SEAT OIL BURNER TASK GROUP

Federal Aviation Administration

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- 1. The use of the sonic burner
- 2. The inclusion of the lightweight seat policy into the new chapter
- 3. How to test thin materials
- 4. How to test non-traditional materials (i.e., pneumatic cushions)

- The use of the sonic burner

- The inclusion of the lightweight seat policy into the new chapter

- How to test thin materials

- How to test non-traditional materials (i.e., pneumatic cushions)

NexGen Fire Test Burner for Seat Cushion Testing

Federal Aviation Administration

2.0 gph NexGen Burner Set-up

- **2.02 gph @ ~95 psi fuel pressure**
- **1/8” sheathed ceramic packed K type TCs**
- **Initial testing performed at an air pressure of ~35 psi**
  - Based on previous seat cushion test results using a 2.0 gph NexGen burner that were comparable to the Park Burner test results

2.0 gph NexGen Burner Set-up

- **Stator Positioning: Rotational Position**
  - Series of tests to systematically locate the “Ideal” stator position.
  - Stator rotated in increments of 45 degrees throughout 360 degree rotation
    - (0, 45, 90,…..360)
  - Temperature measurements taken at each position

2.0 gph NexGen Burner Set-up

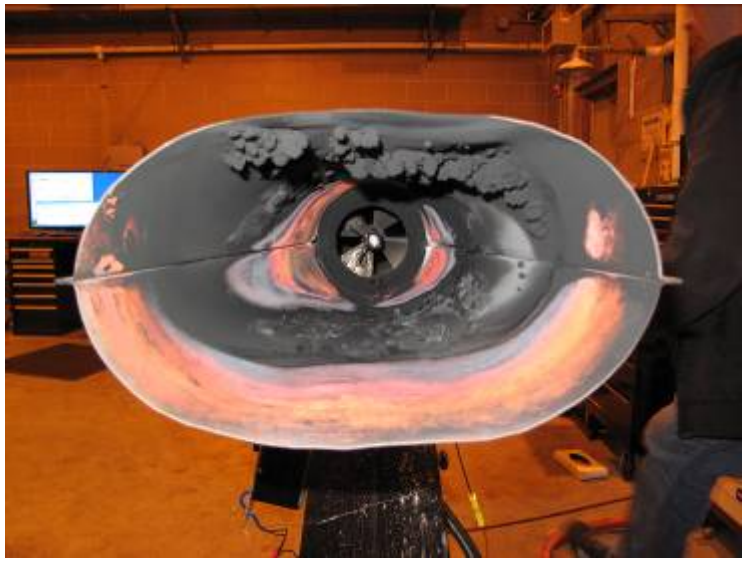
- **Stator Positioning: Axial Location**
  - Stator position tested at three different locations on the axis of the fuel rod
  - Stator was rotated and tested throughout the 360 degree range for each axial location

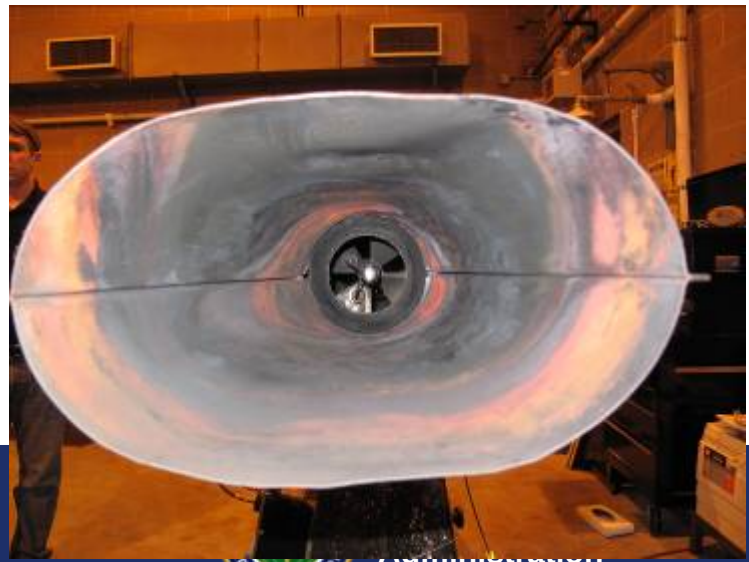
2.0 gph NexGen Burner Setup

- **Stator Positioning: Results**
  - Stator was tested in a total of 36 different positions based on changes in rotational and axial locations.
  - Looking for flame temperature uniformity, repeatability, and temperatures comparable to Park burner test results
  - Rotational Location
    - Igniter centerline located 330 degrees clockwise from zero degrees (igniter vertical centerline)
  - Axial Location
    - Front face of stator located 3.375 inches from front face of turbulator

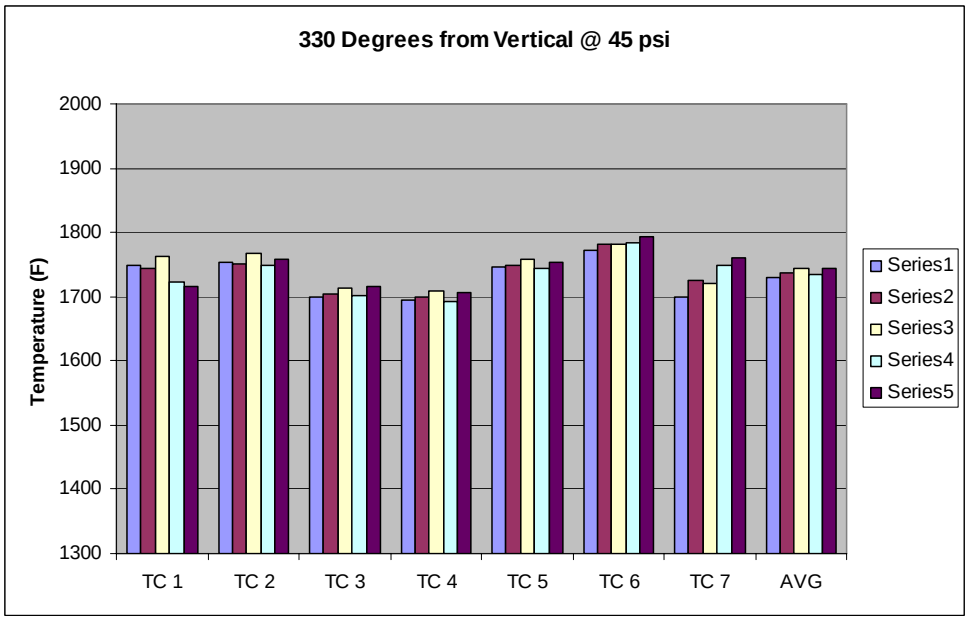
Keeping the Burner Cone Clean

- **It is important to keep the burner cone and thermocouples free of any soot buildup**
- **Even a small amount can affect data results**
- **The cone and TCs should be brushed clean after every burn run**

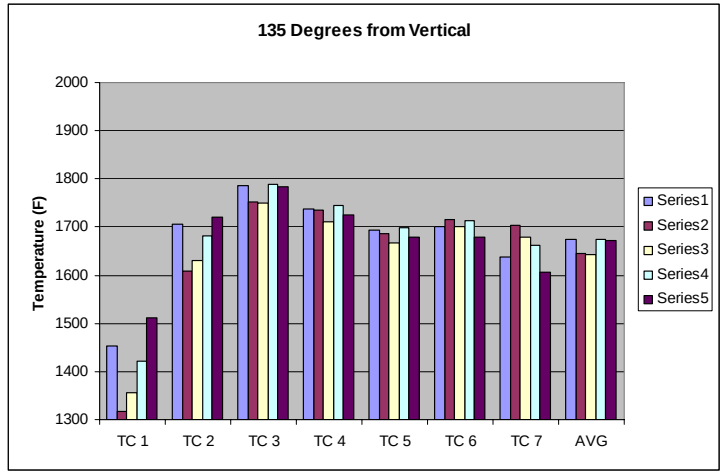




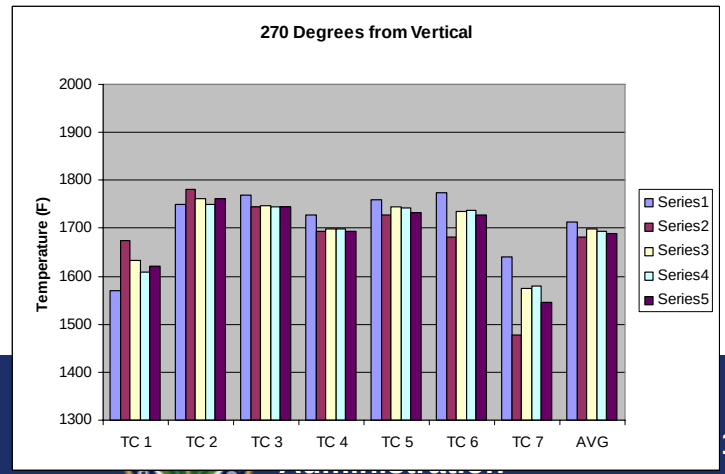
Comparison of Test Results



"Uniform" Flame Profile

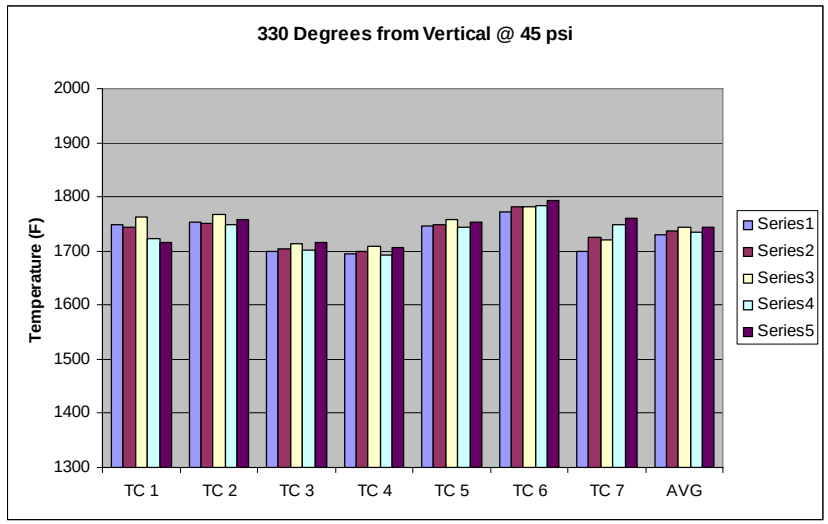


Other Profile Examples



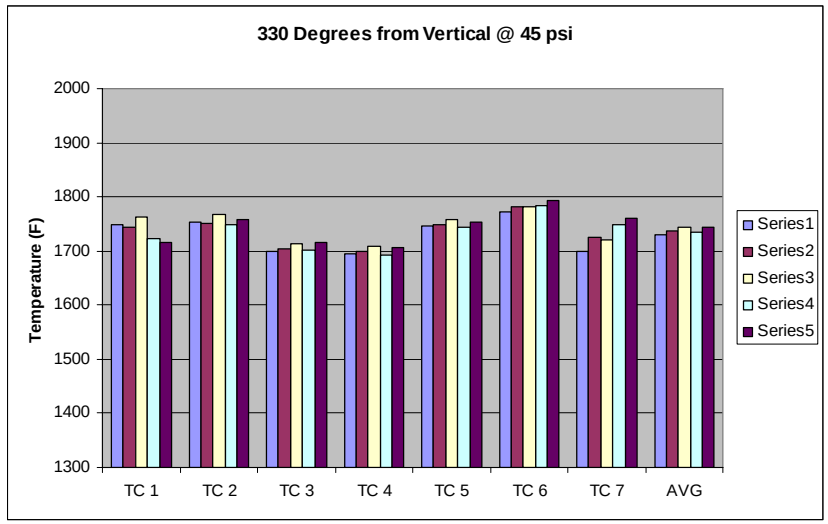
Comparison of Test Results

- **Data shown at right was collected at 45 psi air pressure. There was only a minimal difference in the data when running the burner at 35 psi vs. 45 psi**
  - TC readings were more consistent at 45 psi, but average temperature remained the same when compared to 35 psi
- **Overall temperatures currently are ~100*F lower than Park test results**
  - May have an impact on material burn lengths and mass loss
- **Final settings will be based on test cushion burn specimen results**



Comparison of Test Results

- **Temperature profile does not currently meet handbook standards:**
  - Of the seven thermocouples used, any two will be equal to or greater than 1750°F (954°C), while the remaining thermocouples will each be equal to or greater than 1800°F (982°C). The average of the seven thermocouples must be equal to or greater than 1800°F.



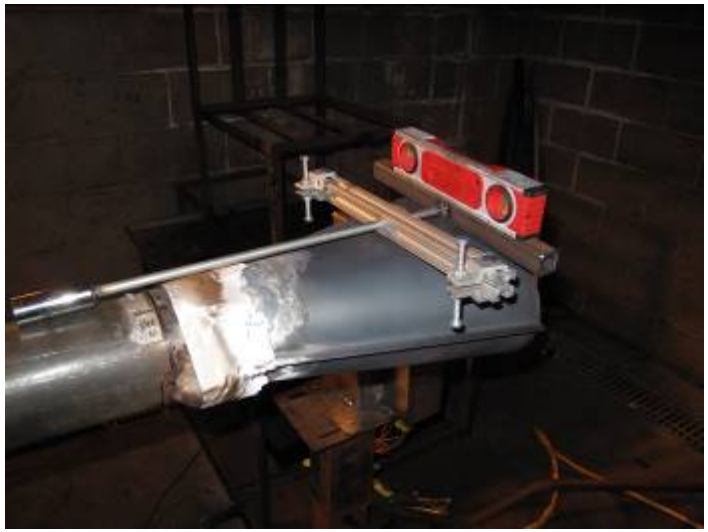
Fuel Nozzle Adjustment

- **Flame temperature profile can further be refined by clocking fuel nozzle**
  - A non-uniform spray pattern can require nozzle adjustment to achieve a more uniform temperature profile
  - This setting would not necessarily be the same for each burner since each fuel nozzle may have slight variations in fuel spray pattern
  - Testing has shown even small changes (a few degrees) can have an effect on the flame temperature profile
  - More testing of fuel nozzle position will need to be performed after running tests on material samples to see if material results are comparable to park burner test results

Fuel Nozzle Adjustment

- **Previously, there was no repeatable method of accurately setting the fuel nozzle position**
- **Recently, a prototype tool using a 3/4” socket, socket extension, and digital angle finder was constructed to address this issue.**
- **Further fuel nozzle position testing will be performed using this tool and will allow for more repeatable results in flame profile adjustments**

Fuel Nozzle Adjustment Tool



Fire Blocking Layer

- **Results of sample testing that was recently performed using new burner settings**
- **The samples were used previously in an extinguisher test. Cushions were burned on one side, and the weight of the samples reflect this.**

NexGen Burner

Air Pressure: 35 psi

Fire Blocking Layer	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.48	5.30	5.30	5.36
Weight After (lb)	5.19	5.04	5.02	5.08
ΔWeight (lb)	0.29	0.26	0.28	0.28
% Weight Loss	5.29	4.91	5.28	5.16
Vertical Front Burn (in)	8.50	9.00	8.00	8.50
Horz Top Burn (in)	7.50	7.50	7.25	7.42

Fire Blocking Comparison

Park Burner

Fire Blocking Layer	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.64	5.58	5.62	5.61
Weight After (lb)	5.22	5.12	5.26	5.20
ΔWeight (lb)	0.42	0.46	0.36	0.41
% Weight Loss	7.45	8.24	6.41	7.37
Vertical Front Burn (in)	7.88	7.63	8.50	8.00
Horz Top Burn (in)	6.38	7.25	8.38	7.33

NexGen Burner @ 35 psi

Air Pressure: 35 psi

Fire Blocking Layer	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.48	5.30	5.30	5.36
Weight After (lb)	5.19	5.04	5.02	5.08
ΔWeight (lb)	0.29	0.26	0.28	0.28
% Weight Loss	5.29	4.91	5.28	5.16
Vertical Front Burn (in)	8.50	9.00	8.00	8.50
Horz Top Burn (in)	7.50	7.50	7.25	7.42

Fire Blocking Layer

NexGen Burner @ 35 psi

Fire Blocking Comparison

NexGen Burner @ 45 psi

Air Pressure: 45 psi

Fire Blocking Layer	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.42	5.46	5.3	5.39
Weight After (lb)	5.1	5.13	5.04	5.09
ΔWeight (lb)	0.32	0.33	0.26	0.30
% Weight Loss	5.90	6.04	4.91	5.62
Vertical Front Burn (in)	7.25	7.50	6.50	7.08
Horz Top Burn (in)	6.25	10.75	5.25	7.42

NexGen Burner @ 35 psi

Air Pressure: 35 psi

Fire Blocking Layer	Run 1	Run 2	Run 3	Average
Weight Before (lb)	**5.48**	**5.30**	**5.30**	**5.36**
Weight After (lb)	**5.19**	**5.04**	**5.02**	**5.08**
ΔWeight (lb)	**0.29**	**0.26**	**0.28**	**0.28**
% Weight Loss	**5.29**	**4.91**	**5.28**	**5.16**
Vertical Front Burn (in)	**8.50**	**9.00**	**8.00**	**8.50**
Horz Top Burn (in)	**7.50**	**7.50**	**7.25**	**7.42**

Fire Blocking Layer

NexGen Burner @ 45 psi

Fire Hardened Foam

- **The following data shows fire hardened foam test results using new burner settings**
- **Three test specimens were burned at an air pressure setting of 35, 45, and 48 psi**

NexGen Burner @ 35 psi

Air Pressure: 35 psi

Fire Hardened Foam	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.94	5.96	5.44	5.78
Weight After (lb)	5.42	5.49	4.95	5.29
ΔWeight (lb)	0.52	0.47	0.49	0.49
% Weight Loss	8.75	7.89	9.01	8.55
Vertical Front Burn (in)	13.75	12.75	13.50	13.33
Vertical Back Burn (in)	0.00	0.00	0.00	0.00
Horz Top Burn (in)	11.25	10.50	12.00	11.25
Horz Bottom Burn (in)	8.75	5.00	3.00	5.58

Fire Hardened Comparison

Park Burner

Fire Hardened Foam	Run 4	Run 5	Run 6	Average
Weight Before (lb)	6.66	6.20	6.32	6.39
Weight After (lb)	6.10	5.56	5.84	5.83
ΔWeight (lb)	0.56	0.64	0.48	0.56
% Weight Loss	8.41	10.32	7.59	8.78
Vertical Front Burn (in)	10.50	14.38	9.75	11.54
Vertical Back Burn (in)	0.00	0.00	0.00	0.00
Horz Top Burn (in)	8.00	12.50	8.25	9.58
Horz Bottom Burn (in)	10.75	11.50	9.00	10.42

NexGen Burner @ 35 psi

Air Pressure: 35 psi

Fire Hardened Foam	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.94	5.96	5.44	5.78
Weight After (lb)	5.42	5.49	4.95	5.29
ΔWeight (lb)	0.52	0.47	0.49	0.49
% Weight Loss	8.75	7.89	9.01	8.55
Vertical Front Burn (in)	13.75	12.75	13.50	13.33
Vertical Back Burn (in)	0.00	0.00	0.00	0.00
Horz Top Burn (in)	11.25	10.50	12.00	11.25
Horz Bottom Burn (in)	8.75	5.00	3.00	5.58

Fire Hardened Foam

NexGen Burner @ 45 psi

Air Pressure: 45 psi

Fire Hardened Foam	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.78	5.98	5.98	5.91
Weight After (lb)	5.32	5.46	5.30	5.36
ΔWeight (lb)	0.46	0.52	0.68	0.55
% Weight Loss	7.96	8.70	11.37	9.34
Vertical Front Burn (in)	13.5	14.75	13.00	13.75
Vertical Back Burn (in)	0.00	0.00	0.00	0.00
Horz Top Burn (in)	11.00	13.00	12.00	12.00
Horz Bottom Burn (in)	1.00	5.00	5.50	3.83

NexGen Burner @ 48 psi

Air Pressure: 48 psi

Fire Hardened Foam	Run 1	Run 2	Run 3	Average
Weight Before (lb)	5.98	5.44	5.84	5.75
Weight After (lb)	5.44	4.99	5.34	5.26
ΔWeight (lb)	0.54	0.45	0.50	0.50
% Weight Loss	9.03	8.27	8.56	8.62
Vertical Front Burn (in)	14.00	14.00	15.00	14.33
Vertical Back Burn (in)	0.00	0.00	0.00	0.00
Horz Top Burn (in)	11.25	11.25	13.25	11.92
Horz Bottom Burn (in)	10.75	4.00	4.50	6.42

Fire Hardened Foam

Further Testing

- **More testing and adjustment will need to be performed to refine the flame temperature profile and to achieve results similar to Park burner test specimens**
  - Stator has greatest affect on burner performance, and the position will likely remain as-is
  - Using 90 degree elbow and muffler on burner also impacts flame temperatures and needs further testing
  - Fuel nozzle position still needs final adjustment
  - More test results are needed to confirm burner settings