

# NexGen Burner for Seat Cushion Fire Testing

Presented to: IAMFTWG, Köln

By: Robert Ochs

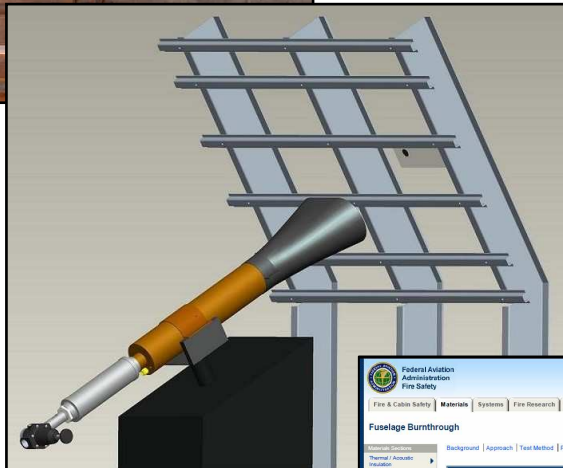
Date: June 23 2010



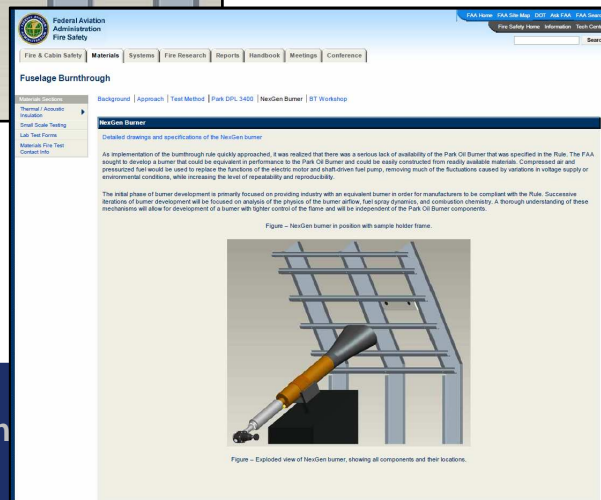
Federal Aviation  
Administration



# Background



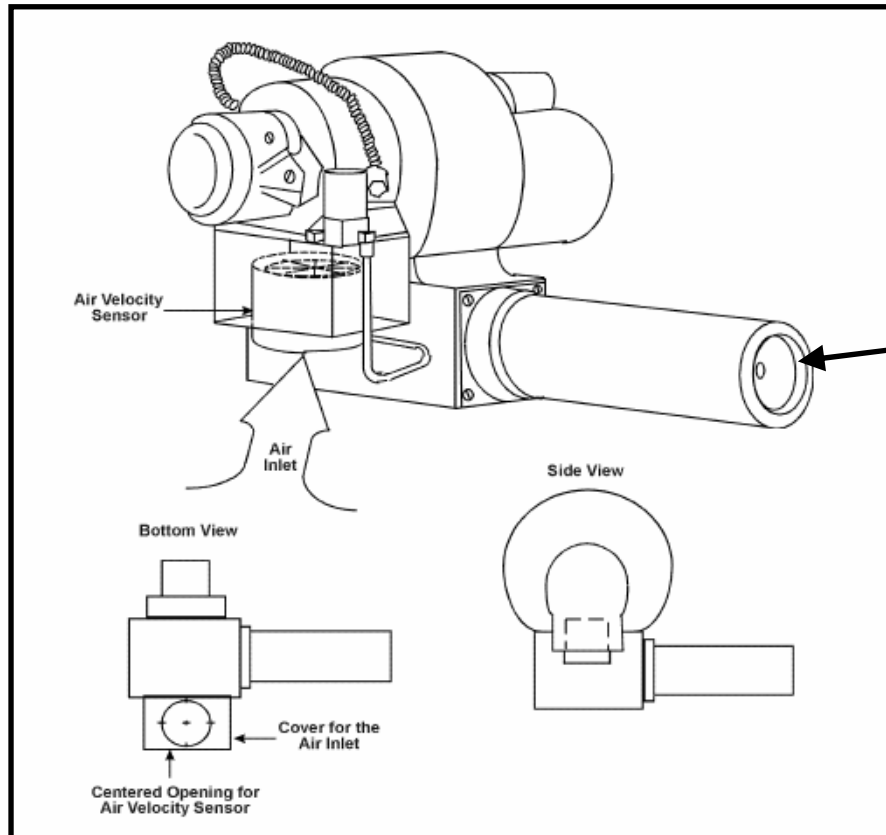
- Lack of availability of burners for seat cushion fire testing has resulted in the need for a readily available, equivalent burner
- The NexGen burner has already been found to provide equivalent results to the Park burner for thermal acoustic insulation burnthrough testing
- Detailed drawings for construction of a NexGen burner can be found on Fire Safety Website



# Objective

- **Configure a NexGen burner to achieve seat test performance similar to a Park burner calibrated to standards set in chapter 7 of the Aircraft Materials Fire Test Handbook**
  - Fuel flow rate of  $2.0 \text{ gph} \pm 0.1 \text{ gph}$
  - Equivalent to an inlet air flow of  $67 \pm 4 \text{ cfm}$
  - 30-second average heat flux of at least  $10 \text{ BTU/ft}^2\text{s}$
  - Flame temperatures of at least  $1800^\circ\text{F}$  on 5 of 7 thermocouples and at least  $1750^\circ\text{F}$  on at most 2 thermocouples
  - 30-second average of 7 thermocouples at least  $1800^\circ\text{F}$
- **Research Plan**
  - Set up NexGen burner with equivalent air velocity, fuel flow rate, and measured flame temperature
  - Perform comparative testing with different types of seat cushions between Park and NexGen
  - If good agreement is found between Park and NexGen, set up another NexGen to determine if burner performance is reproducible

# Equivalent Air Flow Rate

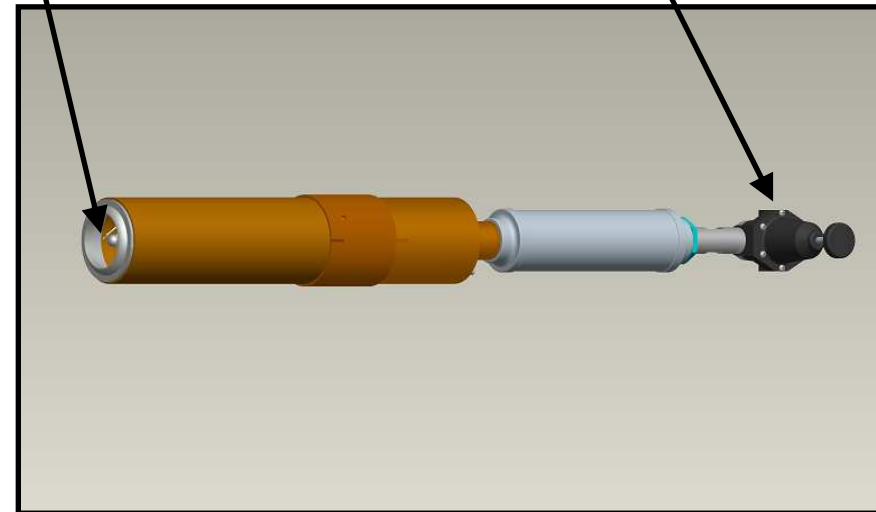


Inlet Air Flow:

67 cfm  $\approx$  1800 fpm in 2.625 in<sup>2</sup> air flow meter (HH30)

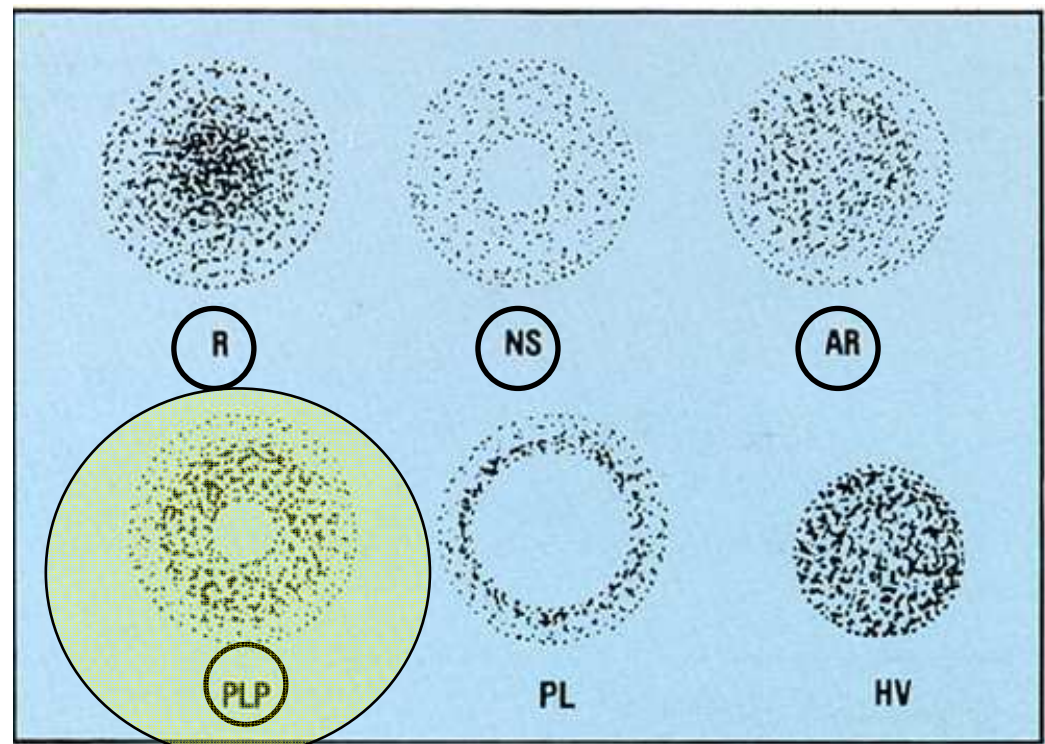
Exit Air Flow  $\sim$  1600 fpm

Resulting Sonic Choke  
Inlet Pressure: 47 psig



# Fuel Flow Rate

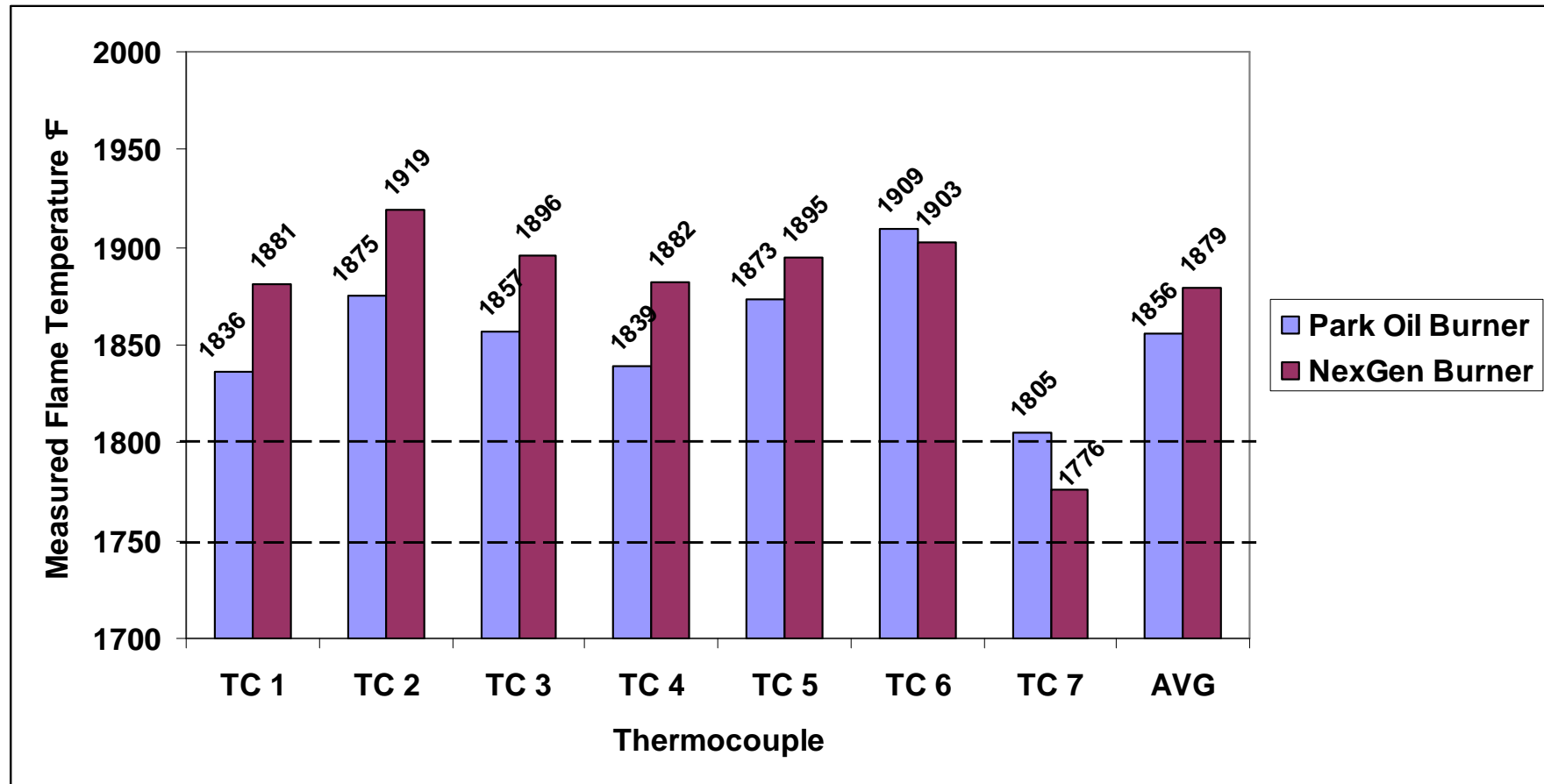
- **Fuel flow rate is dictated by**
  - Specific nozzle used
  - Inlet fuel pressure
  - Fuel viscosity
- **Several nozzle types were attempted**
  - R: Solid
  - NS: Hollow
  - AR: Special Solid
  - PLP: Semi Solid



[www.monarchnozzles.com](http://www.monarchnozzles.com)



# Measured Flame Temperatures

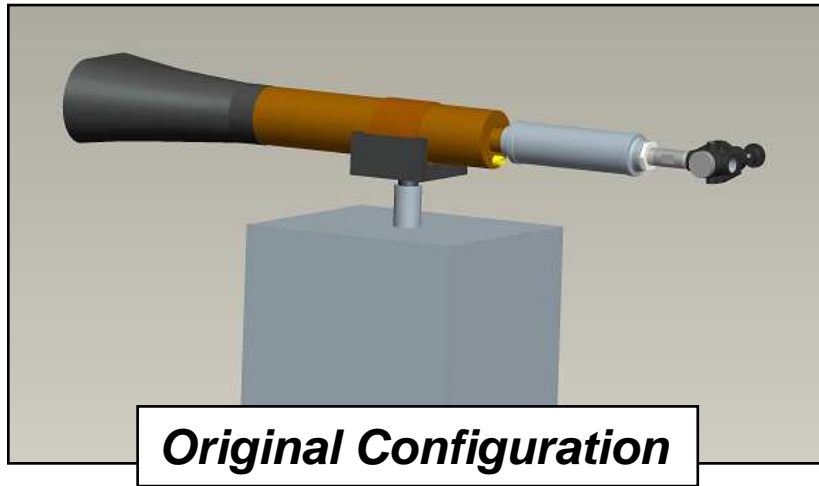


*Note: Static disks or tabs were NOT used for either burner in this test series*

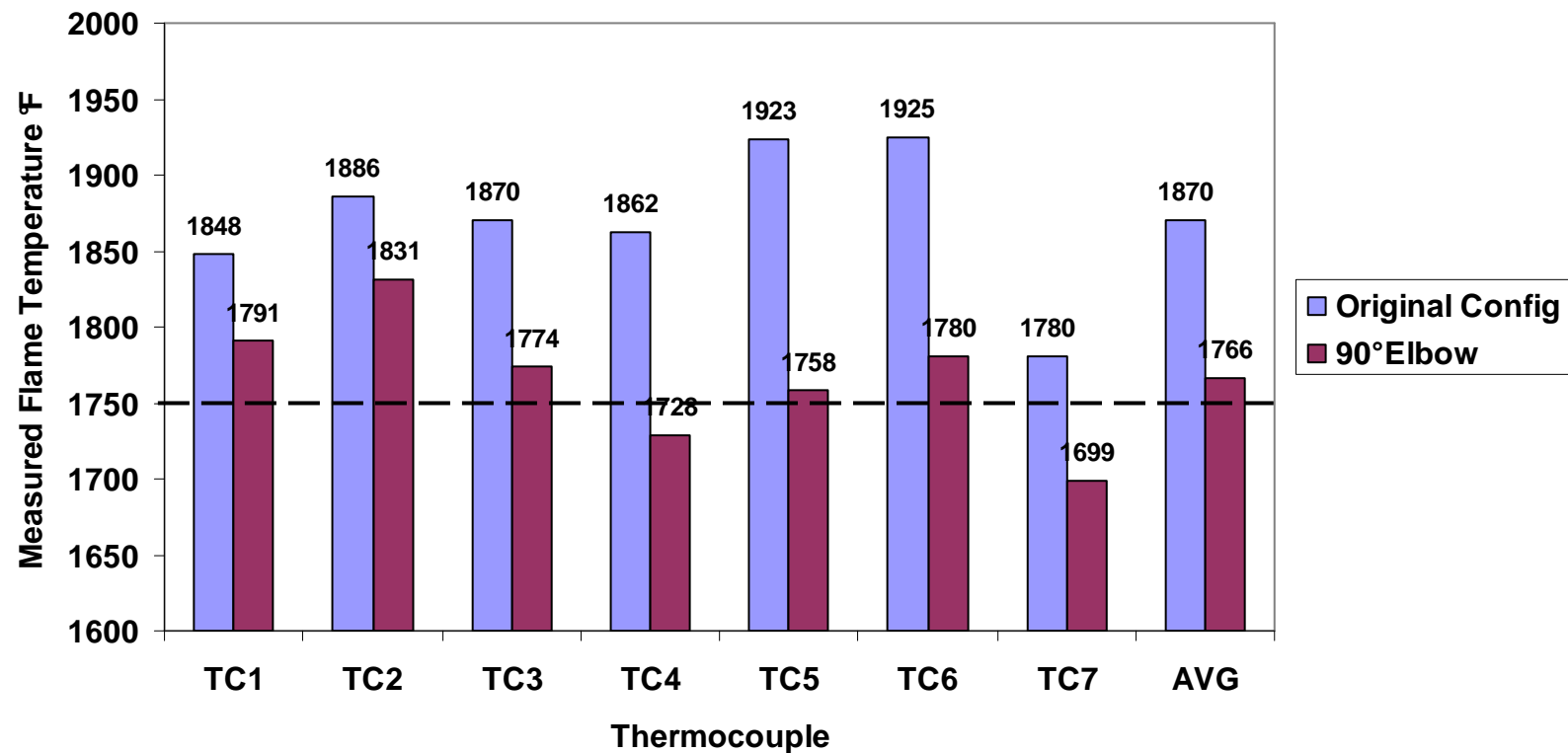
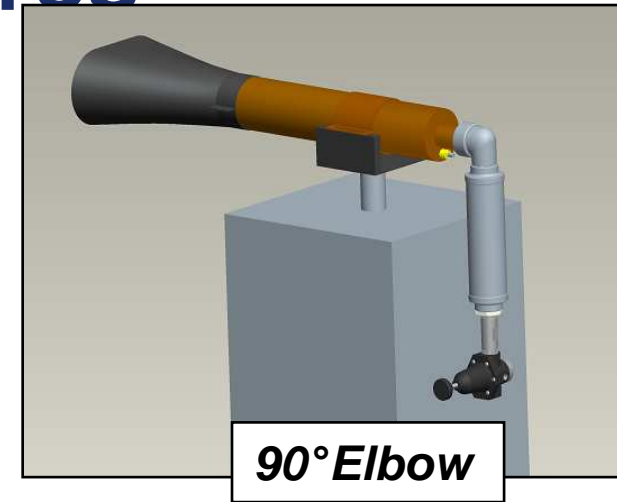
# Park-NexGen Calibration Summary

- **The Park burner was set up according to Chapter 7 of the Fire Test Handbook**
  - Fuel flow rate 2.04 gph
  - Average flame temperature 1856°F
  - Average heat flux 11.0 BTU/ft<sup>2</sup>s
- **The NexGen burner was set up to achieve similar calibration**
  - Fuel flow rate 2.00 gph
  - Average flame temperature 1879°F

# NexGen Flame Temperatures

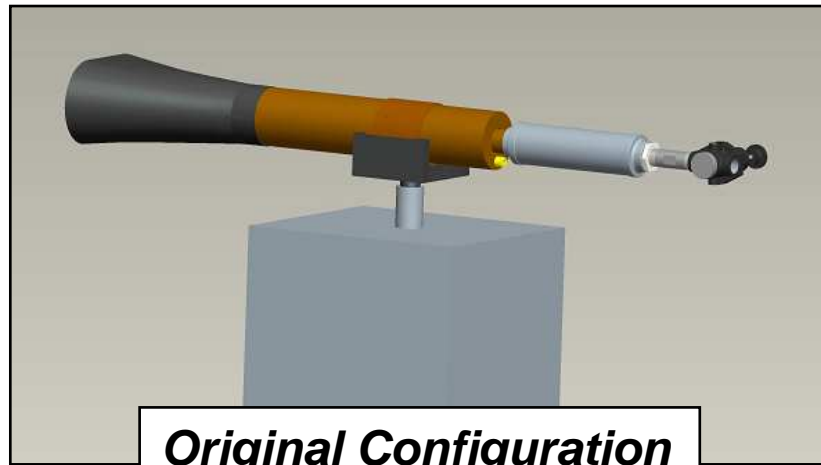


*Vs.*



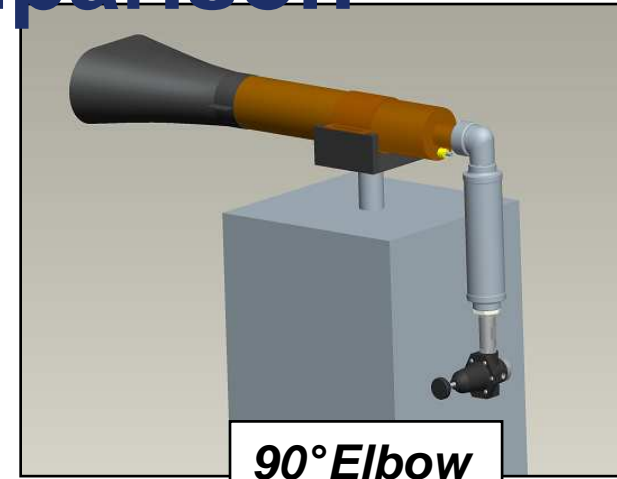


# NexGen Exit Velocity Comparison

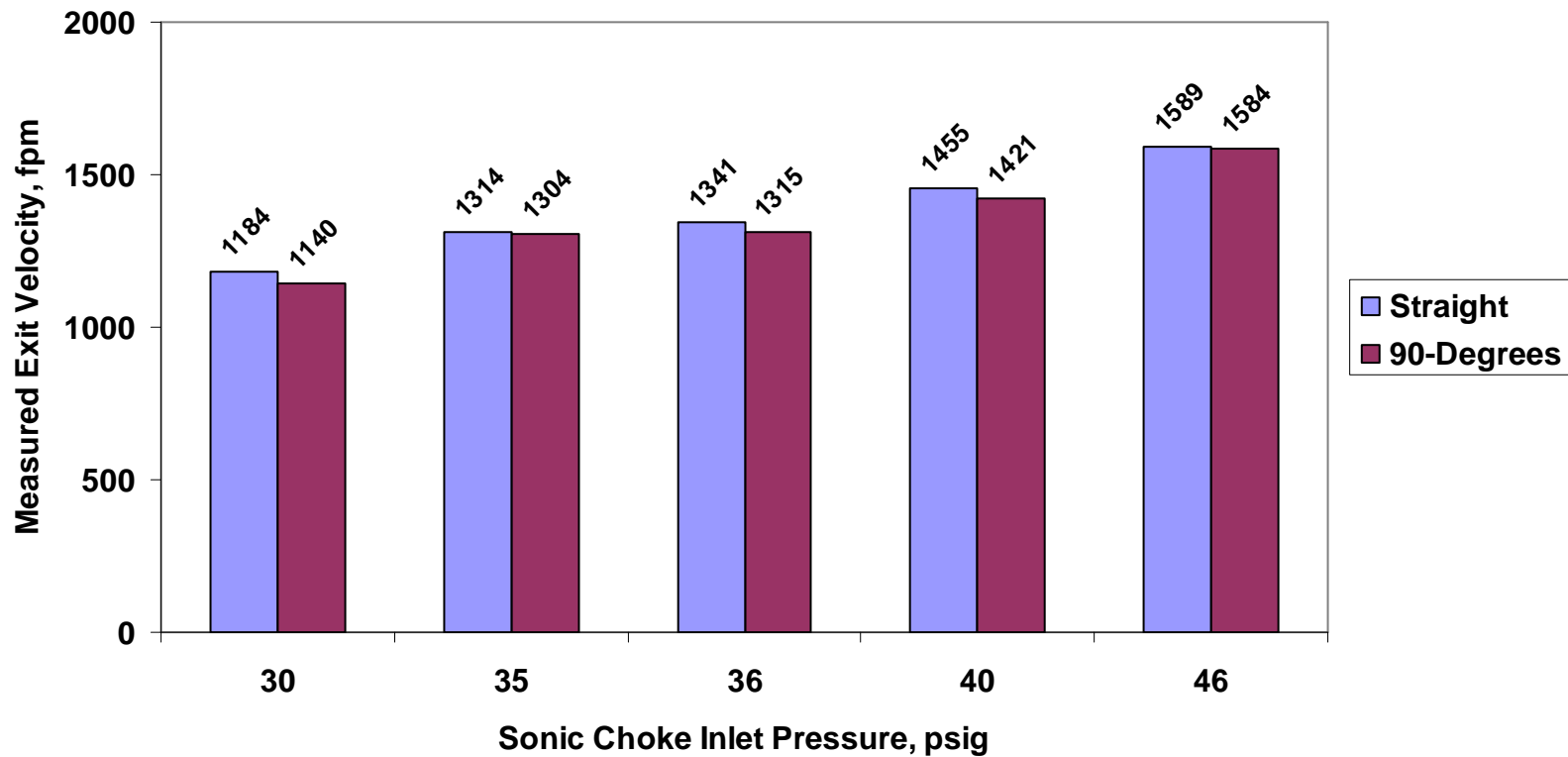


**Original Configuration**

**Vs.**

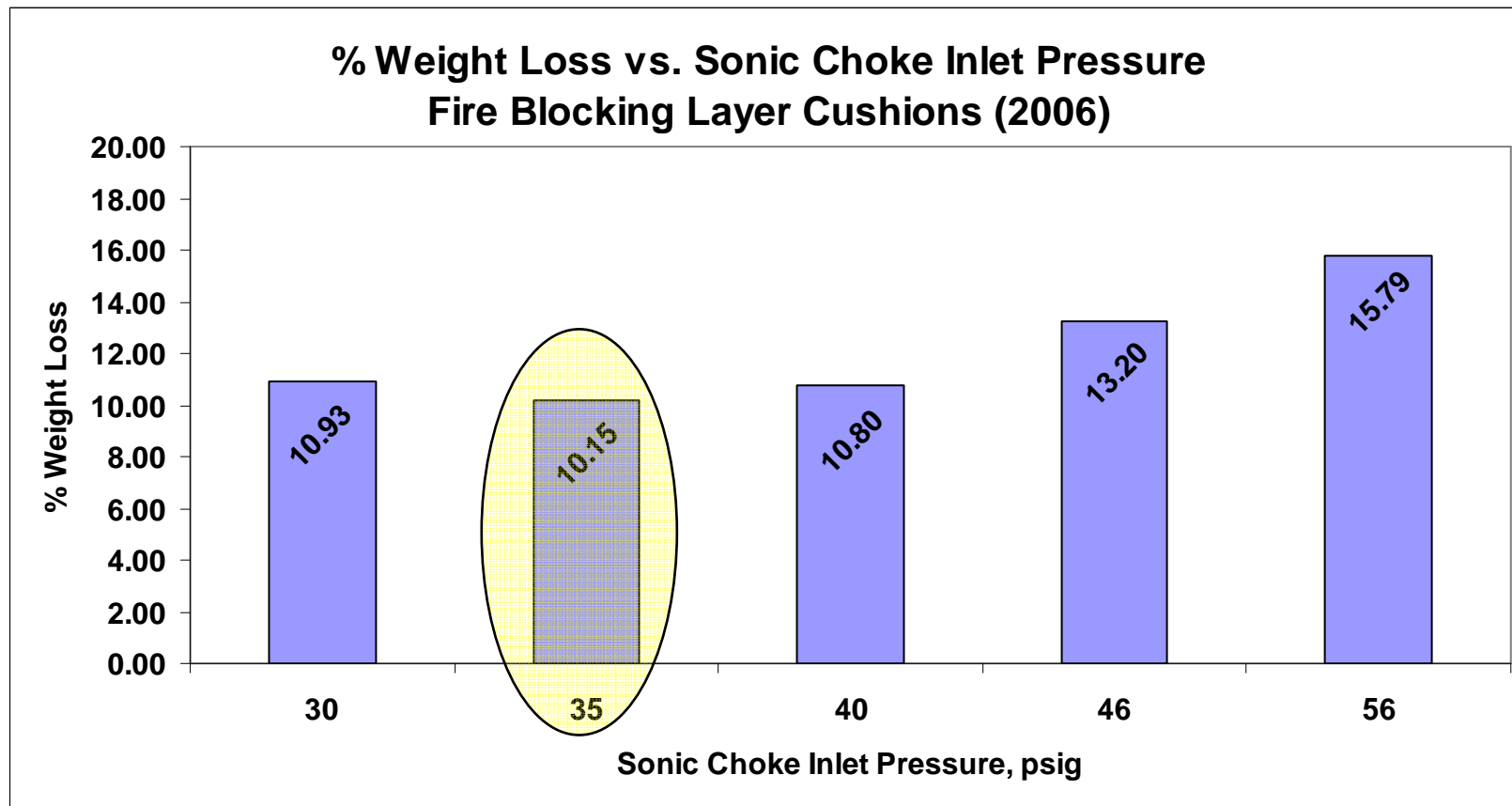


**90° Elbow**



# 90° Elbow Summary

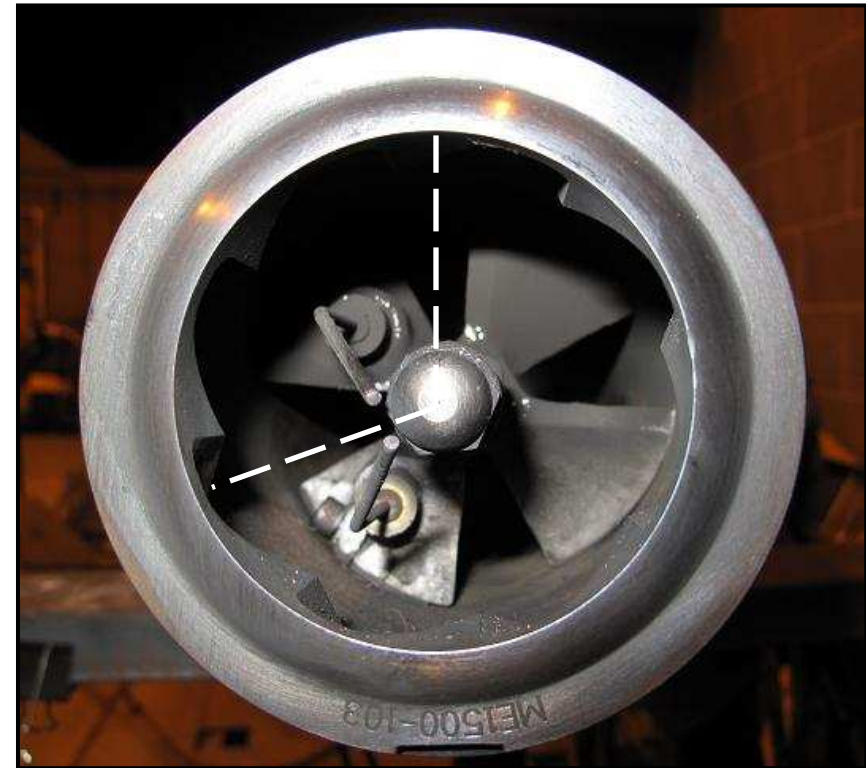
- A 90° elbow was inserted between the burner housing and the muffler section in order to reduce the length of the burner
- The measured flame temperature *decreased* on average about 100°F for the 90° setup
- The measured exit velocity remained relatively constant for both cases
- The two cases can not be considered equivalent until comparative burn testing is performed



# NexGen Burner Settings for Seat Test

- **Fuel Nozzle**
  - 2.25 gph-rated 80°PLP @ 95 psig → 2.03 gph
- **Stator**
  - Reverse engineered CNC machined stator, Marlin Engineering ME1500-101
  - 3 1/16" from stator face to nozzle tip
  - Approximately 262° from vertical
- **Turbulator**
  - Reverse engineered CNC machined turbulator, Marlin Engineering ME1500-103
  - Notch at 6 o'clock position (looks upside down)
- **Air Flow**
  - Sonic choke inlet pressure = 35 psig
- **Air Temperature**
  - 40-60°F
- **Fuel Temperature**
  - 32-52°F

*Stator Clocking Measurement Example*



# Worldwide Seat Round Robin 2007



Figure 1. Fire-Hardened Foam 1



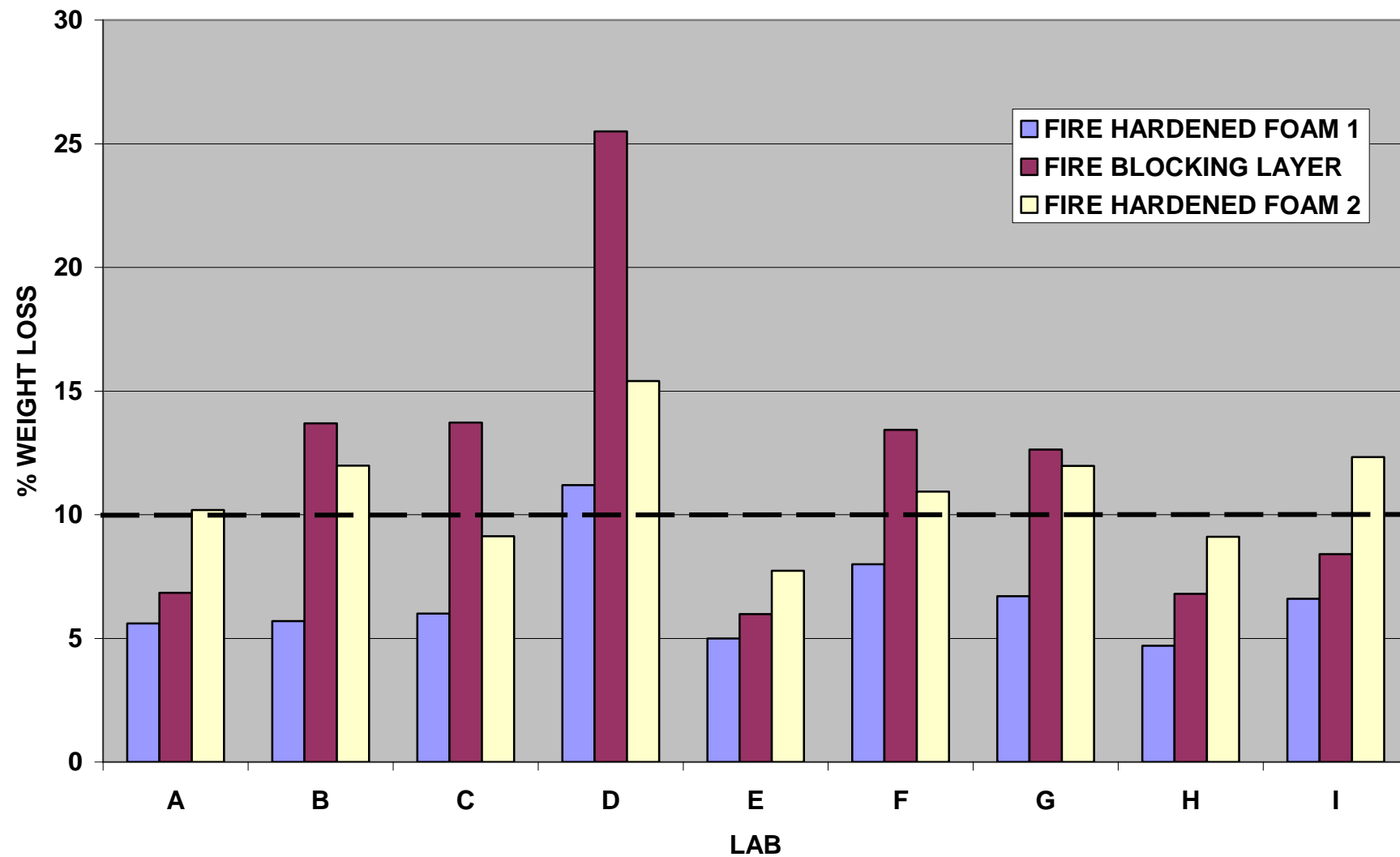
Figure 2. Fire-Blocking Layer



Figure 3. Fire-Hardened Foam 2



## WORLDWIDE SEAT ROUND ROBIN 2007





# 2010 Series Fire Hard Foam 1 (FH1)



**2006 Series FH1**

**5.606 lb**

**2010 Series FH1**

**6.404 lb**

***Difference = 0.798 lb***

# 2010 Series Fire Blocking Layer Cushions (FB)



**2006 Series FB**

**4.890 lb**

**2010 Series FB**

**5.582 lb**

**Difference = 0.692 lb**

# 2010 Series Fire Hard Foam 2 (FH2)



**2006 Series FH2**

**5.778 lb**

**2010 Series FH2**

**5.990 lb**

***Difference = 0.212 lb***

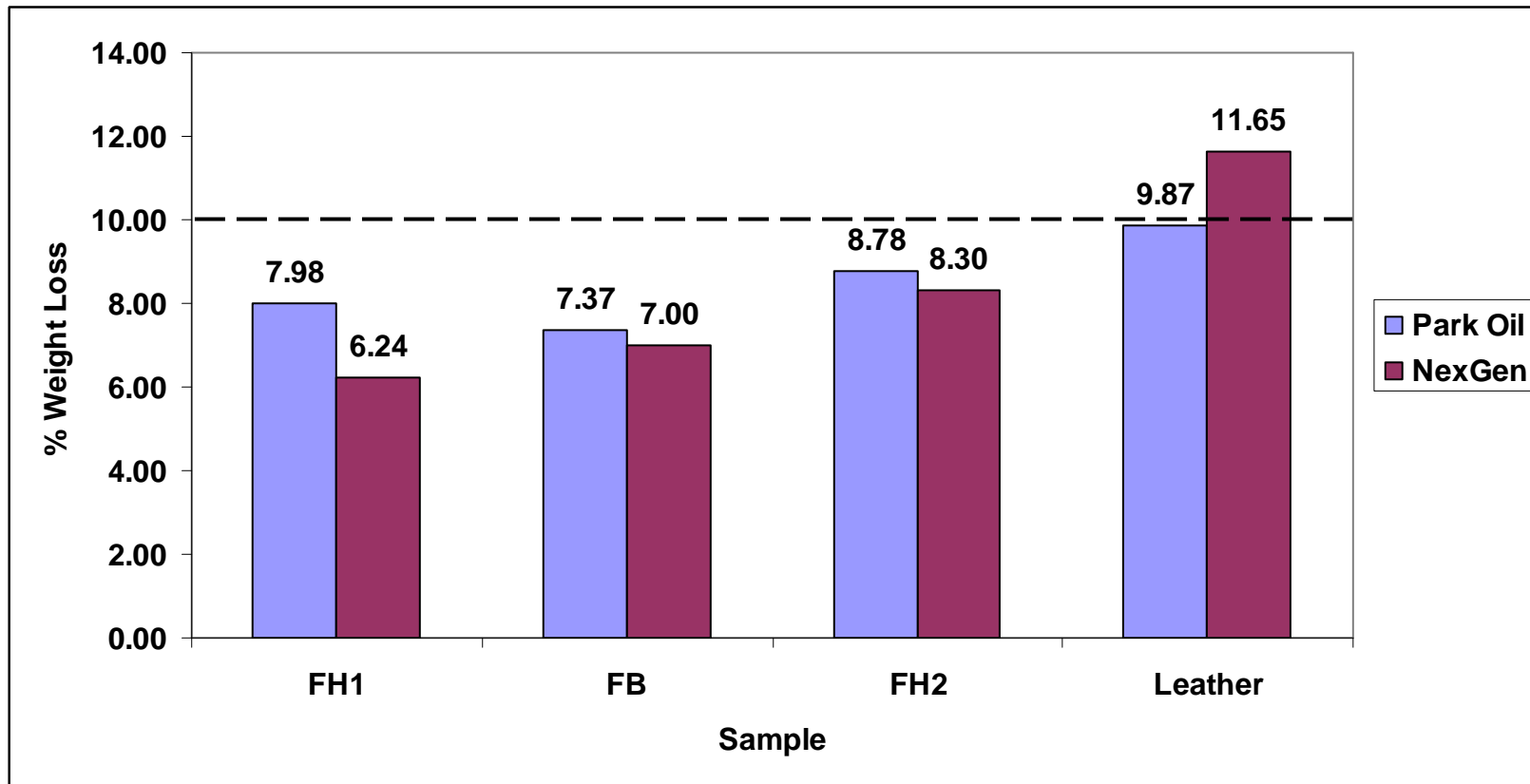
# 2010 Series Leather Seat Cushions



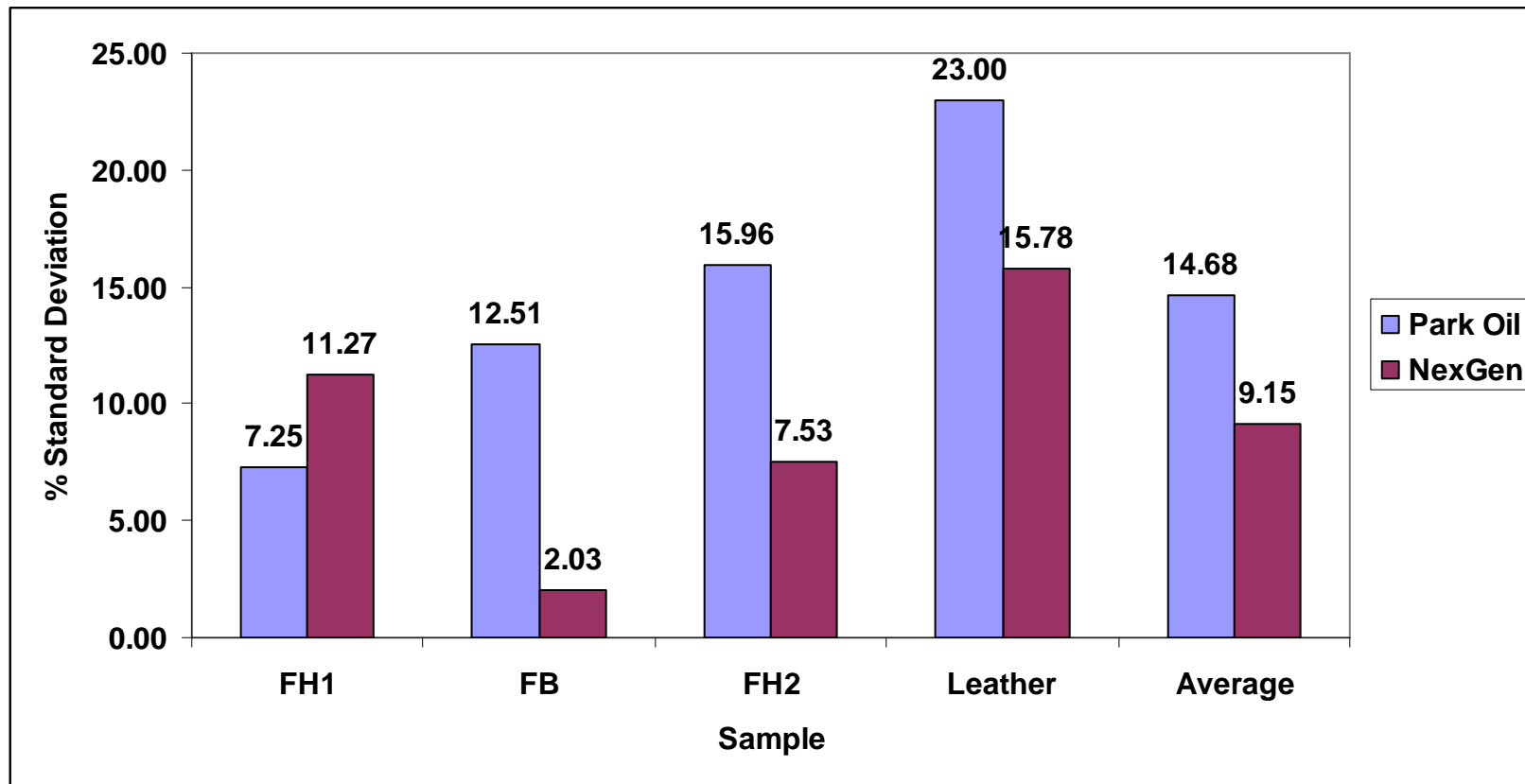
***2010 Series Leather***

***7.12 lb***

# 2010 Series Results - % Weight Loss

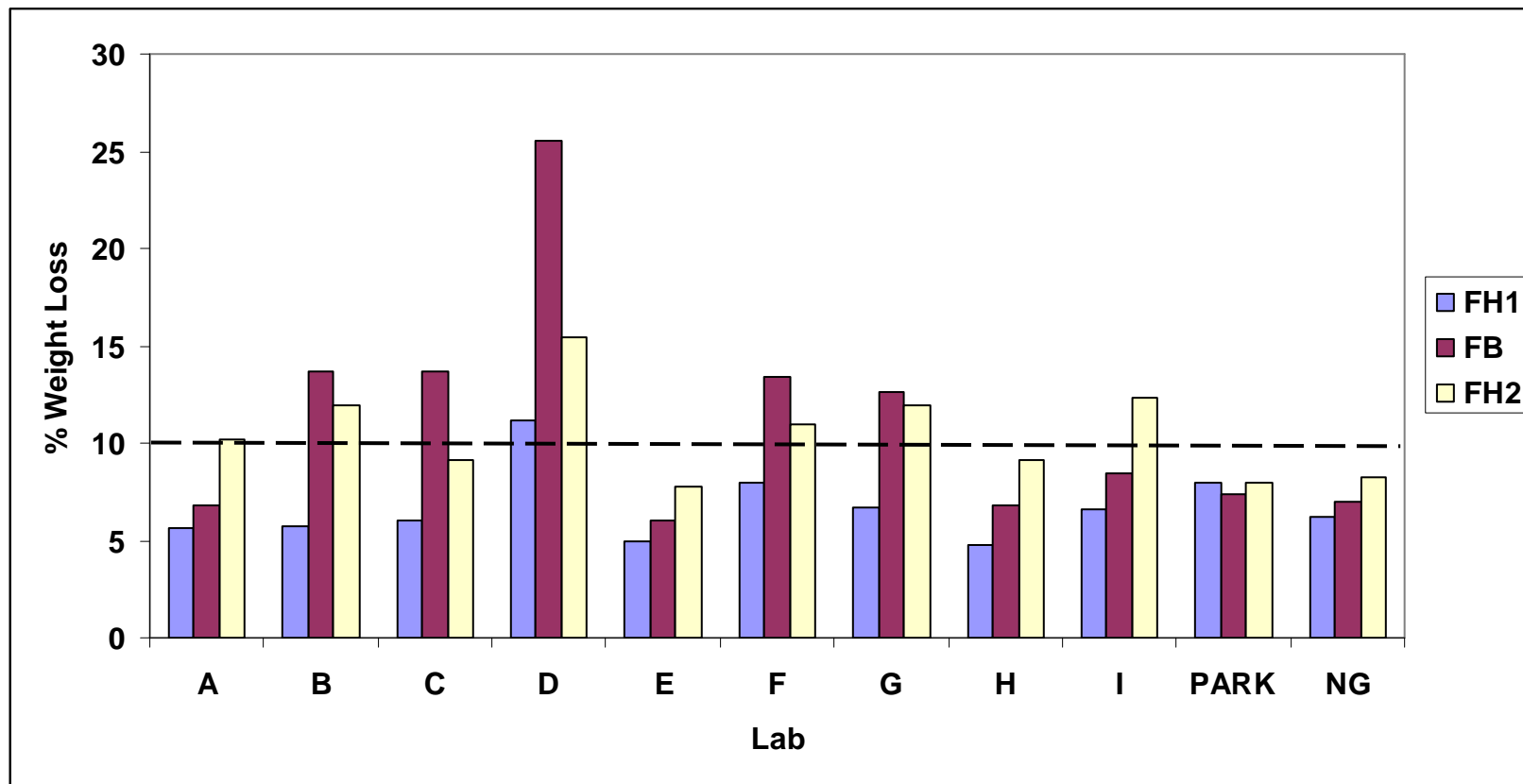


# 2010 Series Results - Repeatability

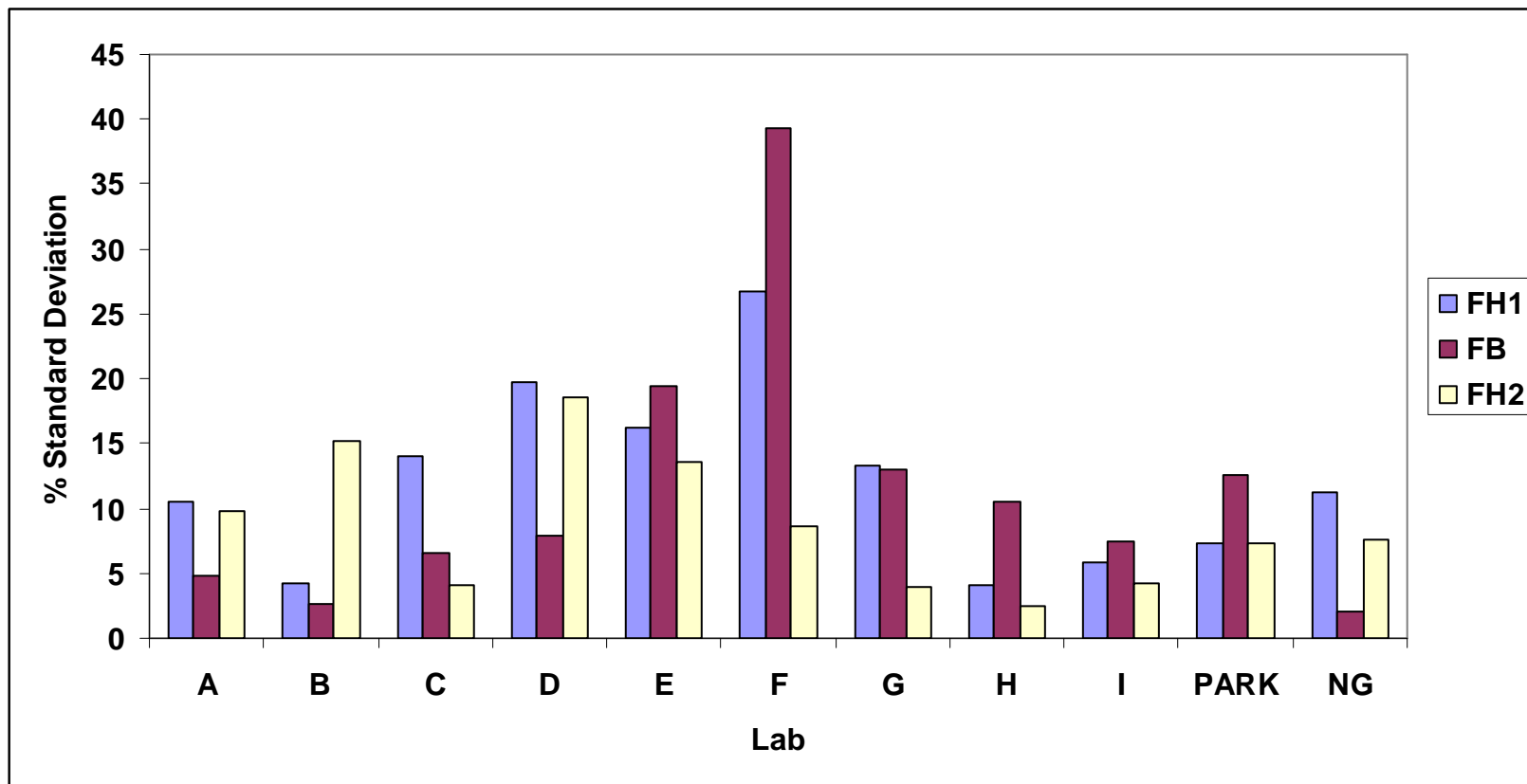




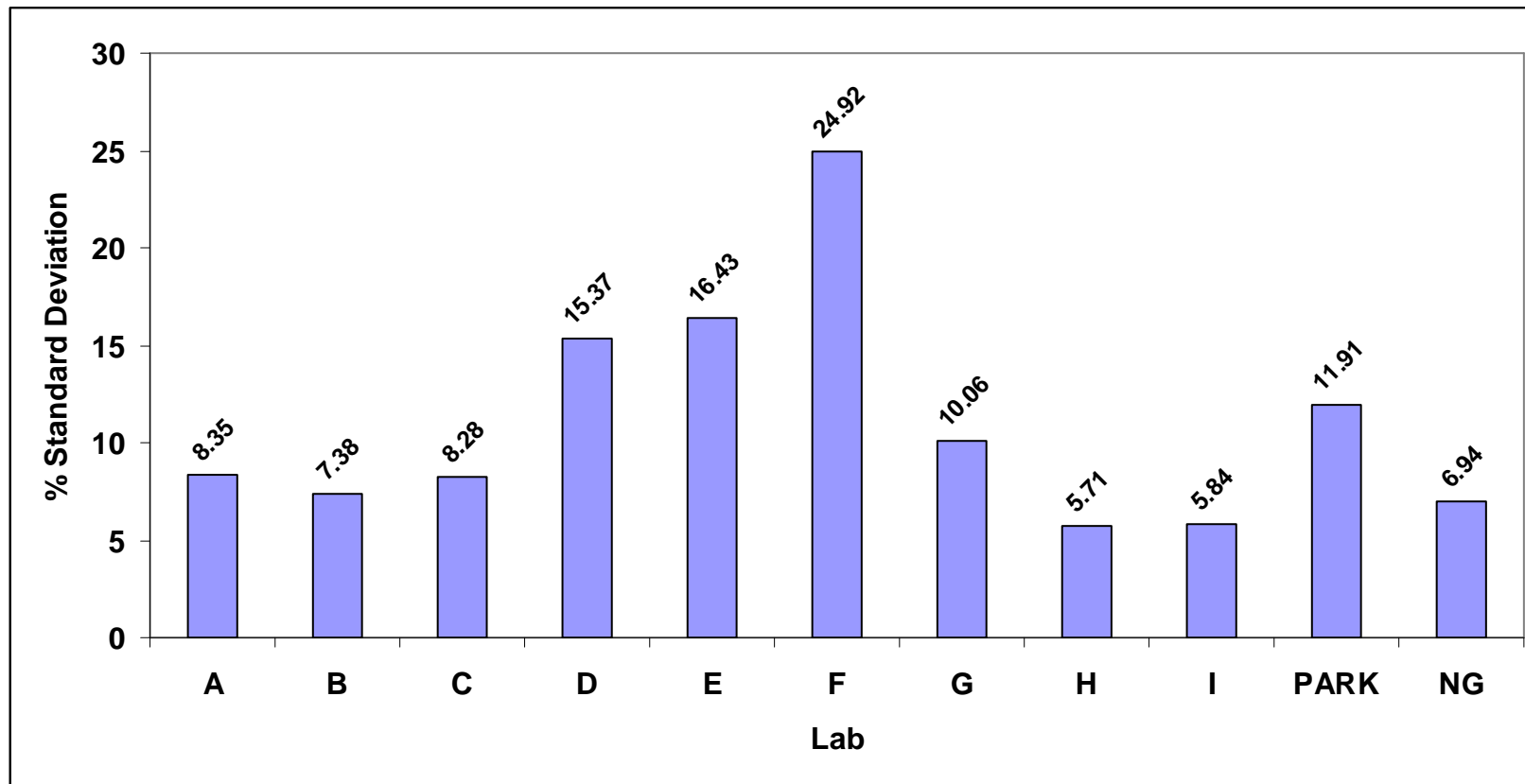
# 2007 Round Robin vs. 2010 Comparison - % Weight Loss



# 2007 Round Robin vs. 2010 Comparison - Repeatability



# 2007 Round Robin vs. 2010 Comparison – Average %Std Dev



# Summary

- **After much trial and error testing, the NexGen burner was able to achieve burner calibration according to the specifications in chapter 7 of the Aircraft Materials Fire Test Handbook**
- **The NexGen burner results compared well with the results from the seat test round robin described in DOT/FAA/AR-TN06/55**
  - Burner airflow reduced to 35 psig to achieve similar results to the Park
  - Reproduced seat cushions were not exact replicas of WWRR 2006 cushions
  - Leather seat cushions were used in this comparison that were not used in WWRR 2006
  - % mass loss data agreed well between Park and NexGen
  - Good repeatability was found with the NexGen burner

# Next Steps

- **Configure an identical NexGen burner and perform calibration and comparative seat tests**
- **Determine limits of burner configuration on performance and dependency of performance on calibration measurements**
  - Use a burnthrough-configured (internal components) NexGen (internal components) with a 2.0 gph fuel flow and 35 psig inlet pressure
  - Use a seat-configured NexGen with a 90° elbow
- **Possible round robin tests with participating labs (need more cushions)**
- **Update/create advisory material to include the use of the NexGen burner for seat cushion testing**

# Questions?

## Contact:

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