OSU & NBS Updates
2009 June Materials Meeting

Federal Aviation Administration

Materials Working Group

Michael Burns, FAA Tech Center

June 17th & 18th, 2009

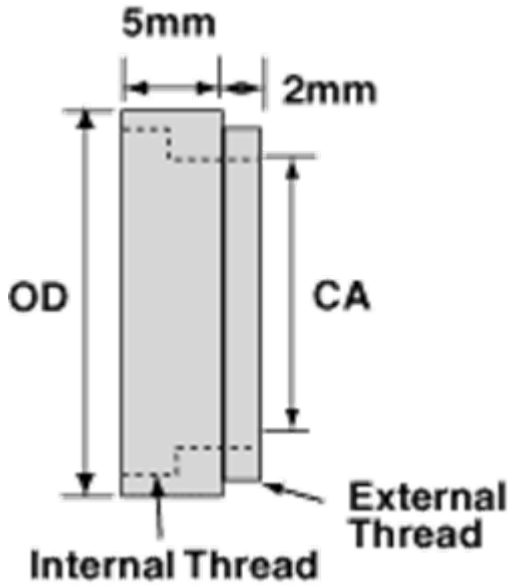
Agenda

1. NBS Update
   - Photometric System Round Robin
2. FAA Heat Flux Gage Calibration Study
3. Heat Flux Sensitivity Study
4. Maintenance Tips & Reminders
5. Next Steps

NBS Photometric System Round Robin

LAST CALL!

- FAA Is Currently Conducting A Round Robin Check Out Of The NBS Photometric System Using Neutral Density Light Filters.
- These Filters Provide A Linearity Check Of Five Data Points.



NBS Photometric System Round Robin

- No Furnace Heat Or Pilot Burner Required
- Zero Then Span System
  - Gradually Slide Filter Over Lower Glass Window
- 21 Labs Have Participated To Date
- Filter Information:
  - Edmund Optics
  - http://www.edmundoptics.com/onlinecatalog/DisplayProduct.cfm?productid=1523
- Filters Are Currently Available For International Lab Testing (Presently, Filters Are Located In France)

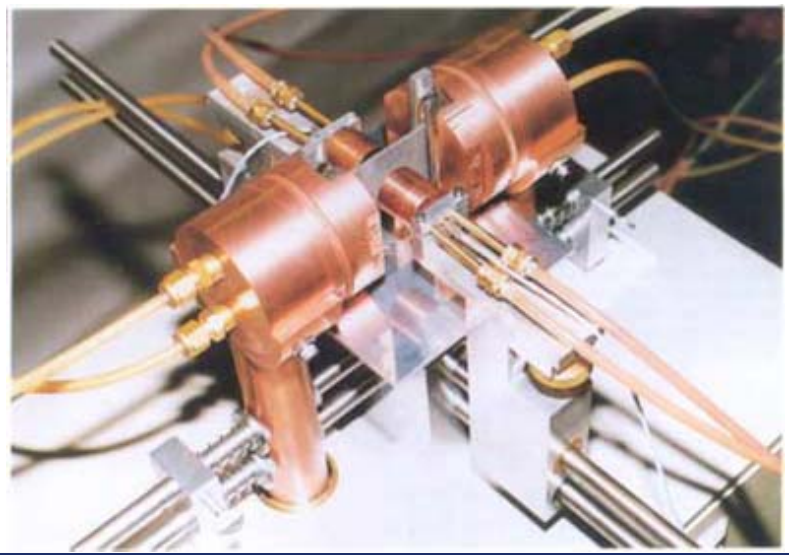
Data Will Be Presented At Next Materials Meeting

FAA Heat Flux Gage Working Group Participants

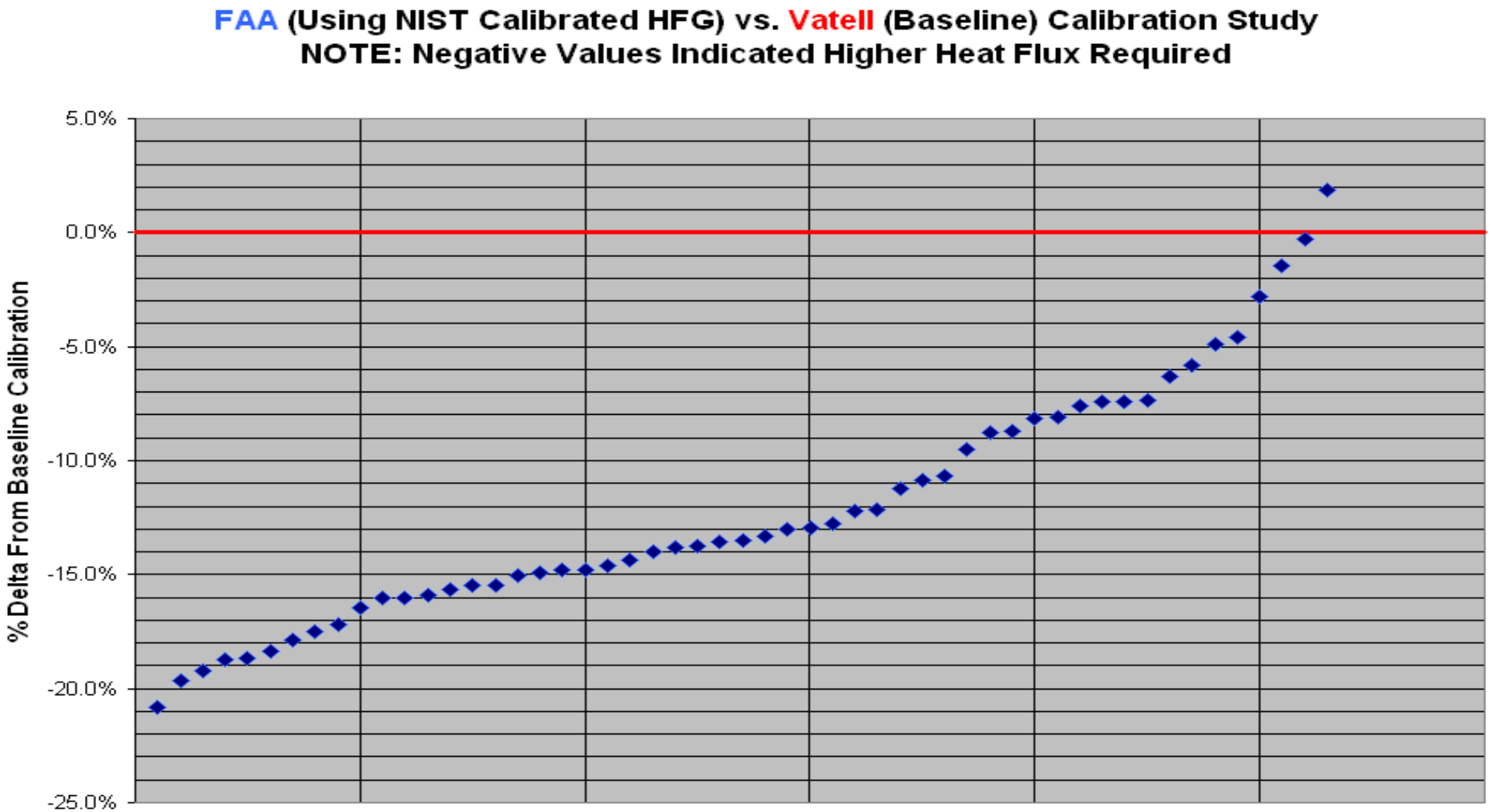
AccuFleet
AEROCON
Airbus Germany
Akro Fireguard
Aplix Incorporated
Bodycote
Boeing
C & D Zodiac
Chase Coating & Laminating
CTA
Custom Products
Damping Technologies
Delsen
DLR
Duracote
EAR Specialty Composites
FAA
Flame Out Inc.
GovMark
Heath Tecna
Herb Curry Inc
Isovolta
JAMCO America
Lamart
Mexmil Company
Orcon Corporation
Polyfab
Polymer Technologies
Schneller Inc
Skandia Inc
Starr Aircraft
Test Corp
TTF Aerospace

FAA Heat Flux Gage Calibration

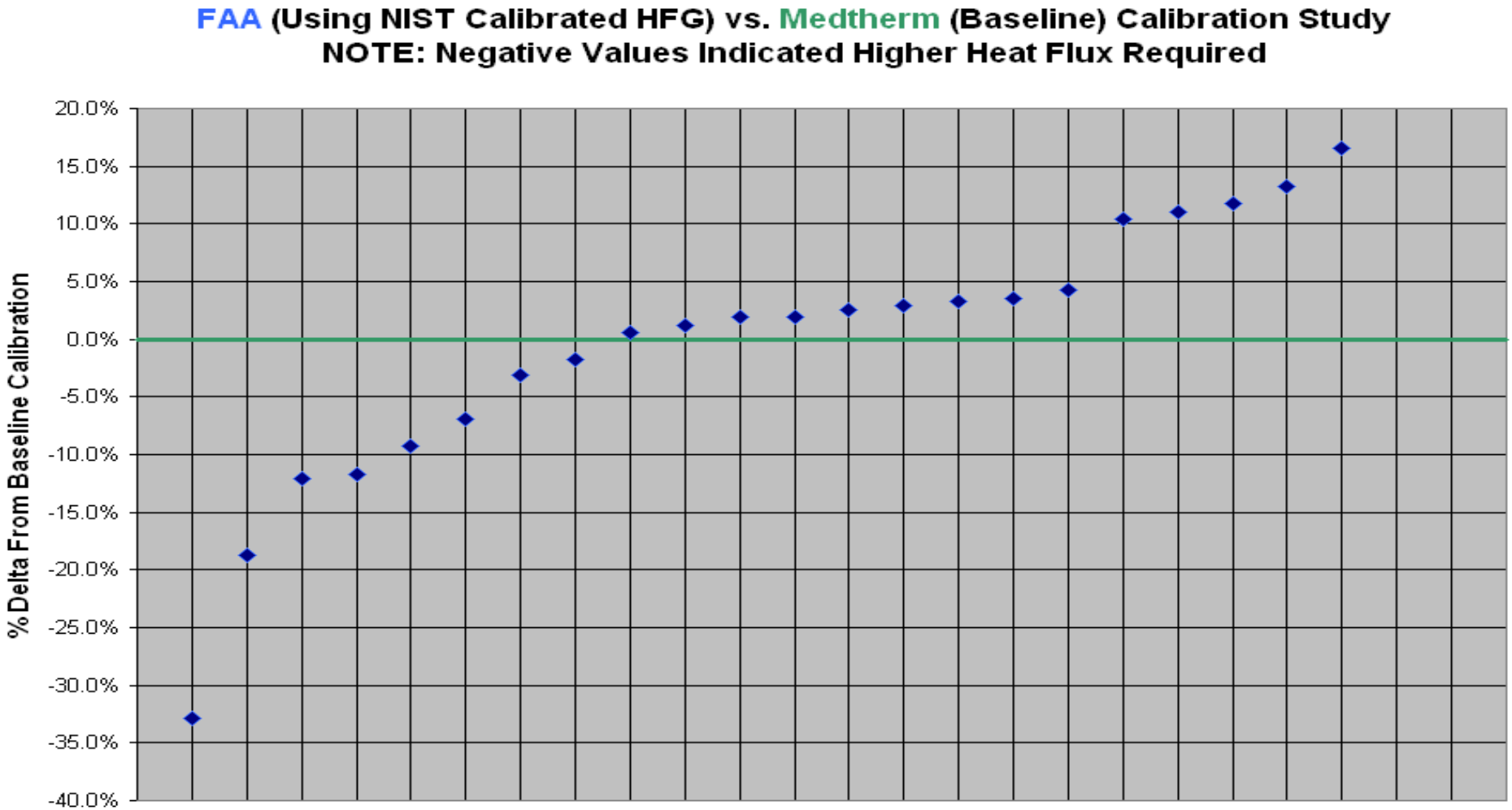
- Each Lab Shipped To The FAA Tech Center Their Working Heat Flux Gages
- The Gages Were Calibrated By Comparison To A NIST Calibrated HFG
- The Transfer Method Was Made Using A Heated Graphite Plate
- 53 Vatell Gages
- 22 Medtherm Gages



FAA Heat Flux Gage Calibration Study



FAA Heat Flux Gage Calibration Study



FAA Heat Flux Gage Calibration Study

Vatell Heat Flux Calibrations

	Manufacturers Slope			FAA Slope as Shipped				
P/N	W/cm2	BTU/ft2-sec	Date	W/cm2	BTU/ft2-sec	% Delta	OHM Reading	coating
TG1000-1A		1.676	3/12/2009		1.3266	-20.8%	0.5	Pryomark 1200
TG1000-1		0.542	3/9/2009		0.4355	-19.6%	1.0	Pryomark 1200
TG1000-1B	0.577		3/11/2009	0.4662		-19.2%	0.9	3M Black Velvet
TG1000-1B	0.543		11/4/2008	0.4412		-18.7%	1.1	3M Black Velvet
TG1000-1B	0.578		11/4/2008	0.4701		-18.7%	1.1	3M Black Velvet
TG1000-1B	0.587		6/17/2008	0.4792		-18.4%	0.7	3M Black Velvet
TG1000-0	0.572		3/24/2008	0.4698		-17.9%	1.0	Zynolyte
TG1000-1	0.687		not provided	0.5666		-17.5%	1.05	Krylon 1602 Ultra Flat Black
TG1000-2	0.896		11/1/2007	0.7422		-17.2%	1.25	3M Black Velvet
1000-1	1.861		not provided	1.5549		-16.4%	0.6	Zynolyte
1000-1B	0.614		12/16/2008	0.5157		-16.0%	0.7	3M Black Velvet
TG1000-1A		0.481	2/26/2009		0.404	-16.0%	0.9	3M Black Velvet
TG1000-1B	0.537		4/23/2008	0.4515		-15.9%	0.7	3M Black Velvet
TG1000-1B	0.563		4/9/2008	0.4748		-15.7%	0.7	3M Black Velvet
TG1000-1	0.6		6/17/2008	0.5072		-15.5%	0.7	Krylon
TG1000-0	0.544		1/17/2009	0.4600		-15.4%	0.9	3M Black Velvet
TG1000-1B		0.493	12/16/2008		0.4189	-15.0%	1.0	3M Black Velvet
TG1000-0S	0.599		7/17/2008	0.5098		-14.9%	0.9	Krylon 1602 Ultra Flat Black
TG2000-8F	0.577		7/17/2008	0.4917		-14.8%	0.8	Krylon 1602 Ultra Flat Black
TG1000-1B	0.588		3/9/2009	0.5011		-14.8%	0.8	3M Black Velvet
1000-1	1.737		12/3/2008	1.4830		-14.6%	0.6	Pryomark 1200
TG1000-1B	0.564		11/1/2007	0.4829		-14.4%	0.7	3M Black Velvet

FAA Heat Flux Gage Calibration Study

Vatell Heat Flux Calibrations

	Manufacturers Slope			FAA Slope as Shipped				
P/N	W/cm2	BTU/ft2-sec	Date	W/cm2	BTU/ft2-sec	% Delta	OHM Reading	coating
TG1000-0	0.547		not provided	0.4706		-14.0%	0.7	Zynolyte
TG1000-0	0.627		10/9/2008	0.5404		-13.8%	0.95	3M Black Velvet
TG1000-1B	0.613		7/14/2008	0.5289		-13.7%	0.8	3M Black Velvet
TG1000-0B	0.627		7/17/2008	0.5421		-13.5%	0.9	Krylon 1602 Ultra Flat Black
TG1000-1	0.602		12/18/2008	0.5207		-13.5%	0.8	Pryomark 1200
TG1000-1	0.520		6/6/2007	0.4507		-13.3%	1.00	Zynolyte
TG1000-1B	0.574		11/4/2008	0.4993		-13.0%	0.7	3M Black Velvet
1000-1A		1.745	7/12/2004		1.5194	-12.9%	0.4	Zynolyte
TG1000-1A		1.570	3/24/2009		1.3699	-12.7%	0.4	Pryomark 1200
TG1000-1B	0.621		8/26/2008	0.545		-12.2%	0.5	3M Black Velvet
TG1000-1B		0.479	6/11/2007		0.4208	-12.2%	0.7	3M Black Velvet
TG1000-0	0.541		12/3/2008	0.4804		-11.2%	1.0	3M Black Velvet
TG1000-1	2.010		not provided	1.7916		-10.9%	1.45	Krylon 1602 Ultra Flat Black
TG1000-1B	0.550		2/6/2008	0.4912		-10.7%	0.8	3M Black Velvet
TG1000-1B	0.529		4/16/2009	0.4787		-9.5%	0.8	not provided
TG1000-1B	0.508		4/16/2009	0.4634		-8.8%	0.7	not provided
TG1000-0	0.581		not provided	0.5305		-8.7%	0.7	Zynolyte
TG1000-1B	0.553		4/16/2009	0.5078		-8.2%	0.7	not provided
1000-1A	1.695		5/3/2004	1.5575		-8.1%	0.40	Zynolyte
TG1000-1B		0.487	not provided		0.4499	-7.6%	0.7	not provided
not provided	0.527		4/10/2008	0.4879		-7.4%	0.7	not provided
TG1000-0	0.591		6/24/2008	0.5473		-7.4%	0.7	3M Black Velvet

FAA Heat Flux Gage Calibration Study

Vatell Heat Flux Calibrations

	Manufacturers Slope			FAA Slope as Shipped				
P/N	W/cm2	BTU/ft2-sec	Date	W/cm2	BTU/ft2-sec	% Delta	OHM Reading	coating
1000-1	1.546		11/19/2007	1.4326		-7.3%	0.6	Zynolyte
1000-1A	1.978		5/3/2004	1.8537		-6.3%	0.45	Zynolyte
TG1000-1	0.524		12/6/2007	0.4934		-5.8%	0.8	Zynolyte
TG1000-1A	1.876		4/22/2008	1.7837		-4.9%	0.1	Zynolyte
TG1000-1B	0.615		5/4/2009	0.5866		-4.6%	0.75	3M Black Velvet
TG1000-1	1.814		11/15/2005	1.7636		-2.8%	0.4	Zynolyte
TG1000-1A	1.474		11/12/2007	1.4523		-1.5%	0.90	Zynolyte
TG1000-1A	1.987		1/15/2007	1.9814		-0.3%	0.6	Zynolyte
TG1000-1B	0.647		5/28/2008	0.6590		1.9%	1.0	3M Black Velvet

FAA Heat Flux Gage Calibration Study

Medtherm Heat Flux Calibrations

	Manufacturers Slope			FAA Slope as Shipped				
P/N	W/cm2	BTU/ft2-sec	Date	W/cm2	BTU/ft2-sec	% Delta	OHM Reading	coating
not provided	0.200		not provided	0.1343		-32.9%	37.4	Zynolyte
64-10-19	1.200		11/1/2007	0.9749		-18.8%	1.0	3M Black Velvet
64-5SB-18	0.484		5/6/2009	0.4257		-12.0%	17.8	not provided
64-10-18	1.202		8/26/2008	1.061		-11.7%	0.5	3M Black Velvet
64-10-18	1.249		8/26/2008	1.1337		-9.2%	0.4	3M Black Velvet
not provided	2.130		not provided	1.9832		-6.9%	0.5	Zynolyte
64-5-20	0.6234		12/14/2007	0.6039		-3.1%	0.5	not provided
64-5-18	0.6165		5/6/2009	0.6054		-1.8%	0.5	not provided
64-20-20		1.612	4/28/2009		1.6215	0.6%	1.15	not provided
64-5-20	0.6305		1/12/2009	0.6379		1.2%	0.7	not provided
64-10-18	1.147		11/14/2006	1.1694		2.0%	0.6	not provided
64-10-18	1.068		11/14/2006	1.089		2.0%	0.75	not provided
64-20-18		1.799	4/3/2009		1.8438	2.5%	1.5	not provided
64-10-18	1.125		1/9/2007	1.1582		3.0%	0.5	not provided
64-20-20-31-240-21822		1.685	4/3/2009		1.7398	3.3%	1.0	not provided
64-20-20		1.838	4/3/2009		1.9025	3.5%	1.4	not provided
64-10-18	1.087		1/9/2007	1.1327		4.2%	0.5	not provided
64-15-20		1.336	4/8/1991		1.4745	10.4%	5.1	not provided
64-15-36-18-20491A	1.479		5/10/2009	1.6428		11.1%	0.5	not provided
64-20-18	2.002		5/6/2009	2.2373		11.8%	0.5	not provided
64-20-20		1.770	2/23/2009		2.0034	13.2%	1.4	not provided
64-20-20-31-240-21822		1.642	2/23/2009		1.9139	16.6%	1.0	not provided

Heat Flux Sensitivity Study – OSU/NBS

- Four Different Materials Tested And Identified As Sample A,B,C & D
- The FAA HFG Calibration Slope Was Initially Used For Testing
- The HFG Slope Was Then Increased (Reducing Heat Flux) by 15% And Tests Repeated
- Both OSU and NBS Data Is Presented In The Following Slides

Heat Flux Sensitivity Study - OSU

Sample A

Thickness (inches)	**0.057**	
Width (inches)	**5.93**	
Length (inches)	**5.93**	
weight (grams)	**47.7**	
Heat Flux (W/cm2)	**3.0**	**3.5**
HFG Slope (W/cm2/mv)	**1.063**	**0.9246**
HFG Setpoint (mv)	**3.29**	**3.79**
Peak (kW/m2)	**38.95**	**40.99**
Time to Peak (Seconds)	**169.67**	**77**
Total HRR (kW/m2)*min	**23.51**	**30.06**
Weight Loss (grams)	**36.00**	**36.8**

Heat Flux Sensitivity Study - OSU

Sample B

Thickness (inches)	**0.089**	
Width (inches)	**5.93**	
Length (inches)	**5.93**	
weight (grams)	**77.5**	
Heat Flux (W/cm2)	**3.0**	**3.5**
HFG Slope (W/cm2/mv)	**1.063**	**0.9246**
HFG Setpoint (mv)	**3.29**	**3.79**
Peak (kW/m2)	**18.19**	**33.79**
Time to Peak (Seconds)	**227**	**222**
Total HRR (kW/m2)*min	**-33.12**	**-17.42**
Weight Loss (grams)	**41.5**	**43.7**

Heat Flux Sensitivity Study - OSU

Sample C

Thickness (inches)	**0.089**	
Width (inches)	**5.93**	
Length (inches)	**5.95**	
weight (grams)	**88.8**	
Heat Flux (W/cm2)	**3.0**	**3.5**
HFG Slope (W/cm2/mv)	**1.063**	**0.9246**
HFG Setpoint (mv)	**3.29**	**3.79**
Peak (kW/m2)	**83.62**	**83.08**
Time to Peak (Seconds)	**230**	**213**
Total HRR (kW/m2)*min	**10.87**	**46.46**
Weight Loss (grams)	**68.8**	**71.3**

Heat Flux Sensitivity Study - OSU

Sample D

Thickness (inches)	**0.073**	
Width (inches)	**5.93**	
Length (inches)	**5.95**	
weight (grams)	**55.8**	
Heat Flux (W/cm2)	**3.0**	**3.5**
HFG Slope (W/cm2/mv)	**1.063**	**0.9246**
HFG Setpoint (mv)	**3.29**	**3.79**
Peak (kW/m2)	**45.55**	**56.00**
Time to Peak (Seconds)	**138**	**120**
Total HRR (kW/m2)*min	**37.59**	**49.96**
Weight Loss (grams)	**37.0**	**33.5**

Heat Flux Sensitivity Study - NBS
Sample A

Thickness (inches)	**0.0570**	
Width (inches)	**2.93**	
Length (inches)	**2.94**	
Weight (grams)	**12.00**	
Heat Flux (W/cm2)	**2.1**	**2.5**
HFG Slope (W/cm2/mv)	**0.566**	**0.493**
HFG Setpoint (mv)	**4.31**	**5.08**
Max Ds	**75.04**	**106.28**
Weight Loss (grams)	**4.33**	**6.0**

Heat Flux Sensitivity Study - NBS
Sample B

Thickness (inches)	**0.0912**	
Width (inches)	**2.93**	
Length (inches)	**2.93**	
Weight (grams)	**19.50**	
Heat Flux (W/cm2)	**2.1**	**2.5**
HFG Slope (W/cm2/mv)	**0.566**	**0.4926**
HFG Setpoint (mv)	**4.31**	**5.08**
Max Ds	**65.42**	**104.55**
Weight Loss (grams)	**5.2**	**6.0**

Heat Flux Sensitivity Study - NBS
Sample C

Thickness (inches)	**0.0870**	
Width (inches)	**2.94**	
Length (inches)	**2.94**	
Weight (grams)	**22.00**	
Heat Flux (W/cm2)	**2.1**	**2.5**
HFG Slope (W/cm2/mv)	**0.566**	**0.4926**
HFG Setpoint (mv)	**4.31**	**5.08**
Max Ds	**98.35**	**149.36**
Weight Loss (grams)	**5.2**	**7.2**

Heat Flux Sensitivity Study - NBS
Sample D

Thickness (inches)	**0.0757**	
Width (inches)	**2.94**	
Length (inches)	**2.95**	
Weight (grams)	**14.17**	
Heat Flux (W/cm2)	**2.1**	**2.5**
HFG Slope (W/cm2/mv)	**0.566**	**0.4926**
HFG Setpoint (mv)	**4.31**	**5.08**
Max Ds	**14.57**	**34.29**
Weight Loss (grams)	**N/A**	**0.7**

Heat Flux Sensitivity Study - SUMMARY

Observed Percent Change In Values With 15% Increase In Heat Flux.

OSU	A	B	C	D
Peak (kW/m^2)	5%	86%	-1%	23%
Time to Peak (Seconds)	-55%	-2%	-7%	-13%
Total HRR(kW/m2)*min	28%	90%	327%	33%
Weight Loss (grams)	2%	5%	4%	-9%
NBS				
Max Ds	42%	60%	52%	135%
Weight Loss (grams)	38%	16%	39%	N/A

Maintenance Tips & Reminders

- **OSU**
  - Ensure Calibration T Burner is in same position as lower pilot burner when it is installed for calibration (in place while setting heat flux too!)
  - It may be helpful to have the following ANSI drill sizes (as a kit) to quickly verify proper hole diameters:
    - Air distribution Lower Plate Holes (8) – #4
    - Air distribution Second Stage Holes (120) – #28
    - Air Distribution Cooling Manifold Holes (48) – #26
    - Upper Pilot holes (15) – # 59
    - Calibration T Burner (6) - #32
- **NBS**
  - Inspect air supply / propane filters if installed
  - Ensure rear wall temperature thermocouple is mounted to wall and not suspended in free air.

Next Steps

- Complete The NBS Photometric System Round For Presentation At Next Materials Meeting
- Continue To Work HFG Calibration Discrepancy Issue
- FAA Contact Information:

  Michael Burns At mike.burns@faa.gov

  +1 (609) 485-4985