
  - Devise a method of restraint to maximize repeatability, but not overcomplicate restraint method in order to keep sample preparation time to a minimum

# Leather Cushion Restraints

## Restraint Example #1

## Restraint Example #2



# Leather Seat Cushion Restraints

- **There is currently a recommended method of leather seat restraint outlined in the handbook**
  - "More than one wire may be used to restrain leather seat components as long as the wires do not impede or redirect the flame."
- **The main focus of recent work has been placed on development of the flame retention head for the seat cushion oil burner**
- **The subject of standardizing leather seat restraints will be revisited after FRH testing has been completed**
- **Open to suggestions for methods of restraint**

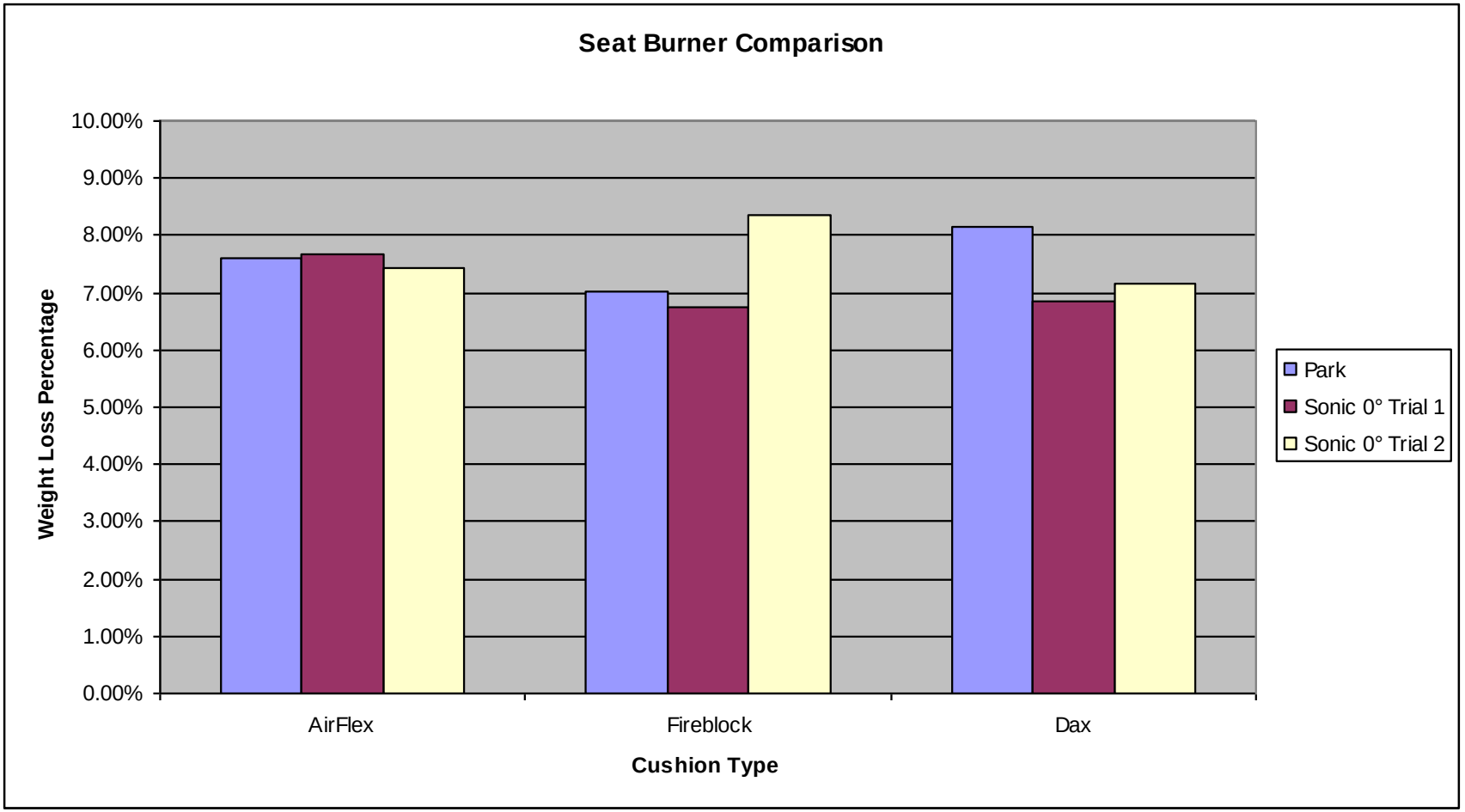
# Round Robin Update

- **Round robin ongoing since April 2012**
- **8 labs participating**
- **6 labs have completed testing**
- **FAA provided each lab with a fuel nozzle, burner setup instructions, and seat cushion test specimens**

# Current Seat Burner Settings

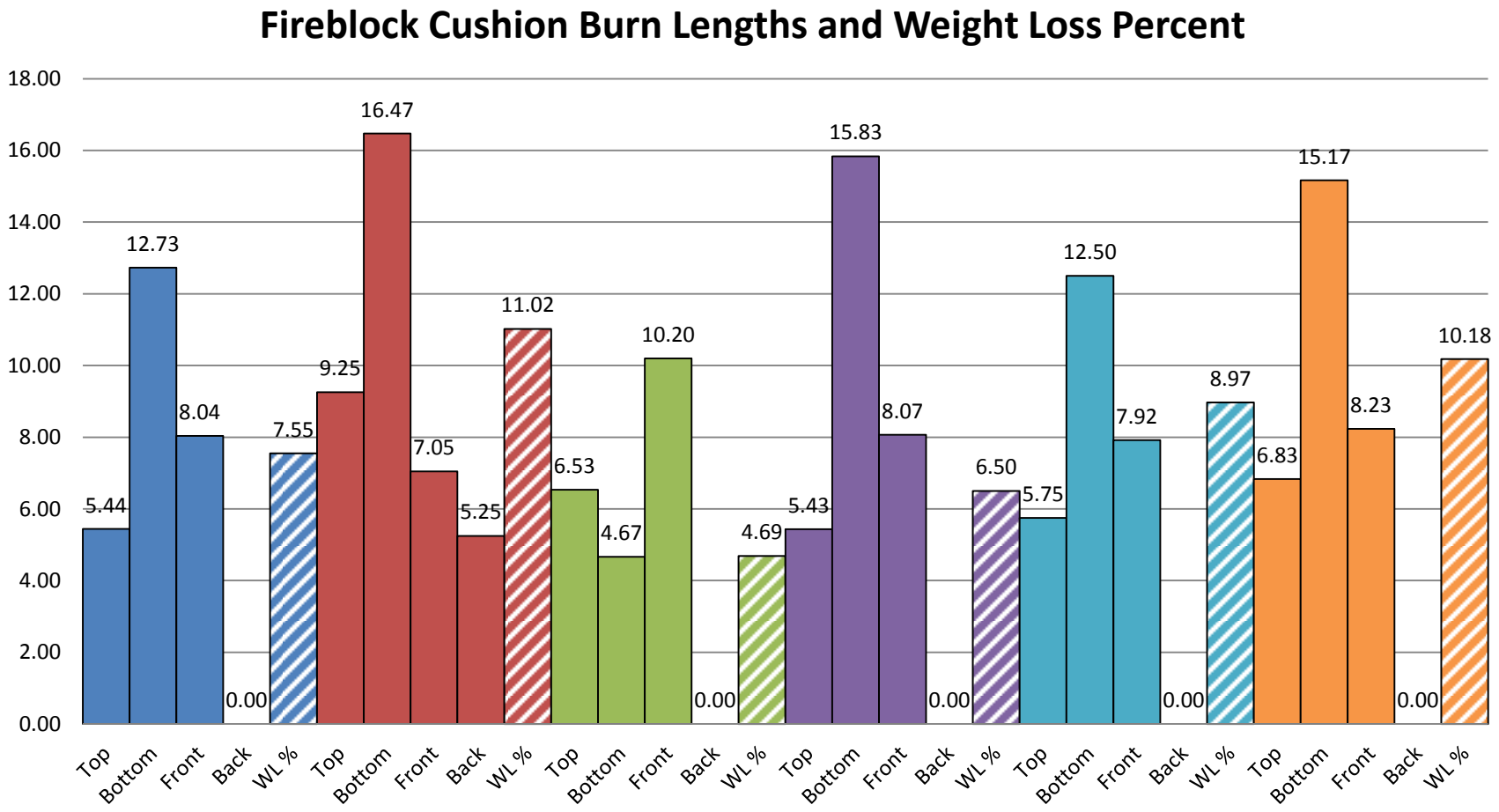
- **Sonic burner settings using stator and turbulator for use as Park burner replacement**
- **All depths are measured from the exit plane of the turbulator to the nozzle tip or front stator face**
  - Recommended Nozzle: Delevan 2.0 gal/hr 80° type B
  - Nozzle Depth:  3/16”
  - Stator Depth:  2  11/16”
  - Stator Angle: 0° (igniter centerline from vertical)
  - Turbulator: Notch will face bottom of tube (180°)
  - Air Pressure: 45.0 psi
  - Air Temperature: 40-60°F
  - Fuel Temperature: 32-52°F

# Seat Cushion Testing



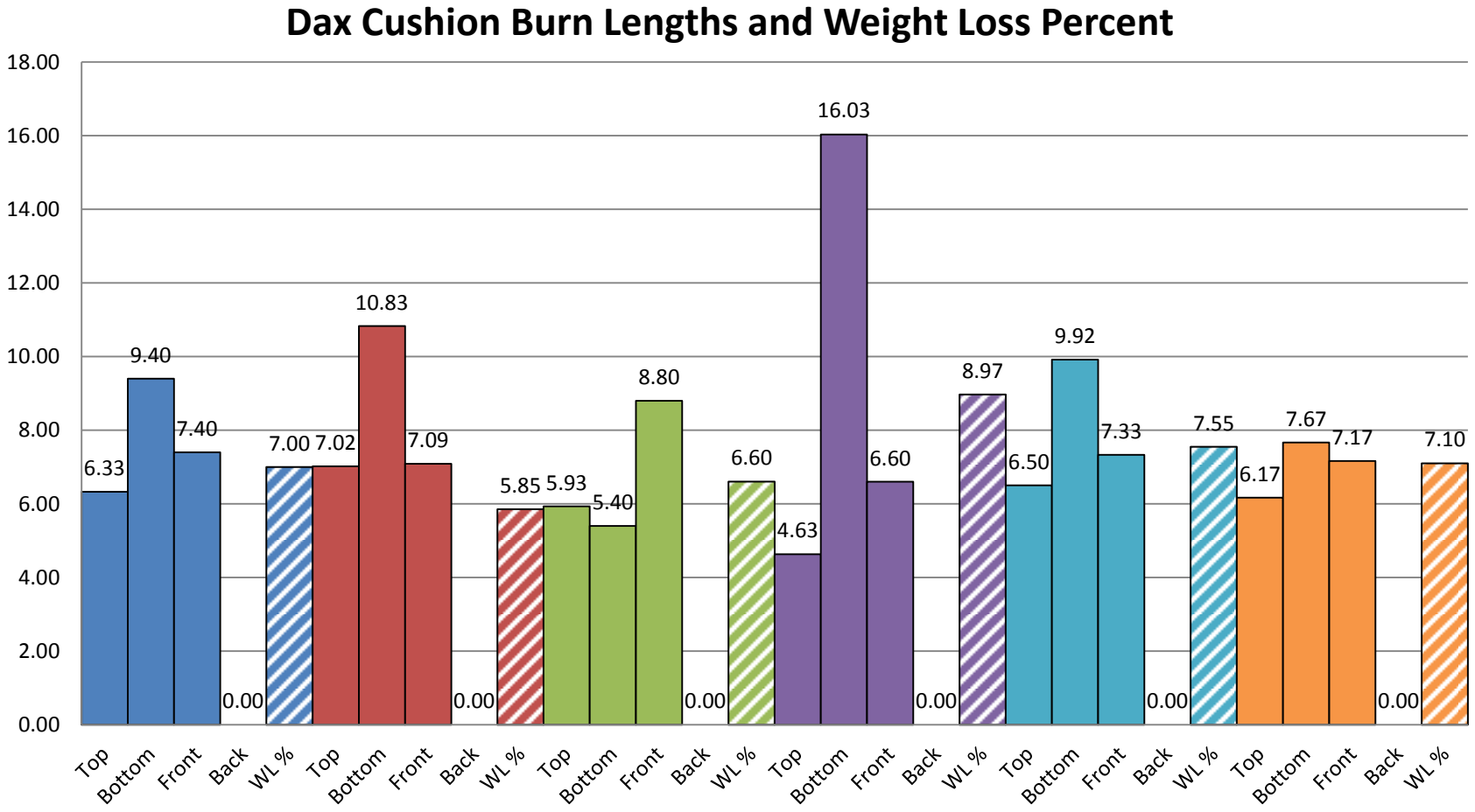

- **3 of each cushion type tested per trial**

# Round Robin Update




- Lab at far left is FAA Technical Center

# Round Robin Update

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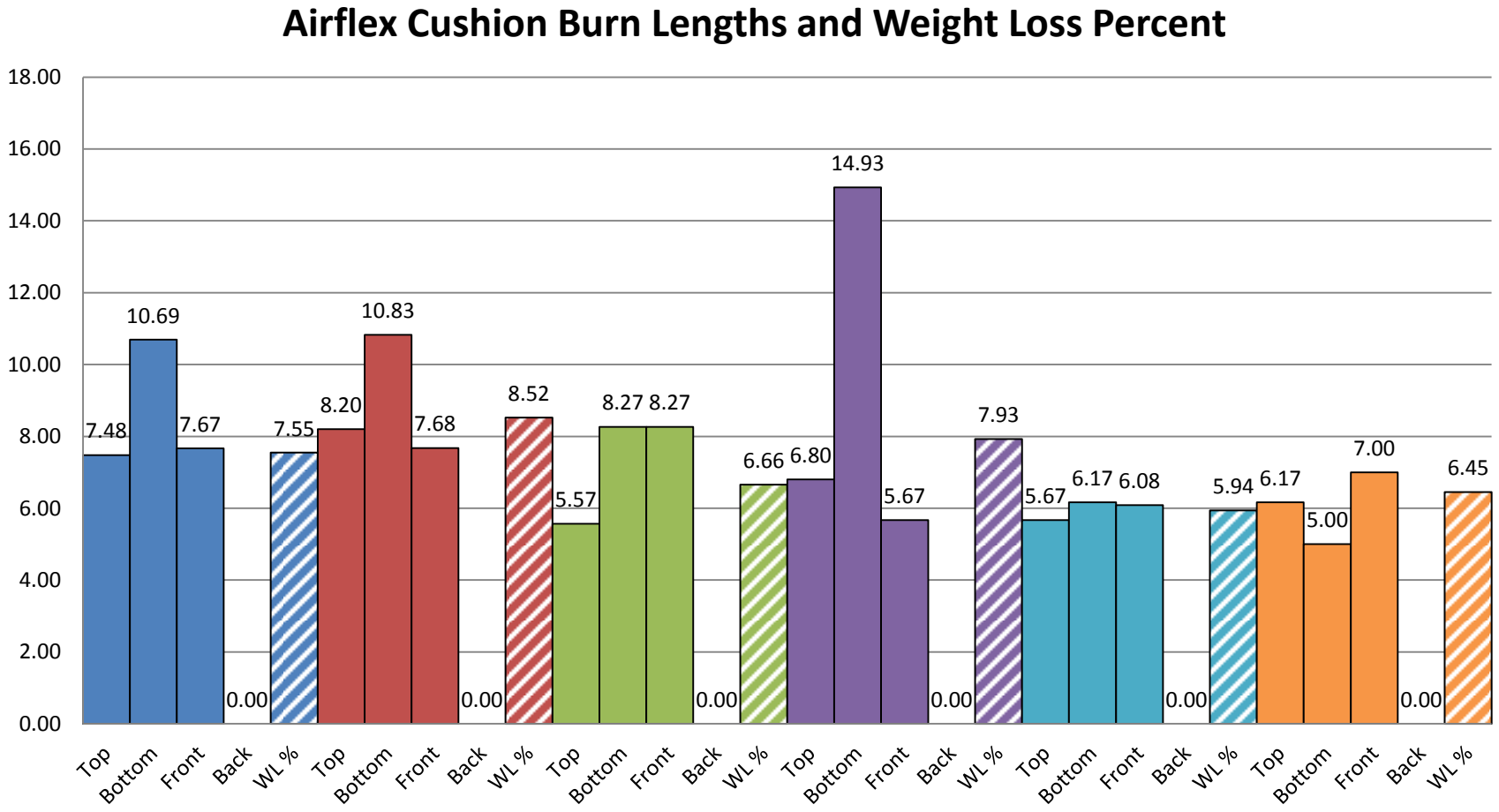


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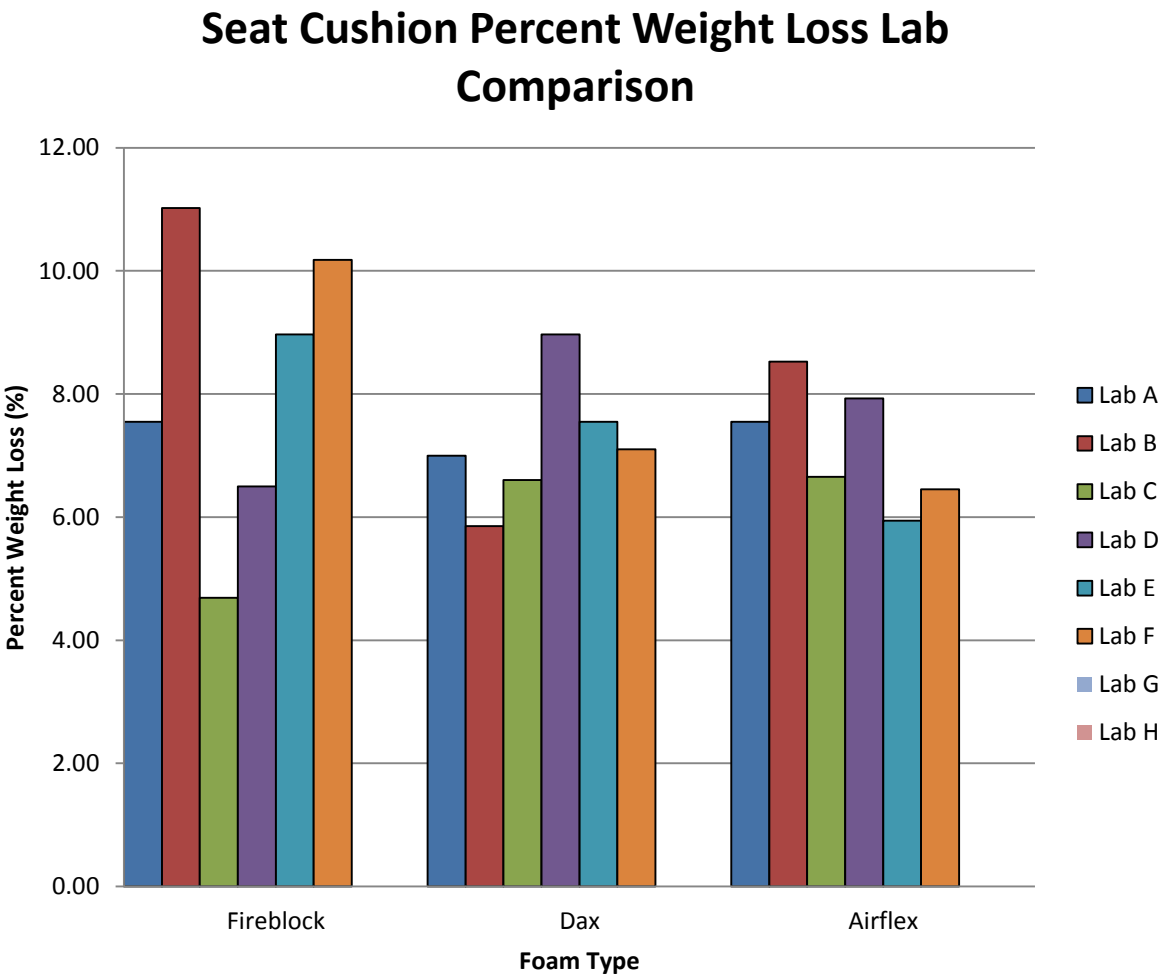



| | Fireblock | Dax | Airflex |
|---|---|---|---|
| Lab A | 7.55 | 7.00 | 7.55 |
| Lab B | 11.02 | 5.85 | 8.52 |
| Lab C | 4.69 | 6.60 | 6.66 |
| Lab D | 6.50 | 8.97 | 7.93 |
| Lab E | 8.97 | 7.55 | 5.94 |
| Lab F | 10.18 | 7.10 | 6.45 |
| Lab G | | | |
| Lab H | | | |
| **Avg** | 8.15 | 7.18 | 7.17 |
| **stdev** | 2.37 | 1.05 | 0.98 |
| **%stdev** | **29.09** | **14.57** | **13.72** |

- **FAA is Lab A**

# Round Robin Update

- **Data indicates that current RR burner settings for the stator and turbulator configuration generate data comparable to Park burner weight loss and burn lengths**
- **Goal is to improve upon current repeatability of Park burner**
- **Decision was made to pursue development of the FRH based on repeatability shown in initial tests and data**

# Thermocouple Calibration

- **Looking further into TC degradation and changing temperature readings**
- **Thermocouple tend to indicate lower temperatures after repeated heat cycling which occurs during calibration of burner**
- **New calibration unit recently arrived at FAA Technical Center**
- **Determine effect of extreme heat cycling on thermocouples**
  - Possibly predict changes in temperature readings based on number of heat cycles?

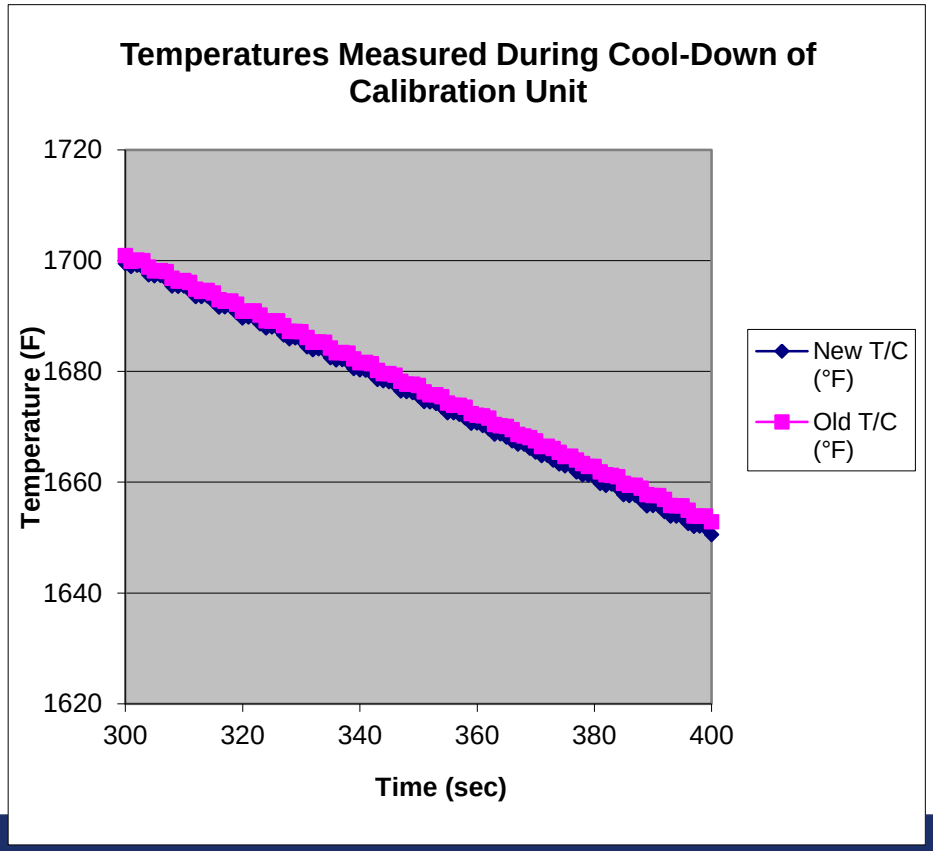
# Thermocouple Calibration

- **First calibration run performing side by side comparison of two thermocouples**
- **Both 1/8” SS sheathed, grounded thermocouples**
  - One new and unused
  - One having been used in an extensive number of calibrations
- **Expectation is that used TC will read significantly lower temperatures than new TC**
- **Initial test showed almost no difference in temperature when tested at 1800 °F**

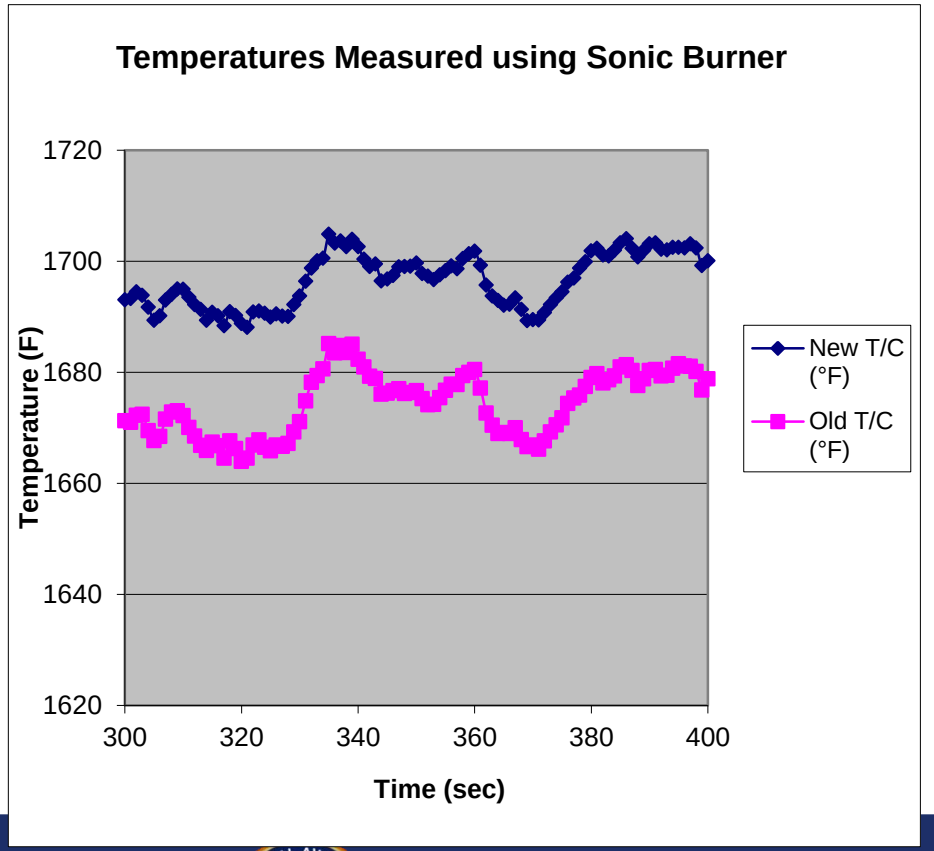
# Thermocouple Calibration

- Abbreviated time duration of actual tests shown below

**Maximum ΔT = 3.56°F**




**Maximum ΔT = 31.69°F**



# Thermocouple Calibration

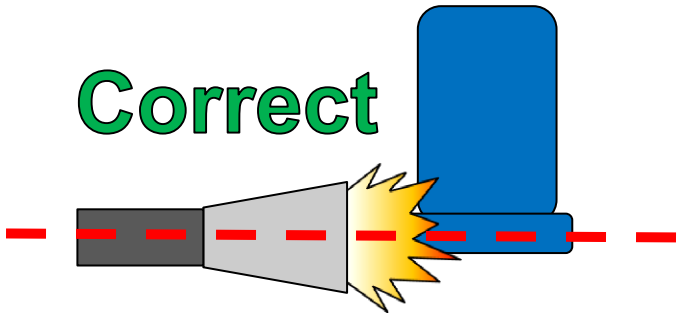
- **Heat cycling appears to have an impact on the response time of thermocouples and not their ability to correctly read relatively steady state temperatures**
- **Extensively heat cycled TCs are unable to respond to rapid changes in temperature as seen when submerged in a turbulent burner flame**
- **Further testing planned to reduce or eliminate the problems associated with thermocouple reading degradation during calibration and testing**

# Planned Activities

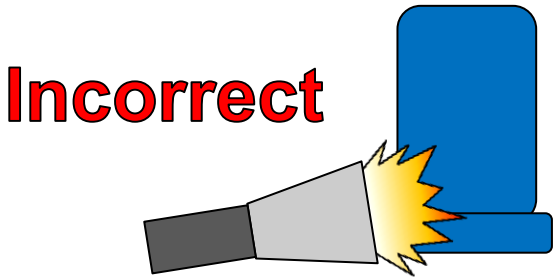
- **Complete current round robin**
  - Finish gathering data from participating labs
- **Development of FRH**
  - Determine air pressure, fuel nozzle, internal settings
  - Plan for a future round robin using retention head
- **Finalize leather seat restraints**
  - Complete cushion testing
  - Share results at working group meeting
- **Thermocouple degradation**
  - Continue testing for methods of limiting inaccurate readings due to thermocouple heat cycling

# Error Due to Burner Misalignment

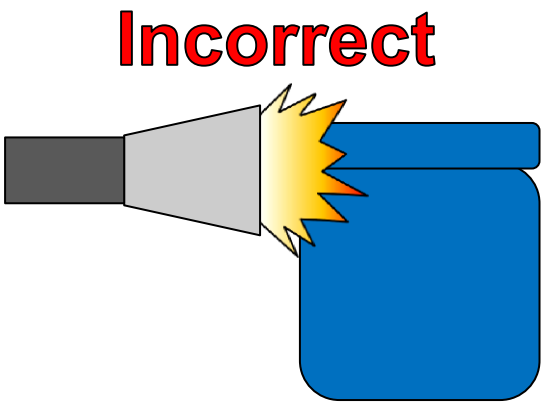
•Front View

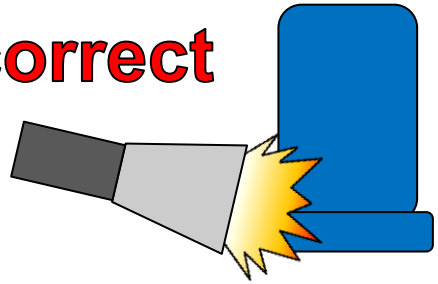



•Front View




•Top View

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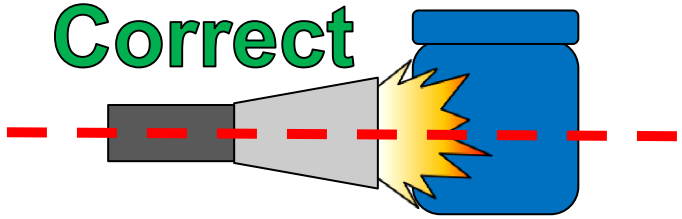


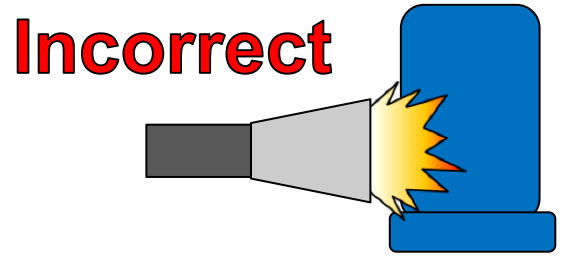


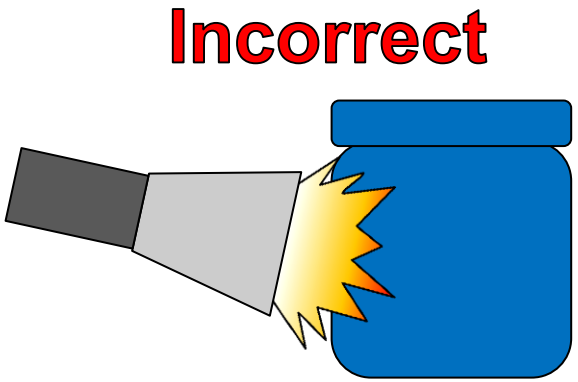

# Questions?