Seat Cushion Test Method Update

Federal Aviation Administration

Presented to: IAMFTWG

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Introduction

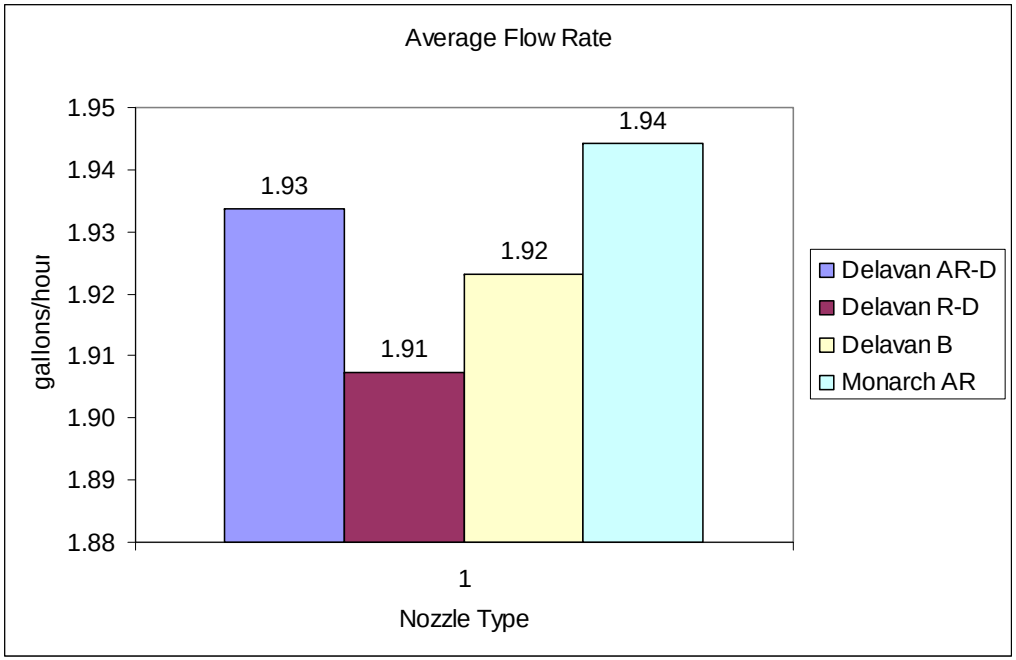
- **Continue working to setup and calibrate sonic burner for use with seat cushion test method for the purpose of replacing Park Burner**
- **Calibration and testing has been ongoing in an attempt to setup the sonic burner such that it will reproduce Park burner test results**
- **The advantage of the sonic burner is that it is capable of producing more consistent results than the Park burner**

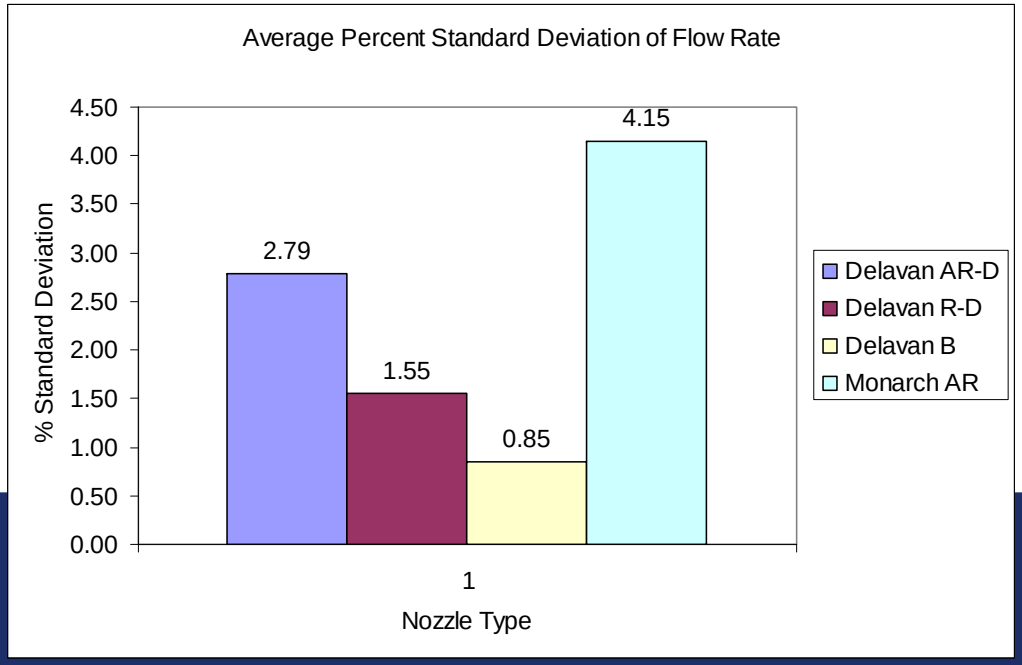
Summary of Last Meeting

- **Flow tested new nozzles**
  - Checked for consistency in flow rates
- **Testing nozzles in sonic burner**
  - Nozzle clocking to check for uniform flame temperature distribution using thermocouple rake
- **Seat cushion tests using sonic burner**
  - Data collected using old Park burner and Monarch nozzles will be compared to data taken using new nozzles and sonic burner
- **Thermocouple Temperature Drift**
  - Thermocouple temperature measurements drop off after repeated heat cycling

Fuel Nozzle Flow Rate

- **Delevan Nozzle Flow Check**
  - The Delevan nozzles were checked on a bench top flow testing rig. The results show, that compared to the typical Monarch nozzles, the Delevan nozzles have a much lower percent error.
  - **Delevan 2.0 gph error: 4.09%**
  - **Monarch 2.25 gph error: 13.59%**
  - Further testing with different nozzles is ongoing.
- **25 Everloy 2.0 gph-rated hollow cone nozzles were also tested, and produced results similar to the Delevan nozzles.**





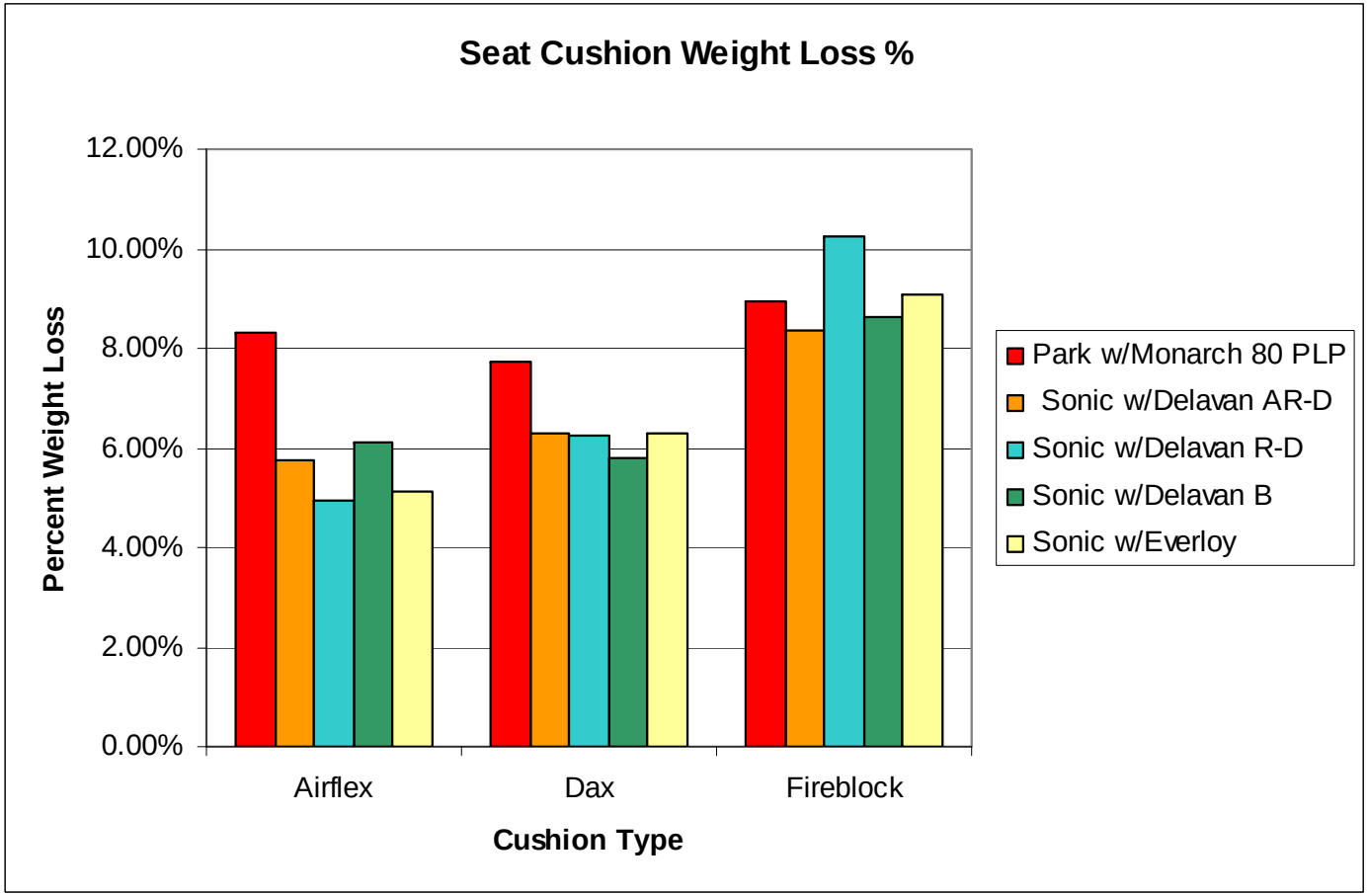
Nozzle Clocking Summary

- **Monarch nozzles are not uniform around the spray cone periphery**
- **Delavan nozzles seem to provide more uniform spray pattern through 360° nozzle rotation**
  - Delevan flame temperatures are lower (~100°F) than Monarch flame
  - Previously recorded lower temperatures partially due to old thermocouples
  - Temperatures for the Delevan nozzles increased after replacing old thermocouples with new ones

Seat Testing with Burner

- **Sonic Burner used to burn seat test cushions using new Delevan and Everloy Nozzles**
- **Park burner used with Monarch nozzle to test cushions and compared to sonic data**
- **Sonic burner produced slightly lower % weight loss than Park**
- **Seat cushions tested in question**
  - Different covers used on different foam cushions
  - Need to run test using the same fabric cover on all foam types

Results

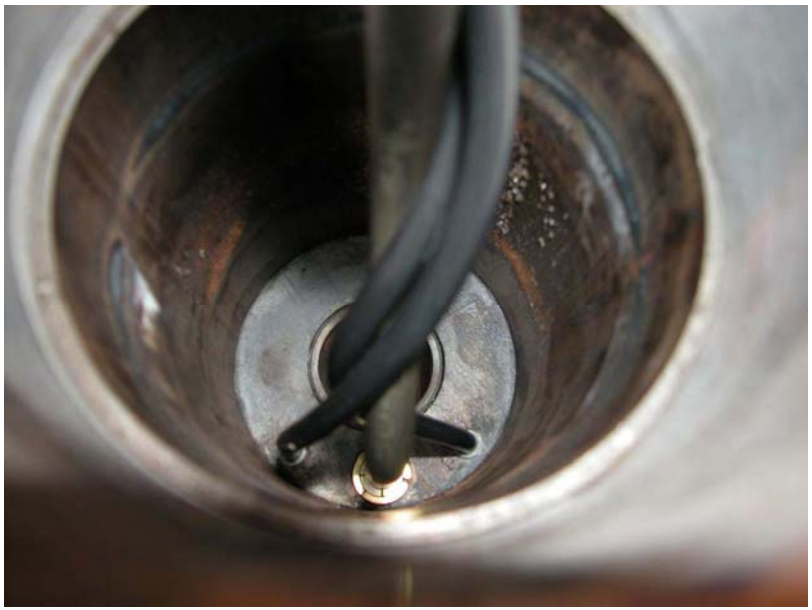

Seat Cushion Weight Loss %
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percent Weight Loss
Airflex
Dax
Fireblock
Cushion Type
Park w/Monarch 80 PLP
Sonic w/Delavan AR-D
Sonic w/Delavan R-D
Sonic w/Delavan B
Sonic w/Everloy

Summary for Current Meeting

- **Ignition Wire Positioning**
- **Igniter Positioning**
- **New Stator and Nozzle Settings**
- **New seat cushion tests with Park and NexGen burners**
- **Update on thermocouples**

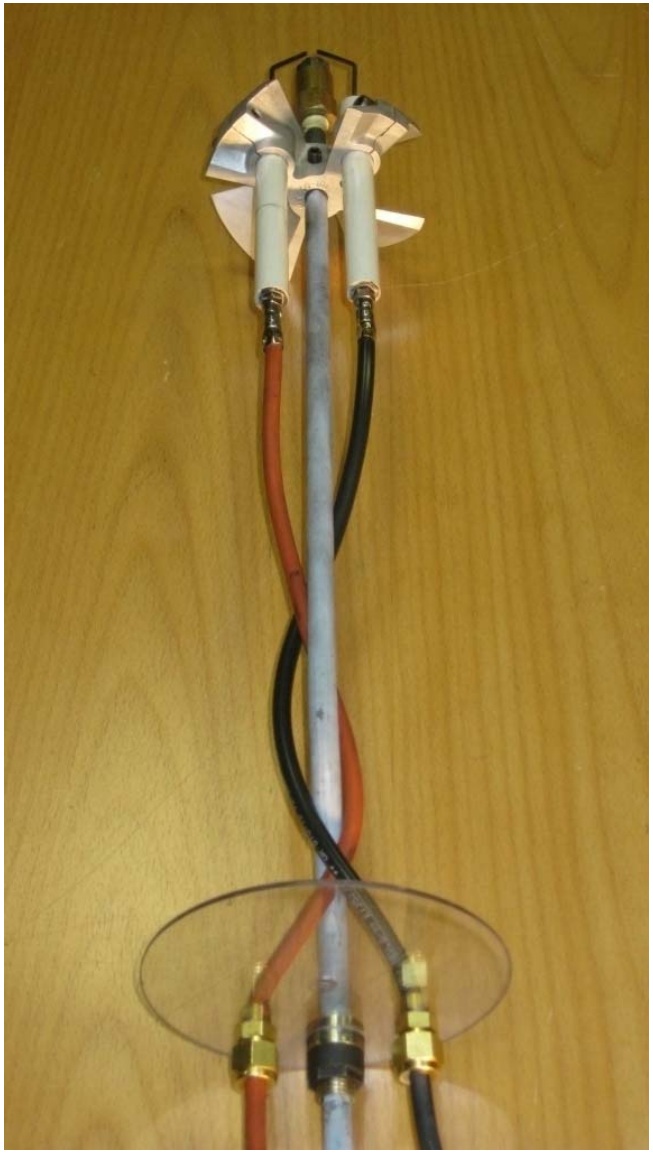
Ignition Wires

- **Ignition wires previously wrapped around fuel rod**
- **Not standardized length or position for wires**
- **Position of wires can impede or redirect airflow within the draft tube and can affect the flame characteristics**

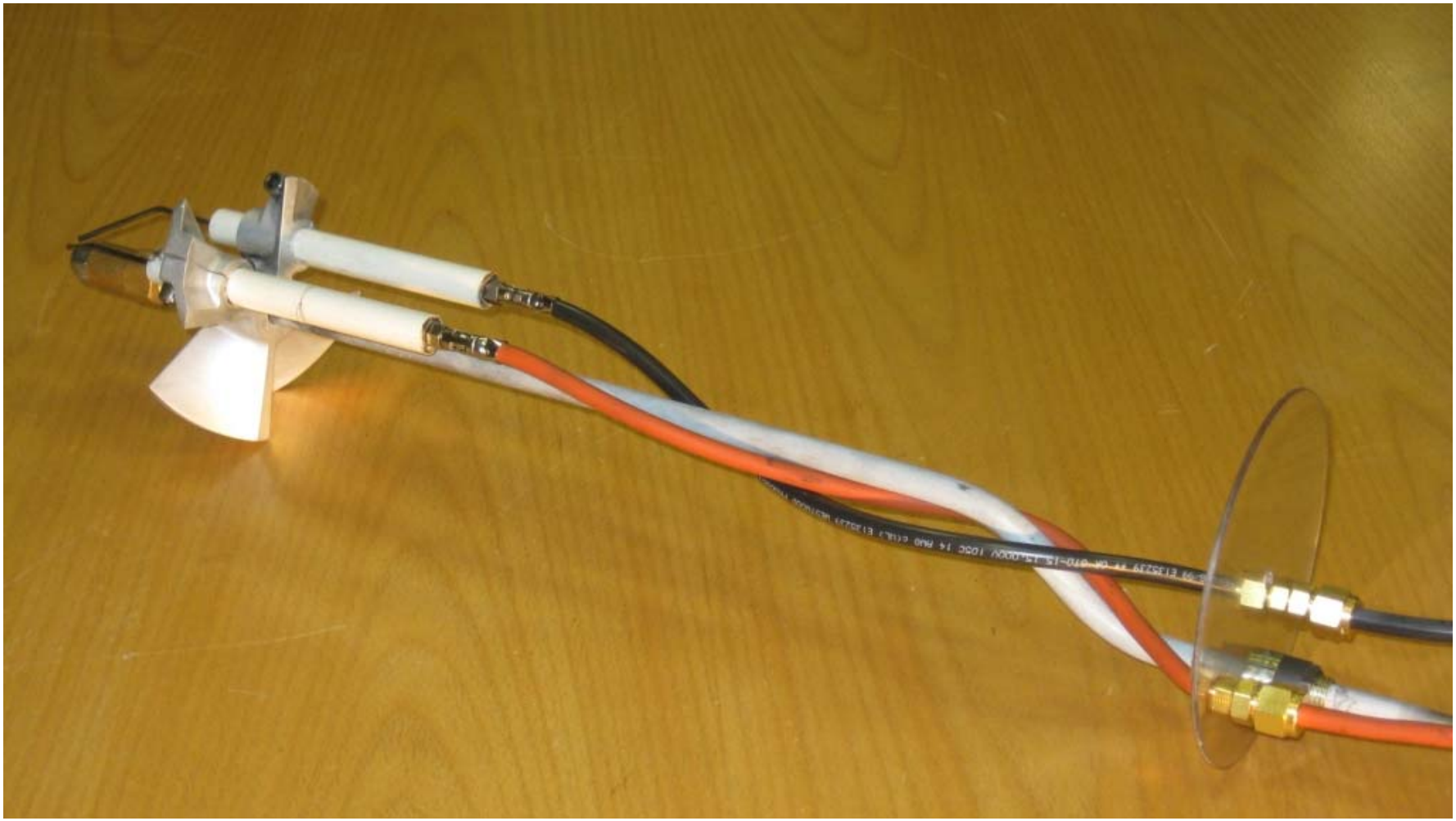


Ignition Wires

- New wire length and positions minimize airflow disturbance
- Standardize wire position to minimize variability in burner performance and data results
- Improved repeatability

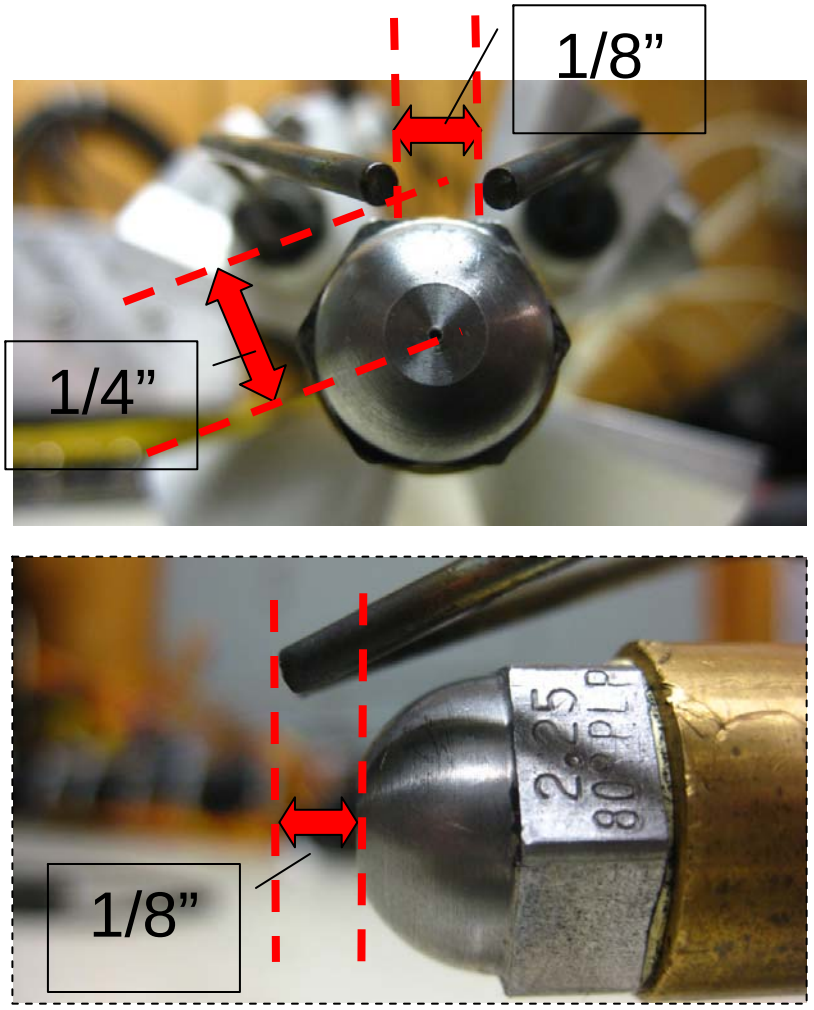


Example: New Ignition Wire Positions



Igniter Position

- **Also needed specific standardized igniter position**
- **Gap between igniters**
  - 1/8”
- **Nozzle center to igniter**
  - ¼”
- **Nozzle face to igniter**
  - 1/8”



Refining Burner Settings

- **Same procedure used on cargo burner**
- **Stator face to turbulator exit plane**
  - 2.5”, 2.75” (2 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”, 9/16” (3 positions)
- **Total of 48 unique combinations tested**

Refining Burner Settings

- **Stator/nozzle position combinations were selected which showed adequate flame properties**
  - Temperature distribution
  - Repeatability
  - Full, even flame coming from cone (visual)
- **Next step, test using seat cushions**

Seat Cushion Testing

- **New shipment of seat cushions for testing**
  - Dax, Airflex, and fireblocked cushions
- **All cushions now covered in the same type of fabric**
  - Previous tests had different fabrics on different cushion types
- **Use Park burner and collect data using new cushions for comparison**

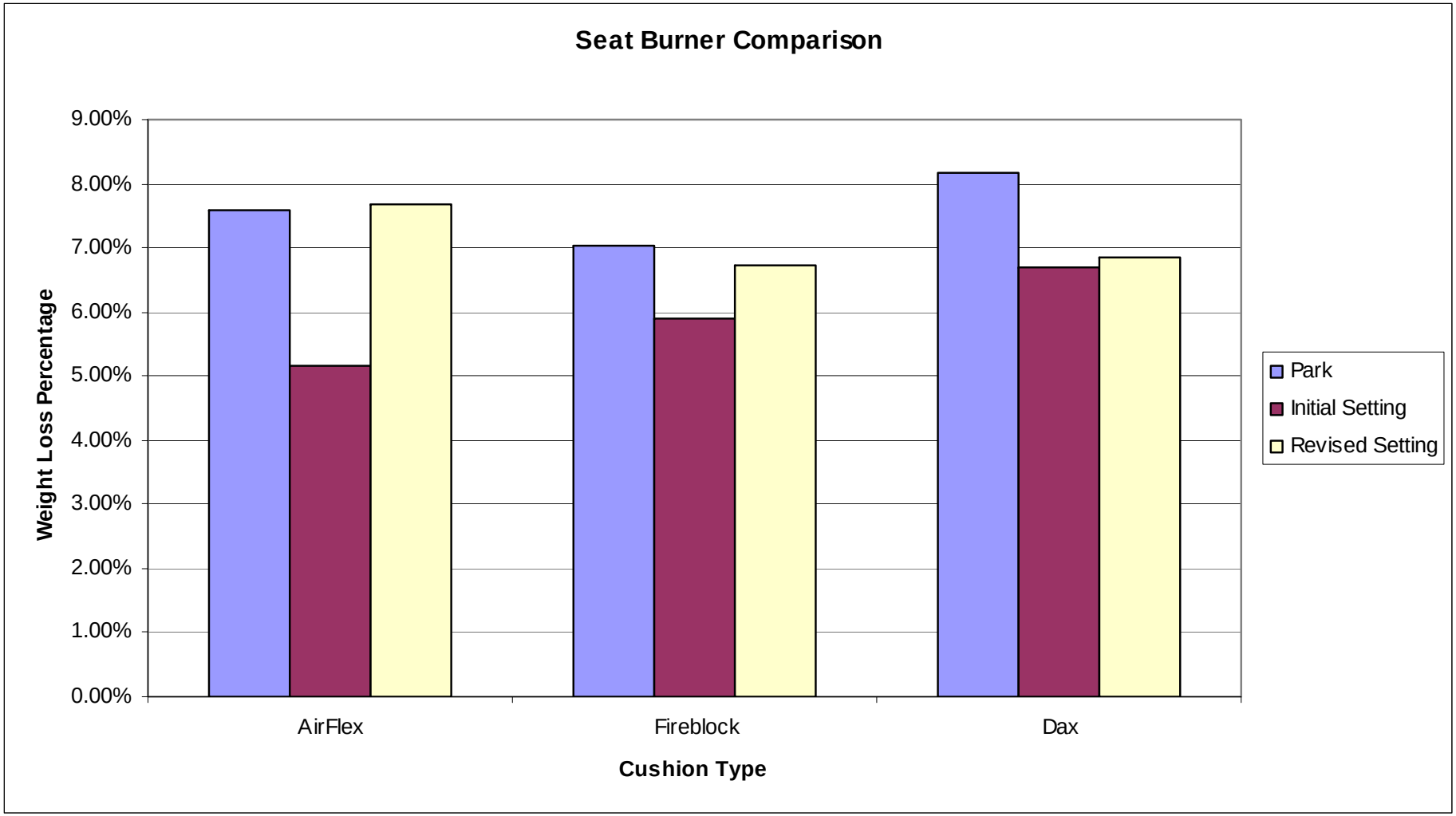
Seat Cushion Testing

- **Use sonic burner with new initial stator settings to test new seat cushions**
- **Results less weight loss using sonic burner compared to Park burner**
  - Minimal burner on bottom of horizontal cushion
- **Stator repositioned to produce a flame that was weighted more on the bottom**

Seat Cushion Testing

- **Revised stator settings tested**
- **Results much closer to Park results**
- **Measured temperature lower, although weight loss % increased**
  - Higher measured temperatures do not necessarily mean greater burn lengths and/or weight loss

Seat Cushion Testing



Seat Cushion Testing

- **Next step is to have other labs setup burner using same settings and check to see if results are comparable**
- **Nozzle Depth: 3/16”**
- **Stator Depth: 2 11/16”**
- **Stator Angle: 0° (centerline from vertical)**

Thermocouple Update

- **Thermocouple readings drop after repeated heat cycling of the TCs**
- **Tests run using cargo burner**
- **Tried larger diameter TCs which have a greater mass, and do not heat as quickly as 1/16” or 1/8” TC**
- **Results not entirely clear if using larger diameter TCs is an advantage**
- **Still some signs of temperatures dropping after repeated heat cycling**

Future Items

- **Continue testing with possibility of trying other stator settings**
- **Compare results from different labs**
  - Have other labs use new burner settings and test
  - Round robin schedule?
- **Kaowool seat testing**
  - On hold from last meeting do to ignition wire positioning and stator readjustment