OSU Calorimetry Test

Final Results from 2016 Industry OSU Round Robin

[Data Current as of 12 MAY 16]

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Topics of Discussion:

- Motivation behind continued OSU study

- Summary of 2016 Industry Round Robin Data

- Discussion on the following parameters:
    - Airflow
    - Differential Pressures
    - Lab Conditions
    - Calibration Data
    - Heat Release Results
    - Correlations
    - FAA Technical Paper

- Next steps

Motivation Behind Study:

- **The Ohio State University Calorimetry (OSU) test used throughout the aircraft industry to determine the heat release of panels flown in the aircraft cabin interior**

  - Significant variation in round robin data acquired among industry labs has been noted

Goal: Establish an accurate baseline for the OSU tests industry-wide, by understanding and then controlling the possible variation due to airflow and other variables.

- **THANK YOU to all (31) the industry-wide participants in the 2016 OSU RR and to Mike Burns [FAA] for compiling the data !**

Results from a Total of 31 Laboratories in the 2016 Round Robin:

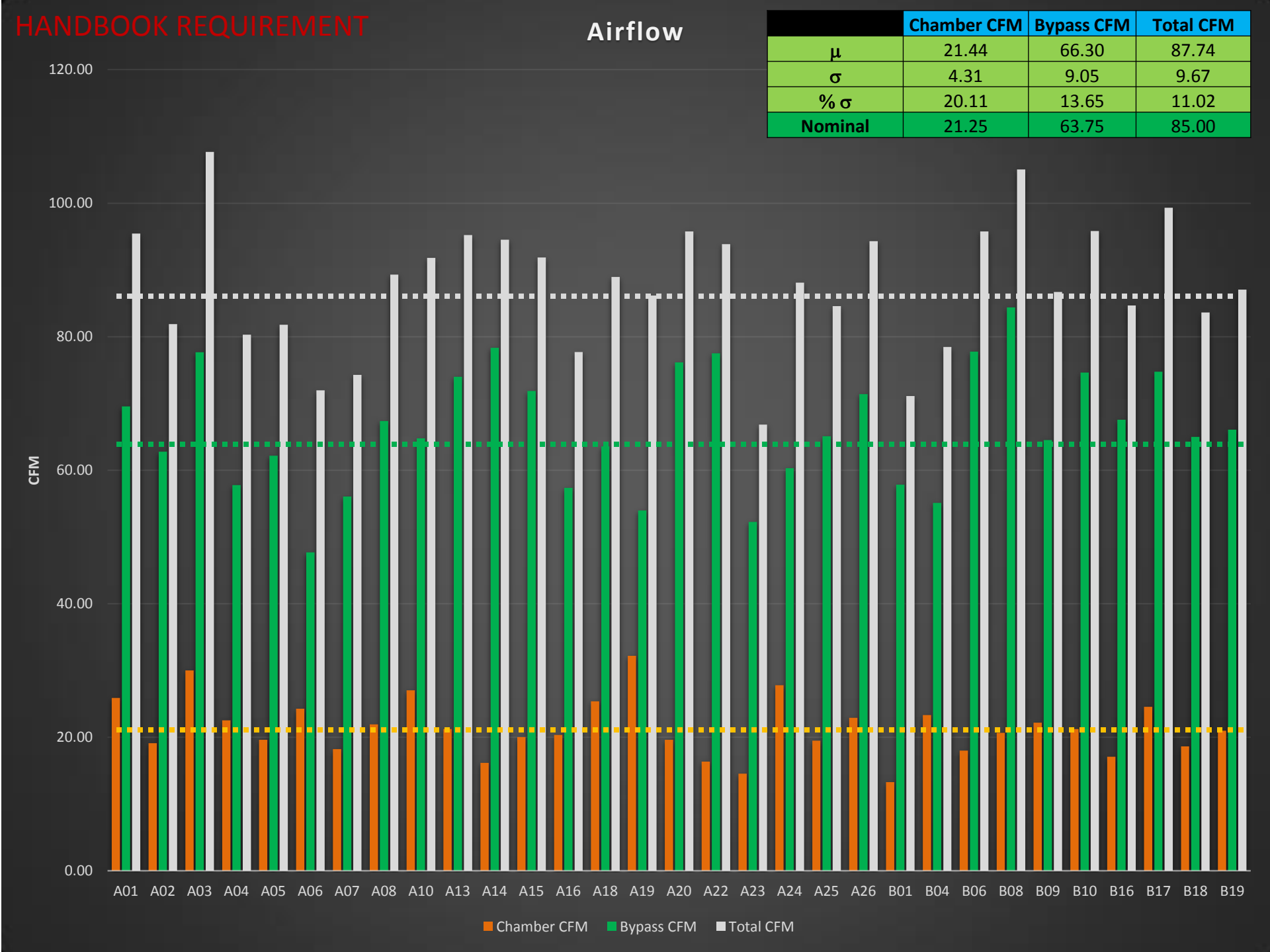
- **News:**
  - As an industry, some critical OSU parameters are reporting the values below:
    - Total Airflow:
      - Average (μ): 87.74 CFM (Expecting 85 CFM) [March 2016 Data: 86.41 CFM]
      - Standard Deviation (σ): 9.67 [March 2016 Data: 10.10]
      - Coefficient of Variation (% σ): 11.02 % [March 2016 Data: 11.69 %]
    - Split Ratio:
      - Average (μ): 3.22 (Expecting 3.0) [March 2016 Data: 3.27]
      - Standard Deviation (σ): 0.78 [March 2016 Data: 1.14]
      - Coefficient of Variation (% σ): 24.17 % [March 2016 Data: 34.74 %]
    - Differential Pressure:
      - Average (μ): 106.81 in H2O (Expecting 107 in H2O) [March 2016 Data: 106.68]
      - Standard Deviation (σ): 2.90 [March 2016 Data: 3.23]
      - Coefficient of Variation (% σ): 2.72% [March 2016 Data: 3.03 %]
- **More News:**
  - As an industry, the variability of several key parameters is high
  - More efforts in standardizing operating procedures & routine checks might be needed.
  - Correlation between airflow, calibration constant, and HRR was not observed in this Round Robin data when reviewing industry data as a whole. Discussion to follow.

Topic: Airflow

HANDBOOK REQUIREMENT

Airflow

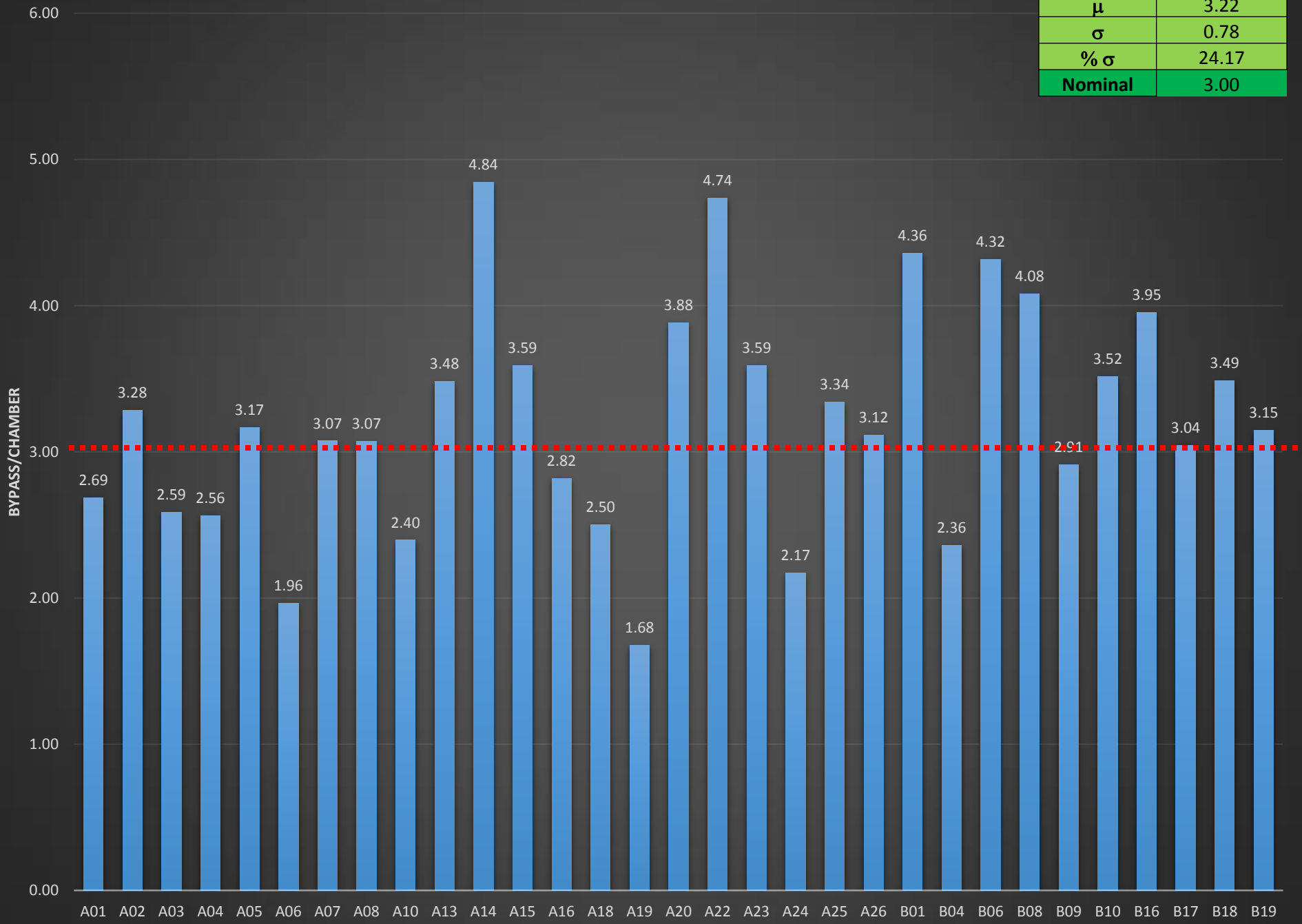
	Chamber CFM	Bypass CFM	Total CFM
μ	21.44	66.30	87.74
σ	4.31	9.05	9.67
% σ	20.11	13.65	11.02
Nominal	21.25	63.75	85.00



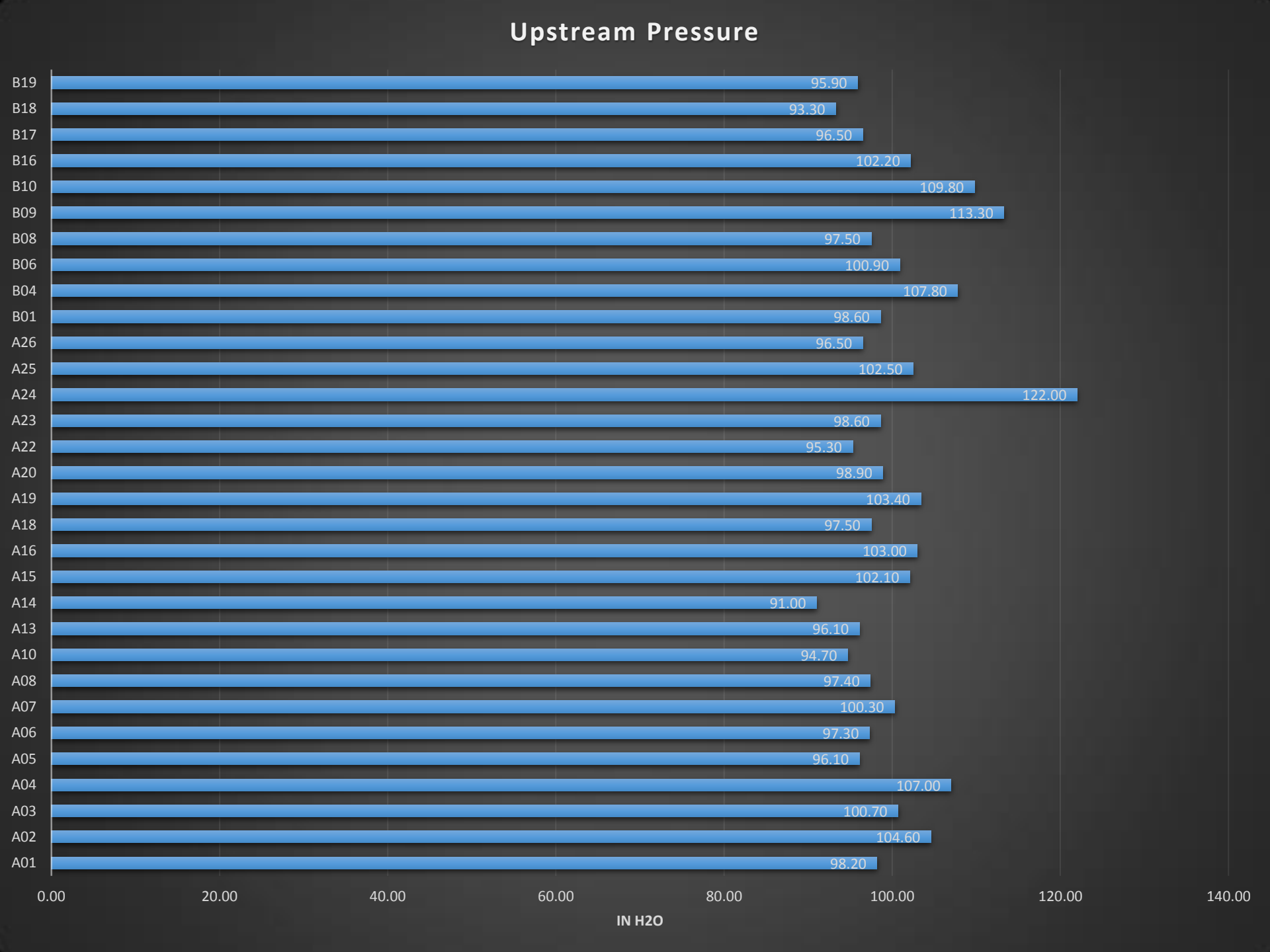
HANDBOOK REQUIREMENT

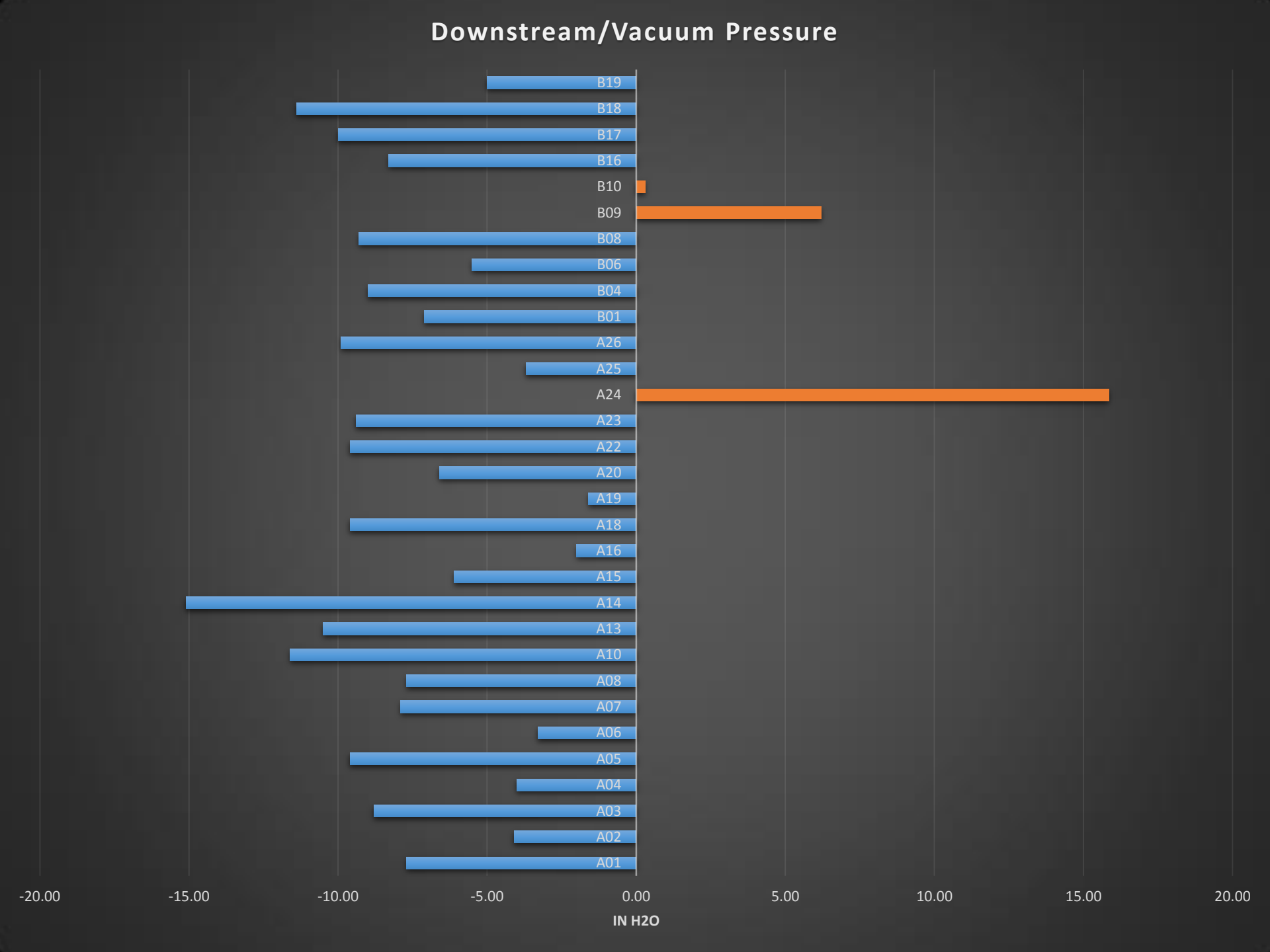
Split Ratio

	Split Ratio
μ	3.22
σ	0.78
% σ	24.17
Nominal	3.00

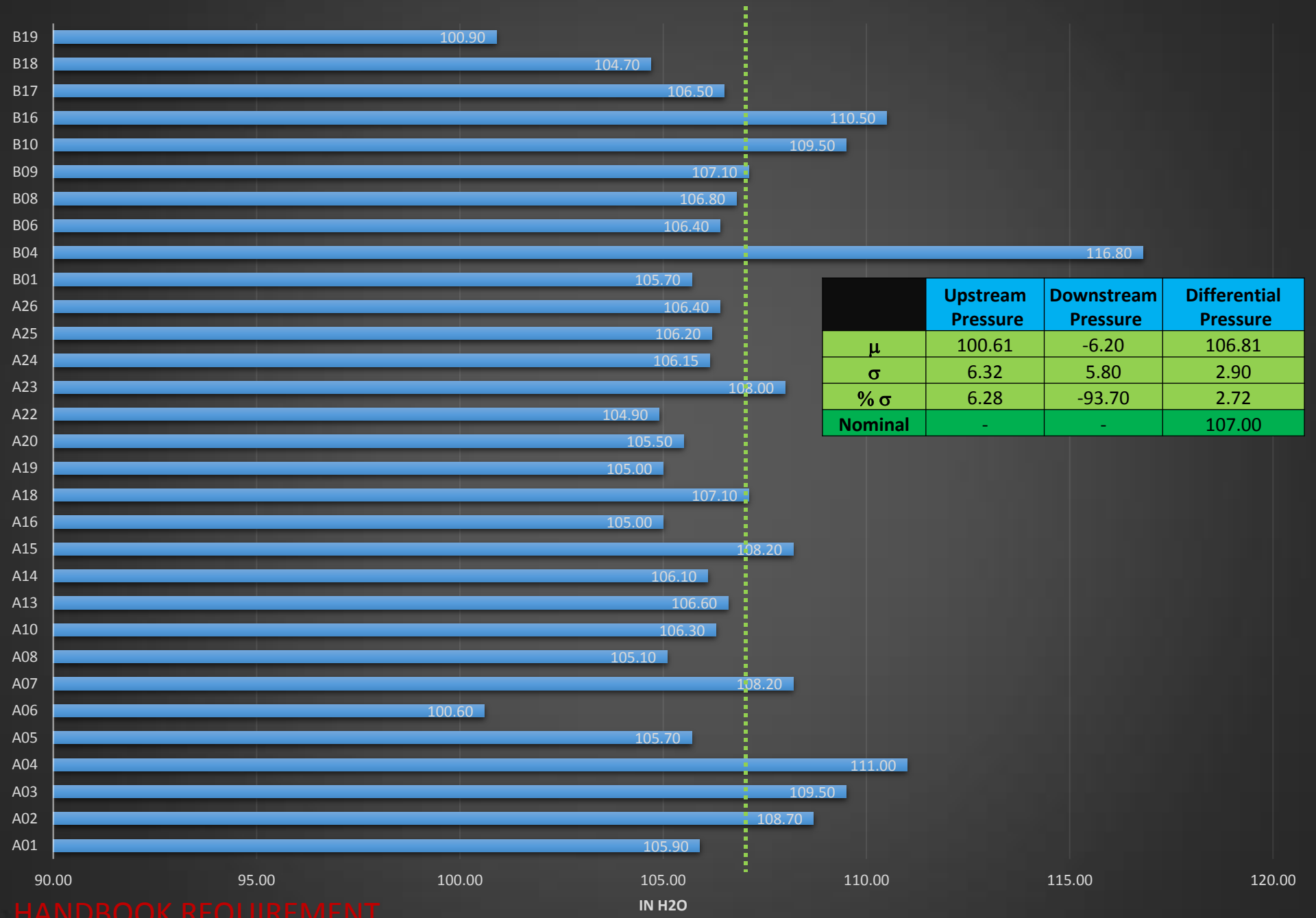


Topic: Differential Pressures


Upstream Pressure
B19
B18
B17
B16
B10
B09
B08
B06
B04
B01
A26
A25
A24
A23
A22
A20
A19
A18
A16
A15
A14
A13
A10
A08
A07
A06
A05
A04
A03
A02
A01
95.90
93.30
96.50
102.20
109.80
113.30
97.50
100.90
107.80
98.60
96.50
102.50
122.00
98.60
95.30
98.90
103.40
97.50
103.00
102.10
91.00
96.10
94.70
97.40
100.30
97.30
96.10
107.00
100.70
104.60
98.20
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
IN H2O


Downstream/Vacuum Pressure
B19
B18
B17
B16
B10
B09
B08
B06
B04
B01
A26
A25
A24
A23
A22
A20
A19
A18
A16
A15
A14
A13
A10
A08
A07
A06
A05
A04
A03
A02
A01
-20.00
-15.00
-10.00
-5.00
0.00
5.00
10.00
15.00
20.00
IN H2O

Orifice Meter Differential Pressure (107 IN H2O = 200 mmHg)



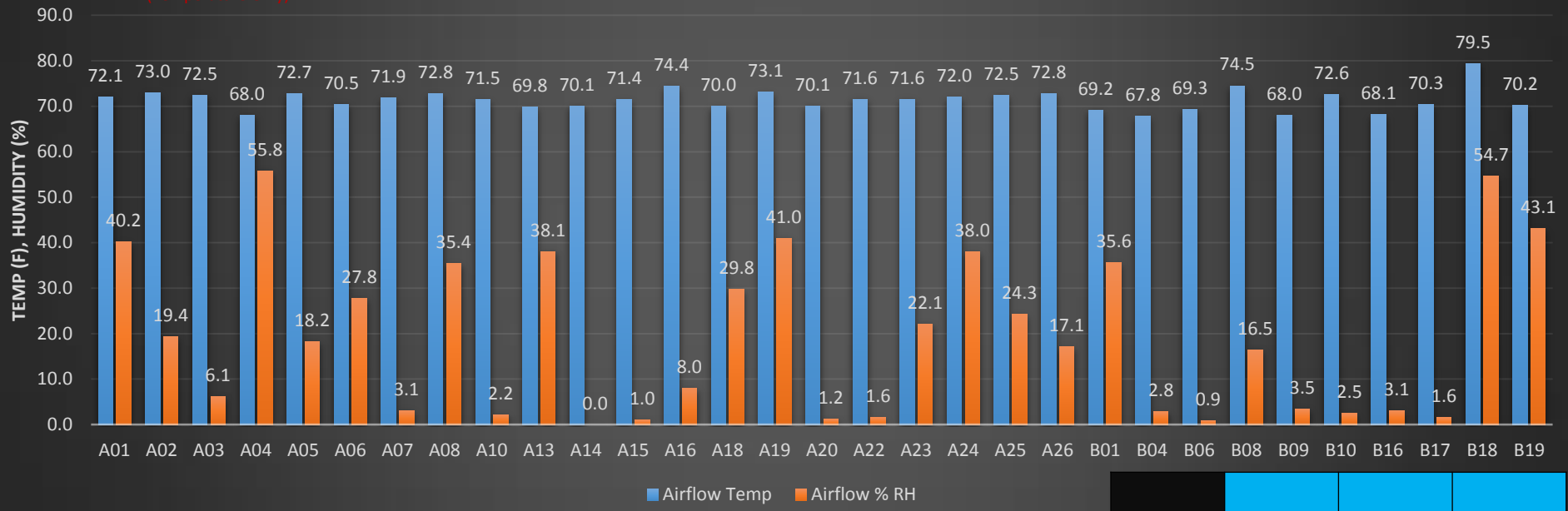
	Upstream Pressure	Downstream Pressure	Differential Pressure
μ	100.61	-6.20	106.81
σ	6.32	5.80	2.90
% σ	6.28	-93.70	2.72
Nominal	-	-	107.00

HANDBOOK REQUIREMENT

Topic: Laboratory Conditions

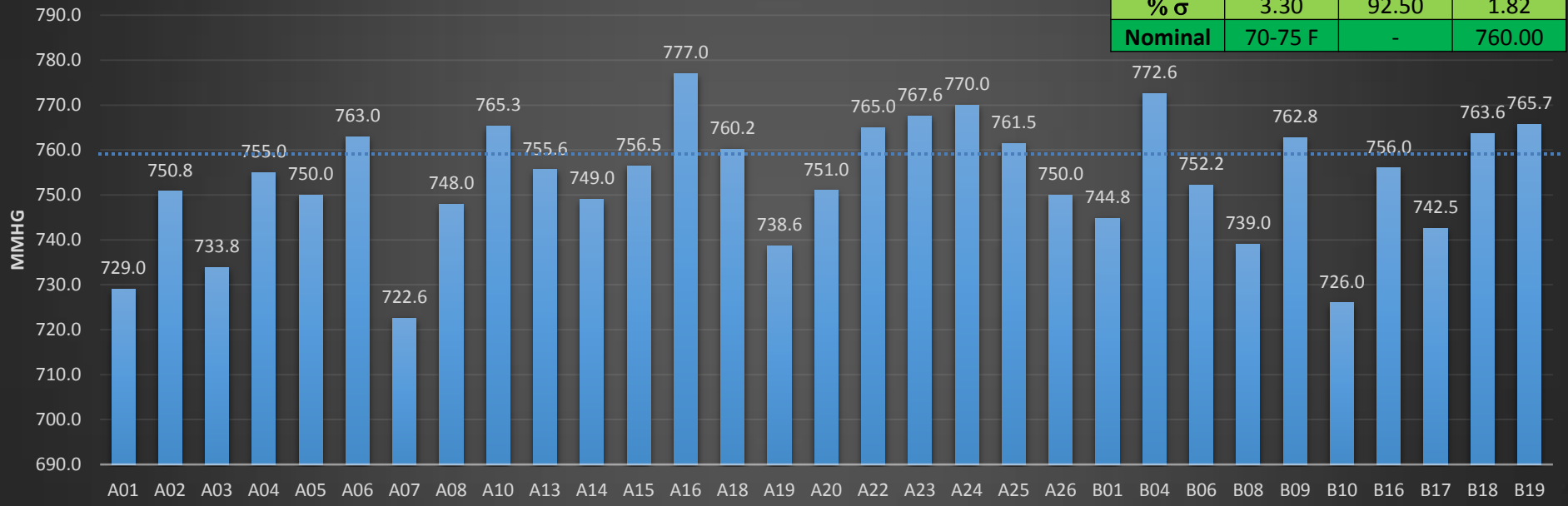
HANDBOOK REQUIREMENT
(Temperature Only)

Airflow Temperature & Humidity



	AF Temp	AF %RH	Lab Press
μ	71.41	19.18	753.05
σ	2.36	17.74	13.70
% σ	3.30	92.50	1.82
Nominal	70-75 F	-	760.00

Lab Atmospheric Pressure

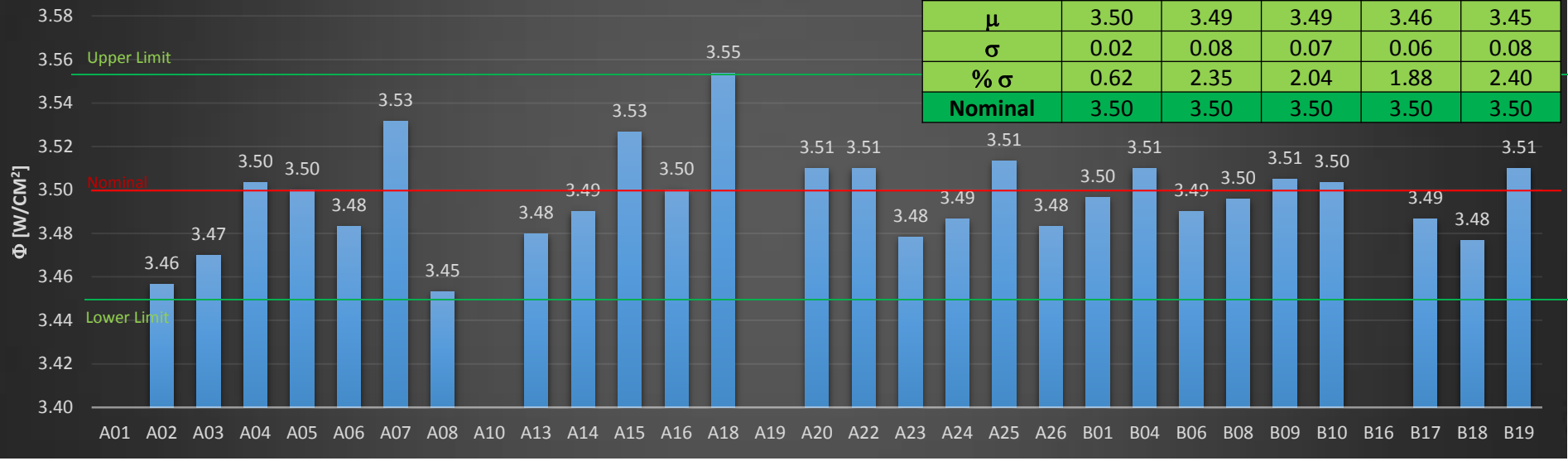


Topic: Calibration Data

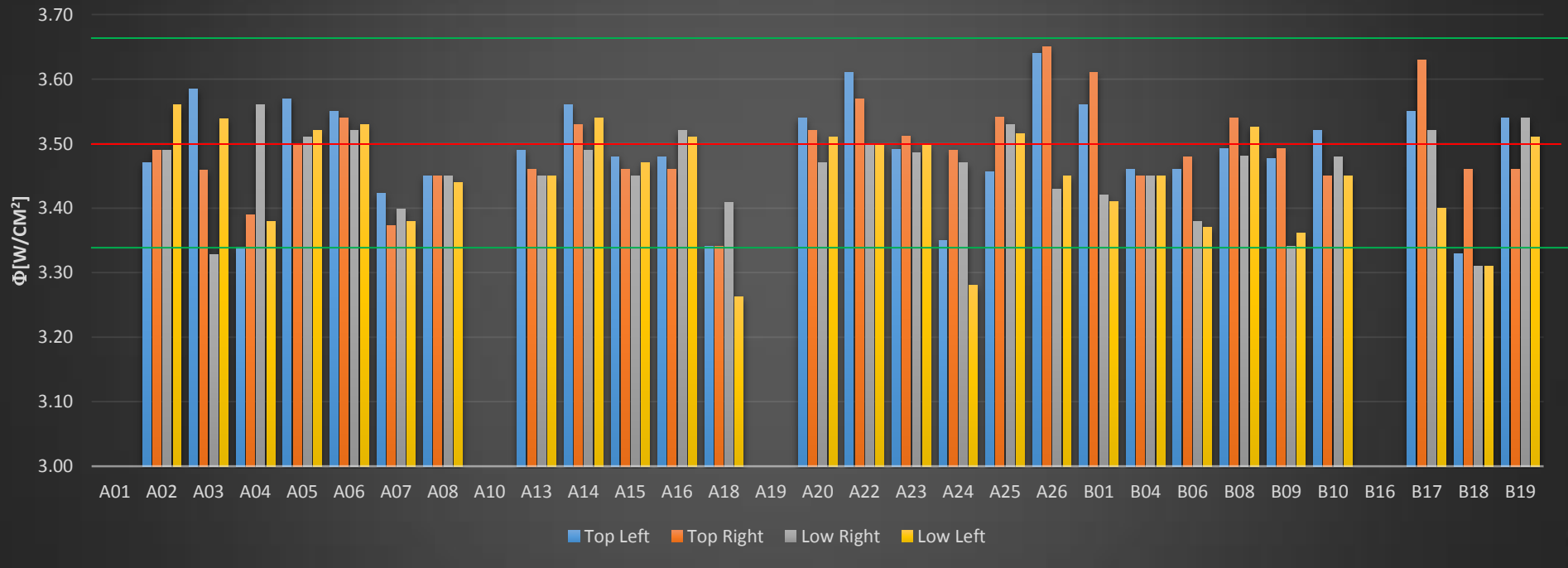
HANDBOOK REQUIREMENT

Center Heat Flux

	Center HF	Top Left	Top Right	Low Right	Low Left
μ	3.50	3.49	3.49	3.46	3.45
σ	0.02	0.08	0.07	0.06	0.08
% σ	0.62	2.35	2.04	1.88	2.40
Nominal	3.50	3.50	3.50	3.50	3.50

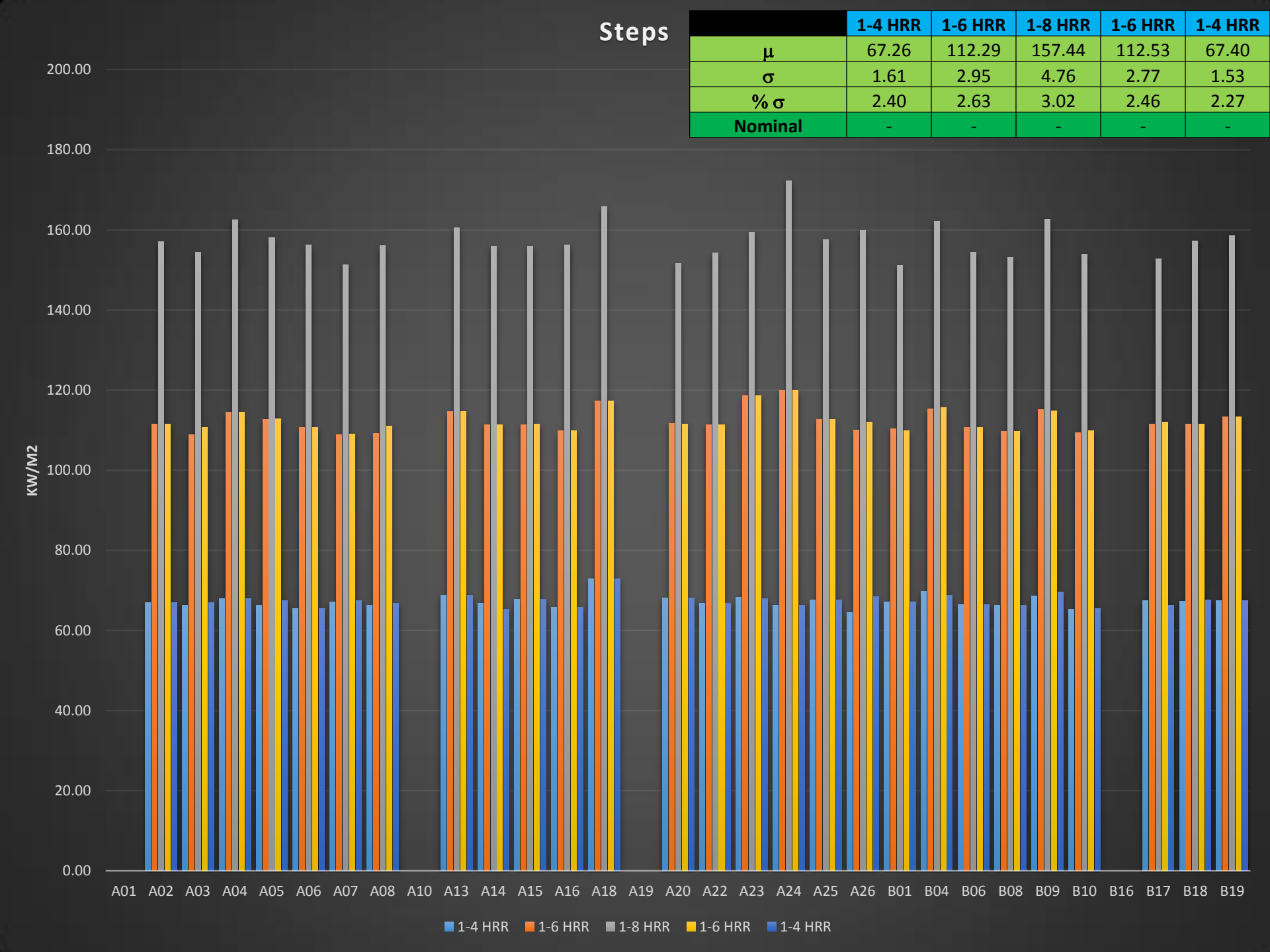


Corner Heat Flux

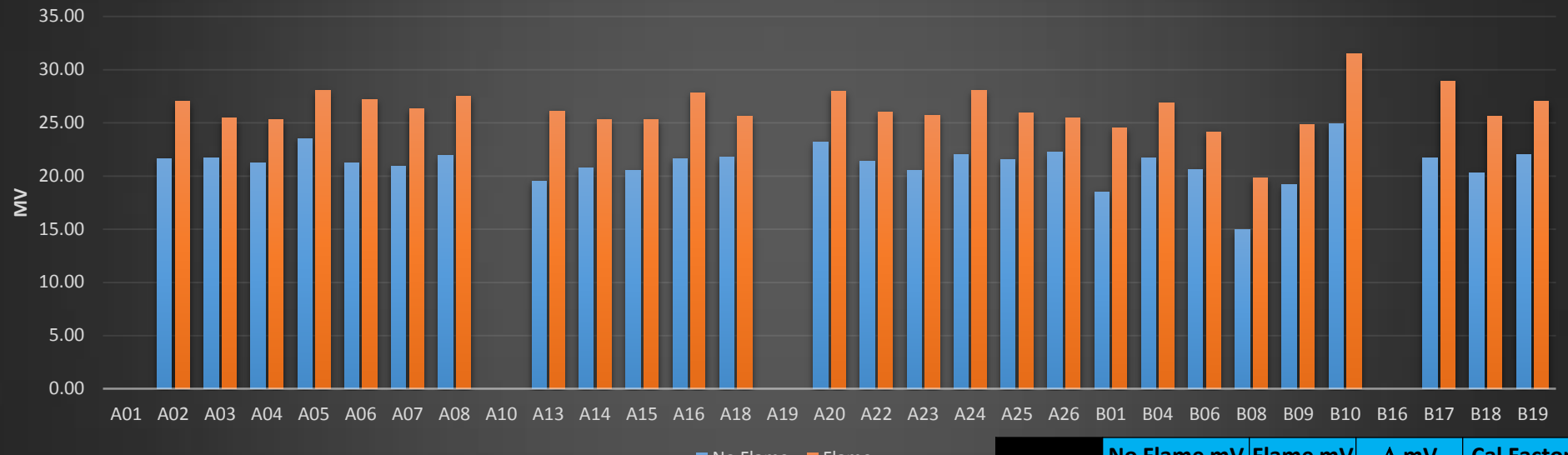


Steps

	1-4 HRR	1-6 HRR	1-8 HRR	1-6 HRR	1-4 HRR
μ	67.26	112.29	157.44	112.53	67.40
σ	1.61	2.95	4.76	2.77	1.53
% σ	2.40	2.63	3.02	2.46	2.27
Nominal	-	-	-	-	-



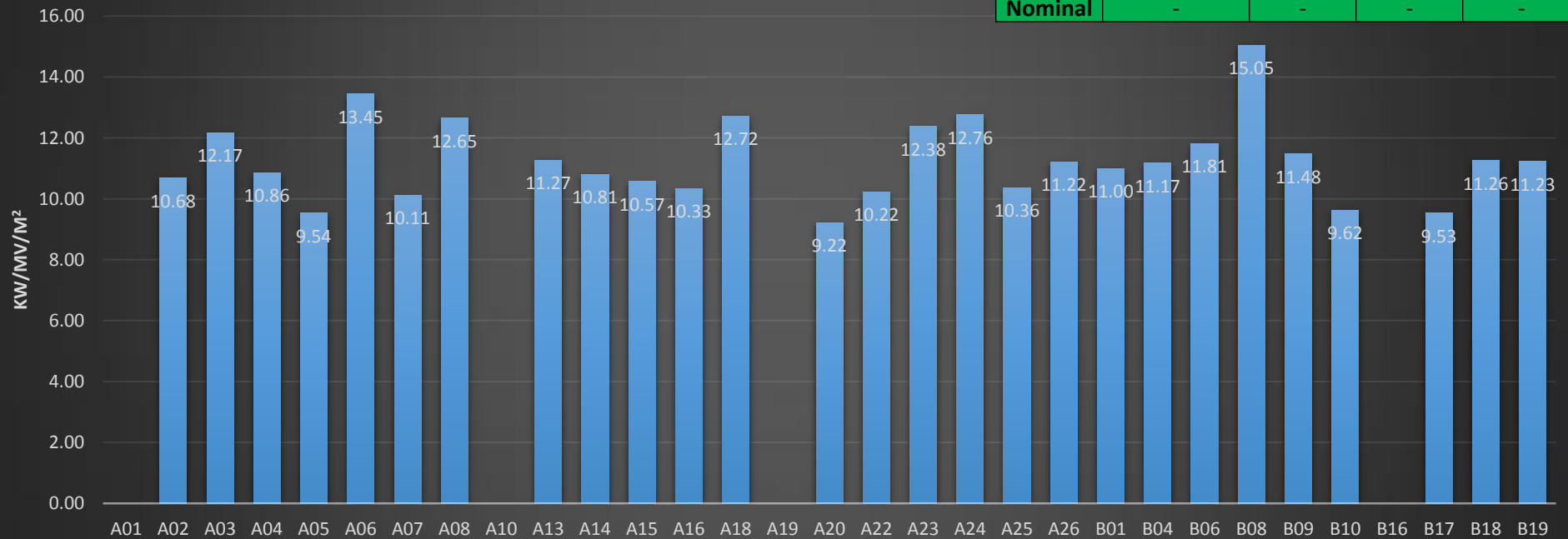
Baseline mV



Note: Some labs did not report

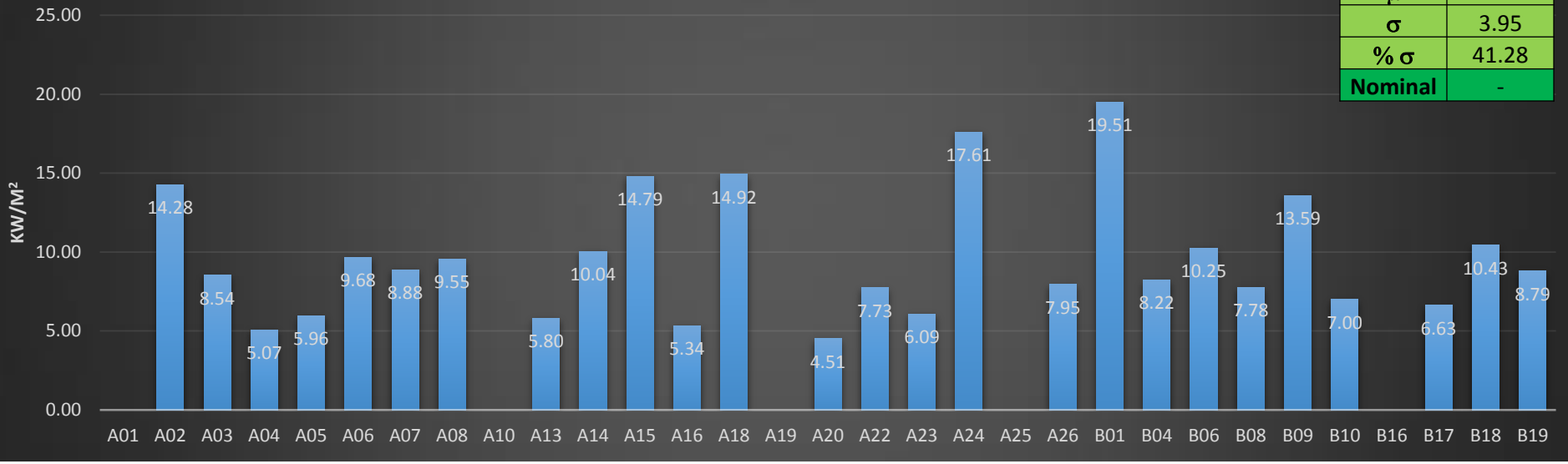
	No Flame mV	Flame mV	Δ mV	Cal Factor
μ	21.13	26.25	5.12	11.24
σ	1.79	2.03	0.99	1.33
% σ	8.46	7.72	19.38	11.84
Nominal	-	-	-	-

Calibration Factor



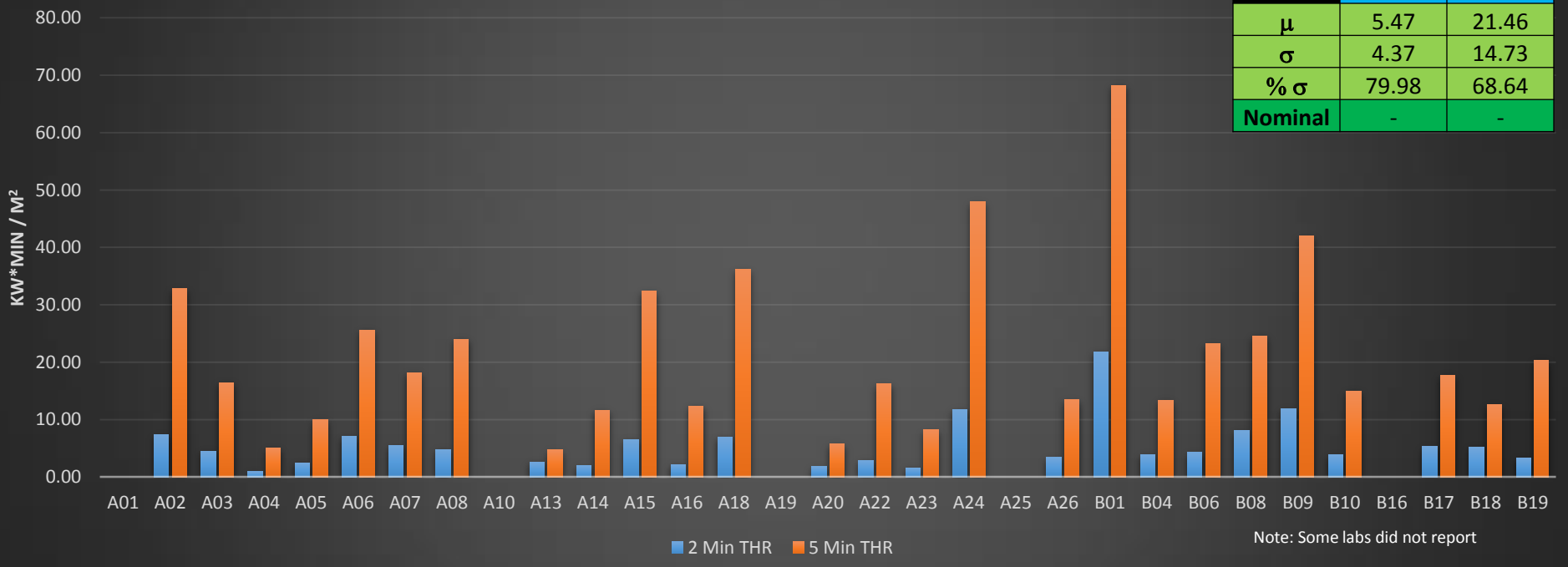
Topic: Heat Release Results

Peak Heat [Blank Test Run]



	PHR
μ	9.57
σ	3.95
% σ	41.28
Nominal	-

Total Heat Release [Blank Test Run]

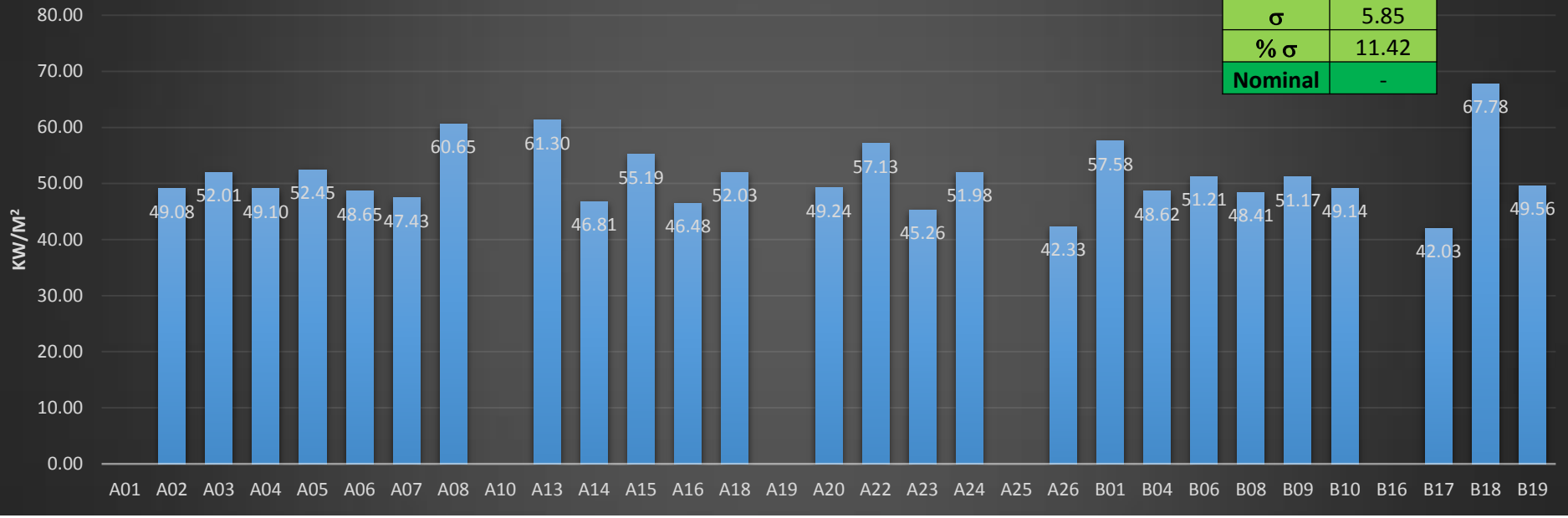


	2 Min THR	5 Min THR
μ	5.47	21.46
σ	4.37	14.73
% σ	79.98	68.64
Nominal	-	-

Note: Some labs did not report

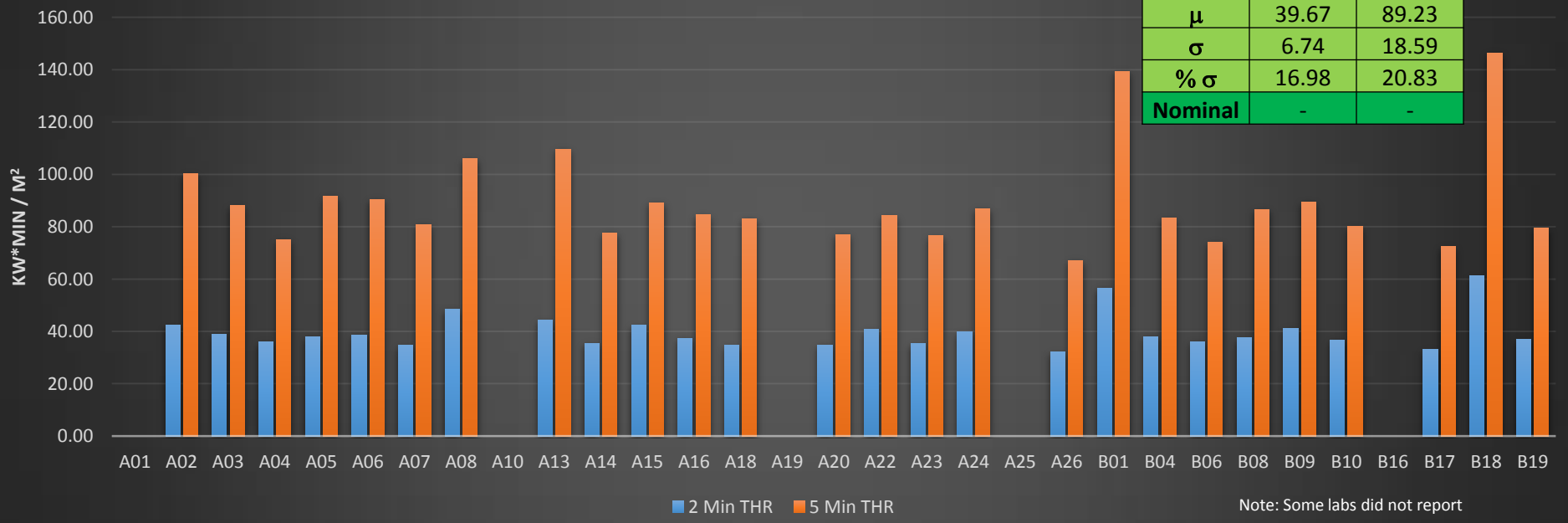
Peak Heat [Schneller Panel]

	PHR
μ	51.25
σ	5.85
% σ	11.42
Nominal	-



Total Heat Release [Schneller Panel]

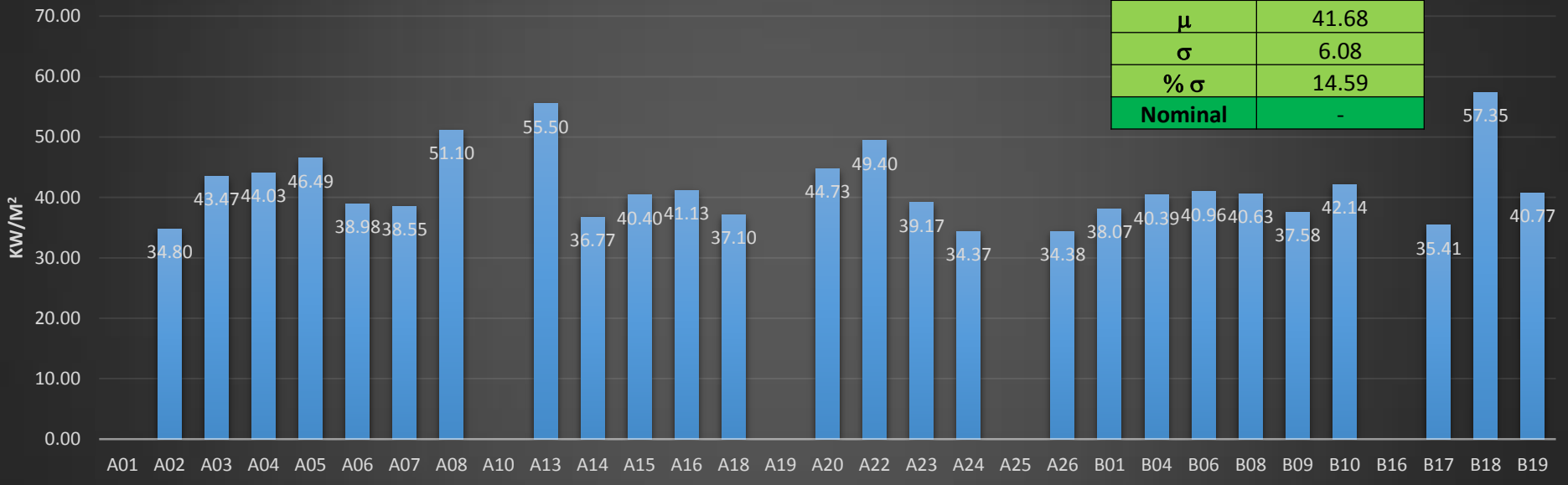
	2 Min THR	5 Min THR
μ	39.67	89.23
σ	6.74	18.59
% σ	16.98	20.83
Nominal	-	-



Note: Some labs did not report

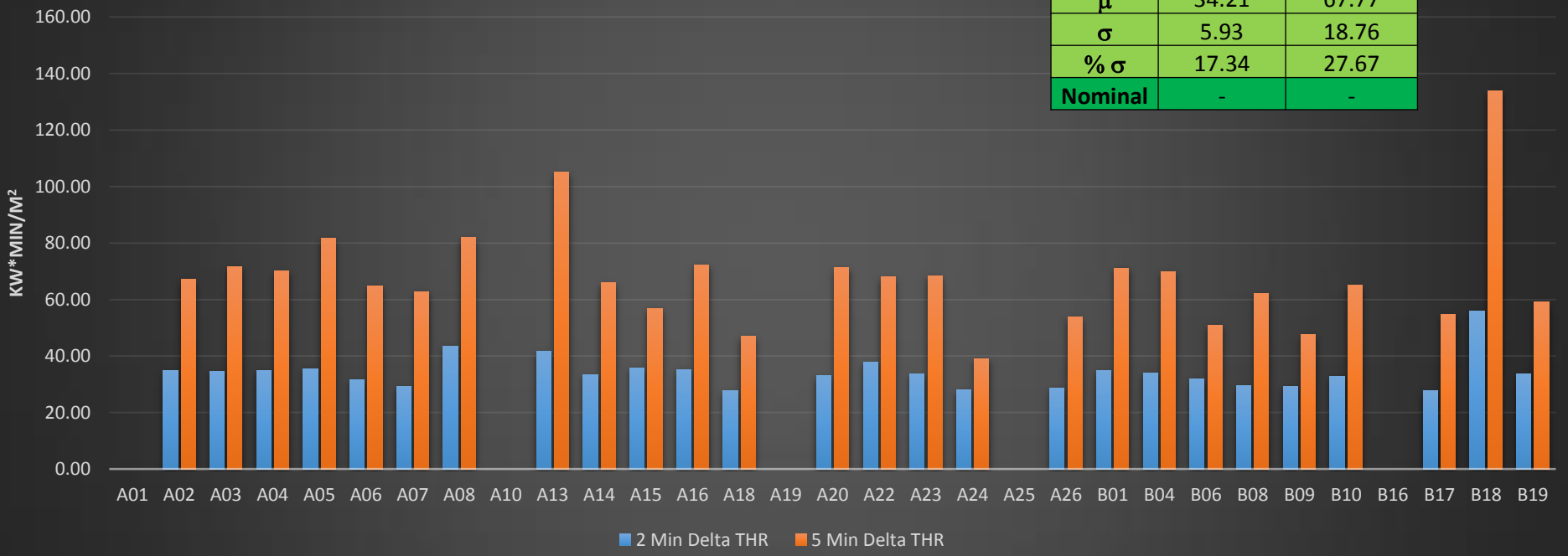
Peak Heat [Schneller - Blank]

	Δ PHR
μ	41.68
σ	6.08
% σ	14.59
Nominal	-



Total HR [Schneller - Blank]

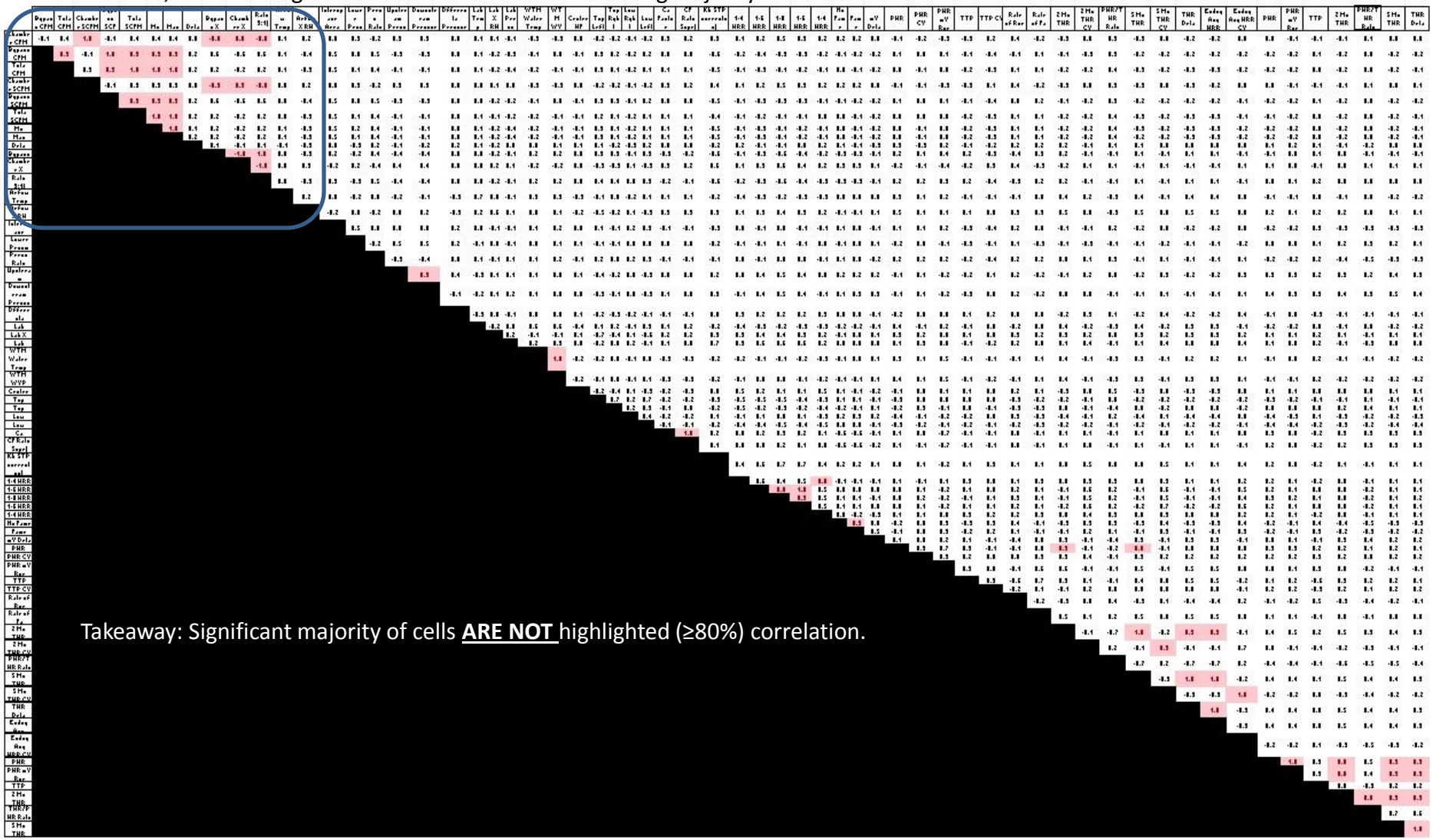
	Δ2 Min THR	Δ5 Min THR
μ	34.21	67.77
σ	5.93	18.76
% σ	17.34	27.67
Nominal	-	-



Topic: Correlations

COMPLETE CORRELATION TABLE

CORRELATION TABLE: An attempt at correlating the various parameters was made using the 'CORREL' function in Excel. Anything greater than 80% correlation is highlighted below. This data is inclusive of all laboratories reporting up to 12 MAY 16. Similar to results presented in March 2016, where no significant correlation is evident among majority of OSU variables.



Takeaway: Significant majority of cells **ARE NOT** highlighted (≥80%) correlation.

CORRELATION TABLE CUTOUT

	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH
Chamber CFM	-0.1	0.4	1.0	-0.1	0.4	0.4	0.4	0.0	-0.8	0.8	-0.8	0.1	0.2
Bypass		0.9	-0.1	1.0	0.9	0.9	0.9	0.2	0.6	-0.6	0.6	0.1	-0.4
Total CFM			0.3	0.9	1.0	1.0	1.0	0.2	0.2	-0.2	0.2	0.1	-0.3
Chamber SCFM				-0.1	0.3	0.3	0.3	0.0	-0.9	0.9	-0.8	0.0	0.2
Bypass SCFM					0.9	0.9	0.9	0.2	0.6	-0.6	0.6	0.0	-0.4
Total SCFM						1.0	1.0	0.2	0.2	-0.2	0.2	0.0	-0.3
Min							1.0	0.1	0.2	-0.2	0.2	0.1	-0.3
Max								0.2	0.2	-0.2	0.2	0.1	-0.3
Delta									0.1	-0.1	0.1	-0.1	-0.3
Bypass %										-1.0	1.0	0.0	-0.3
Chamber %											-1.0	0.0	0.3
Ratio (3:1)												0.0	-0.3
Airflow Temp													0.2
Airflow % RH													
Interspace Area													
Lower Plenum													
Press Ratio													
Upstream Pressure													
Downstream Pressure													

ISOLATING BY MANUFACTURER: In March 2016 presentation, it was found that by isolating the data by manufacturer, one can notice a significant increase in correlations. Note: The below data was presented in March 2016.

Code	Manufacturer	Chamber CFM	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH
Ax	A	19.63	62.18	81.81	19.21	60.84	80.05	81.47	82.33	0.85	0.76	0.24	3.17	72.70	18.23
Ay	A	20.35	57.35	77.70	20.56	57.95	78.51	77.70	77.70	0.00	0.74	0.26	2.82	74.40	8.00
Az	A	27.79	60.31	88.10	27.95	60.67	88.62	88.06	88.21	0.15	0.68	0.32	2.17	72.00	38.00

	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH	Interspace Area	Lower Plenum	Press Ratio	Upstream Pressure	Downstream Pressure	Differential Pressure	Lab Temp	Lab % RH	Lab Press	WTM Water Temp	WTM WVP	Center HF	Top Left	Top Right	Low Right	Low Left	Cal Factor	CF Ratio	Kh (STP correction)
Chamber CFM	0.05	0.89	1.00	0.38	0.98	0.90	0.86	-0.43	-0.98	0.98	-0.96	-0.67	0.91	-1.00	-0.39	-0.77	0.98	0.98	0.75	-0.73	0.79	0.34	-1.00	-0.99	-1.00	-0.94	0.20	-0.96	-1.00	0.99	0.99	0.90
Bypass CFM		0.51	-0.01	0.94	0.27	0.48	0.55	0.88	0.16	-0.16	0.22	-0.78	0.45	-0.13	-0.94	0.60	-0.13	-0.16	0.70	0.65	-0.58	-0.92	-0.13	-0.16	-0.13	0.28	0.99	-0.31	-0.09	-0.11	-0.11	-0.40
Total CFM			0.85	0.77	0.97	1.00	1.00	0.04	-0.77	0.77	-0.73	-0.94	1.00	-0.92	-0.77	-0.39	0.79	0.77	0.97	-0.33	0.41	-0.13	-0.92	-0.93	-0.92	-0.68	0.63	-0.98	-0.90	0.80	0.80	0.59
Chamber SCFM				0.32	0.96	0.87	0.83	-0.48	-0.99	0.99	-0.98	-0.62	0.88	-0.99	-0.33	-0.81	0.99	0.99	0.70	-0.77	0.82	0.40	-0.99	-0.99	-0.99	-0.96	0.14	-0.94	-0.99	1.00	1.00	0.92
Bypass SCFM					0.57	0.74	0.80	0.67	-0.18	0.18	-0.12	-0.94	0.73	-0.45	-1.00	0.29	0.21	0.17	0.90	0.35	-0.27	-0.74	-0.45	-0.48	-0.45	-0.05	0.98	-0.61	-0.42	0.23	0.23	-0.07
Total SCFM						0.97	0.95	-0.22	-0.91	0.91	-0.88	-0.81	0.98	-0.99	-0.58	-0.61	0.92	0.91	0.87	-0.56	0.63	0.13	-0.99	-0.99	-0.99	-0.85	0.41	-1.00	-0.98	0.93	0.93	0.78
Min							1.00	0.01	-0.79	0.79	-0.75	-0.92	1.00	-0.93	-0.75	-0.42	0.81	0.79	0.96	-0.36	0.44	-0.10	-0.93	-0.94	-0.93	-0.71	0.60	-0.98	-0.92	0.82	0.82	0.62
Max								0.09	-0.74	0.74	-0.69	-0.95	0.99	-0.90	-0.80	-0.34	0.76	0.73	0.98	-0.28	0.36	-0.18	-0.90	-0.91	-0.90	-0.64	0.67	-0.97	-0.88	0.77	0.77	0.55
Delta									0.60	-0.60	0.65	-0.39	-0.02	0.35	-0.67	0.90	-0.58	-0.61	0.28	0.93	-0.89	-1.00	0.35	0.33	0.35	0.70	0.80	0.17	0.39	-0.56	-0.56	-0.78
Bypass %										-1.00	1.00	0.50	-0.81	0.96	0.19	0.89	-1.00	-1.00	-0.59	0.86	-0.90	-0.53	0.96	0.95	0.96	0.99	0.01	0.89	0.97	-1.00	-1.00	-0.97
Chamber %											-1.00	-0.50	0.81	-0.96	-0.19	-0.89	1.00	1.00	0.59	-0.86	0.90	0.53	-0.96	-0.95	-0.96	-0.99	-0.01	-0.89	-0.97	1.00	1.00	0.97
Ratio (3:1)												0.44	-0.77	0.94	0.12	0.91	-1.00	-1.00	-0.54	0.89	-0.92	-0.58	0.94	0.93	0.94	1.00	0.07	0.86	0.95	-0.99	-0.99	-0.98
Airflow Temp													-0.91	0.73	0.94	0.04	-0.52	-0.49	-0.99	-0.02	-0.06	0.47	0.73	0.74	0.73	0.38	-0.86	0.84	0.70	-0.54	-0.54	-0.27
Airflow % RH														-0.94	-0.73	-0.44	0.82	0.80	0.95	-0.39	0.46	-0.07	-0.94	-0.95	-0.94	-0.72	0.58	-0.99	-0.93	0.84	0.84	0.64
Interspace Area															0.46	0.72	-0.97	-0.96	-0.80	0.67	-0.73	-0.27	1.00	1.00	1.00	0.91	-0.28	0.98	1.00	-0.97	-0.97	-0.86
Lower Plenum																-0.29	-0.21	-0.18	-0.90	-0.35	0.27	0.73	0.46	0.48	0.46	0.06	-0.98	0.62	0.43	-0.23	-0.24	0.06
Press Ratio																	-0.87	-0.89	-0.15	1.00	-1.00	-0.86	0.72	0.70	0.72	0.94	0.47	0.57	0.74	-0.86	-0.86	-0.97
Upstream Pressure																		1.00	0.61	-0.84	0.88	0.51	-0.97	-0.96	-0.97	-0.99	0.02	-0.90	-0.98	1.00	1.00	0.96
Downstream Pressure																			0.59	-0.86	0.90	0.54	-0.96	-0.95	-0.96	-0.99	-0.01	-0.88	-0.97	1.00	1.00	0.97
Differential Pressure																				-0.09	0.17	-0.37	-0.80	-0.81	-0.80	-0.48	0.80	-0.90	-0.77	0.63	0.63	0.38
Lab Temp																					-1.00	-0.89	0.67	0.65	0.67	0.92	0.52	0.52	0.70	-0.83	-0.83	-0.96
Lab % RH																						0.85	-0.73	-0.72	-0.73	-0.95	-0.45	-0.59	-0.76	0.87	0.87	0.98
Lab Press																							-0.27	-0.24	-0.27	-0.64	-0.85	-0.08	-0.30	0.49	0.49	0.72
WTM Water Temp																								1.00	1.00	0.91	-0.28	0.98	1.00	-0.97	-0.97	-0.86
WTM WVP																									1.00	0.90	-0.30	0.99	1.00	-0.96	-0.97	-0.85
Center HF																										0.91	-0.28	0.98	1.00	-0.97	-0.97	-0.86
Top Left																											0.14	0.82	0.93	-0.98	-0.98	-0.99

Takeaway: Significant majority of cells **ARE** highlighted (≥80%) correlation.

ISOLATING BY MANUFACTURER CONTINUED:

From March 2016

Code	Manufacturer	Chamber CFM	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH
Bw	B	21.93	67.37	89.30	21.40	65.74	87.14	88.65	89.84	1.18	0.75	0.25	3.07	72.76	35.37
Bx	B	27.03	64.76	91.79	27.05	64.81	91.86	90.69	92.50	1.81	0.71	0.29	2.40	71.48	2.21
By	B	24.55	74.76	99.31	23.89	72.74	96.63	99.20	99.38	0.19	0.75	0.25	3.04	70.34	1.55
Bz	B	20.99	66.06	87.05	21.07	66.30	87.37	86.47	87.62	1.15	0.76	0.24	3.15	70.21	43.05

	PHR	PHR CV	PHR mV Rise	TTP	TTP CV	Rate of Rise	Rate of Fall	2 Min THR	2 Min THR CV	PHR/THR Ratio	5 Min THR	5 Min THR CV	THR Delta	Ending Avg HRR	Ending Avg HRR CV	PHR	PHR mV Rise	TTP	2 Min THR	PHR/THR Ratio	5 Min THR	THR Delta
Chamber CFM	-0.63	0.86	-0.26	0.91	0.82	-0.99	-0.44	-0.49	-0.67	-0.55	-0.45	-0.80	-0.41	-0.42	-0.83	-0.87	-1.00	-0.98	0.86	1.00	-0.65	-0.84
Bypass CFM	-0.71	0.80	-0.37	0.86	0.75	-1.00	-0.54	-0.59	-0.76	-0.45	-0.55	-0.86	-0.52	-0.52	-0.89	-0.92	-0.99	-0.95	0.79	0.99	-0.73	-0.90
Total CFM	-0.69	0.82	-0.34	0.87	0.77	-1.00	-0.52	-0.56	-0.73	-0.48	-0.52	-0.85	-0.49	-0.49	-0.88	-0.91	-0.99	-0.96	0.81	0.99	-0.71	-0.88
Chamber SCFM	-0.74	0.78	-0.40	0.84	0.73	-1.00	-0.57	-0.62	-0.78	-0.42	-0.58	-0.88	-0.55	-0.55	-0.91	-0.94	-0.98	-0.94	0.77	0.98	-0.75	-0.91
Bypass SCFM	-1.00	1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00
Total SCFM	-0.82	0.69	-0.52	0.76	0.63	-0.99	-0.67	-0.71	-0.85	-0.30	-0.68	-0.93	-0.65	-0.65	-0.95	-0.97	-0.94	-0.89	0.68	0.95	-0.83	-0.96
Min	-0.70	0.81	-0.35	0.87	0.76	-1.00	-0.53	-0.57	-0.74	-0.47	-0.53	-0.85	-0.50	-0.51	-0.88	-0.92	-0.99	-0.96	0.80	0.99	-0.72	-0.89
Max	-0.69	0.82	-0.34	0.88	0.77	-1.00	-0.51	-0.56	-0.73	-0.48	-0.52	-0.84	-0.49	-0.49	-0.87	-0.91	-0.99	-0.96	0.81	0.99	-0.71	-0.88
Delta	0.82	-0.68	0.53	-0.76	-0.63	0.99	0.68	0.72	0.86	0.29	0.69	0.94	0.66	0.66	0.96	0.98	0.94	0.88	-0.67	-0.95	0.84	0.96
Bypass %	0.15	-1.00	-0.26	-0.99	-1.00	0.80	-0.07	-0.01	0.21	0.90	-0.06	0.39	-0.10	-0.09	0.44	0.51	0.89	0.95	-1.00	-0.88	0.18	0.46
Chamber %	-0.15	1.00	0.26	0.99	1.00	-0.80	0.07	0.01	-0.21	-0.90	0.06	-0.39	0.10	0.09	-0.44	-0.51	-0.89	-0.95	1.00	0.88	-0.18	-0.46
Ratio (3:1)	0.15	-1.00	-0.26	-0.99	-1.00	0.79	-0.07	-0.02	0.21	0.90	-0.06	0.39	-0.10	-0.10	0.44	0.50	0.89	0.94	-1.00	-0.88	0.17	0.45
Airflow Temp	0.90	0.30	1.00	0.20	0.37	0.34	0.97	0.96	0.87	-0.69	0.97	0.76	0.98	0.98	0.72	0.67	0.17	0.03	0.32	-0.19	0.89	0.71
Airflow % RH	0.69	-0.82	0.34	-0.87	-0.77	1.00	0.51	0.56	0.73	0.48	0.52	0.85	0.49	0.49	0.88	0.91	0.99	0.96	-0.81	-0.99	0.71	0.88
Interspace Area	0.92	0.26	1.00	0.16	0.33	0.38	0.98	0.97	0.89	-0.66	0.98	0.79	0.99	0.99	0.75	0.70	0.21	0.07	0.27	-0.23	0.91	0.74
Lower Plenum	-0.75	-0.55	-0.95	-0.46	-0.61	-0.07	-0.87	-0.84	-0.70	0.86	-0.87	-0.56	-0.89	-0.89	-0.51	-0.44	0.11	0.24	-0.56	-0.08	-0.73	-0.50
Press Ratio	0.90	0.29	1.00	0.19	0.36	0.35	0.98	0.96	0.87	-0.68	0.97	0.77	0.98	0.98	0.73	0.68	0.18	0.04	0.31	-0.20	0.89	0.72
Upstream Pressure	0.68	0.62	0.92	0.54	0.68	-0.02	0.83	0.79	0.63	-0.90	0.82	0.48	0.84	0.84	0.43	0.36	-0.20	-0.33	0.63	0.17	0.66	0.41
Downstream Pressure	0.36	-0.98	-0.05	-0.99	-0.96	0.91	0.14	0.20	0.42	0.78	0.15	0.58	0.12	0.12	0.62	0.68	0.97	0.99	-0.97	-0.96	0.38	0.64
Differential Pressure	-0.13	1.00	0.28	0.99	1.00	-0.78	0.09	0.03	-0.19	-0.90	0.08	-0.37	0.12	0.11	-0.42	-0.49	-0.88	-0.94	1.00	0.87	-0.16	-0.44
Lab Temp	0.86	-0.63	0.58	-0.71	-0.57	0.97	0.73	0.77	0.89	0.22	0.73	0.96	0.71	0.71	0.97	0.99	0.92	0.85	-0.62	-0.92	0.87	0.98
Lab % RH	0.81	-0.71	0.50	-0.78	-0.65	0.99	0.66	0.70	0.84	0.32	0.66	0.93	0.63	0.64	0.95	0.97	0.95	0.90	-0.70	-0.96	0.82	0.95
Lab Press	0.12	-1.00	-0.29	-0.99	-1.00	0.78	-0.10	-0.05	0.18	0.91	-0.09	0.36	-0.13	-0.13	0.41	0.48	0.87	0.93	-1.00	-0.86	0.14	0.43
WTM Water Temp	0.87	0.36	0.99	0.26	0.43	0.28	0.96	0.94	0.84	-0.73	0.95	0.72	0.97	0.96	0.68	0.63	0.11	-0.03	0.37	-0.13	0.86	0.67
WTM WVP	0.78	-0.73	0.47	-0.80	-0.68	0.99	0.63	0.67	0.82	0.35	0.64	0.91	0.61	0.61	0.93	0.96	0.96	0.91	-0.72	-0.97	0.80	0.94

ISOLATING BY MANUFACTURER:

More bad news: As more labs reported data using equipment from the same manufacturer, the correlations shown in March decreased !

			Flow Data												
	Code	Manufacturer	Chamber CFM	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH
	Bw	B	21.93	67.37	89.30	21.40	65.74	87.14	88.65	89.84	1.18	0.75	0.25	3.07	72.76	35.37
	Bx	B	27.03	64.76	91.79	27.05	64.81	91.86	90.69	92.50	1.81	0.71	0.29	2.40	71.48	2.21
New	**Ba**	B	21.25	73.99	95.24	21.06	73.34	94.40	94.98	95.46	0.48	0.78	0.22	3.48	69.83	38.08
	By	B	24.55	74.76	99.31	23.89	72.74	96.63	99.20	99.38	0.19	0.75	0.25	3.04	70.34	1.55
New	**Bb**	B	18.65	64.99	83.64	18.34	63.93	82.28	82.95	84.06	1.11	0.78	0.22	3.49	79.45	54.74
	Bz	B	20.99	66.06	87.05	21.07	66.30	87.37	86.47	87.62	1.15	0.76	0.24	3.15	70.21	43.05

	PHR	PHR CV	PHR mV Rise	TTP	TTP CV	Rate of Rise	Rate of Fall	2 Min THR	2 Min THR CV	PHR/THR Ratio	5 Min THR	5 Min THR CV	THR Delta	Ending Avg HRR	Ending Avg HRR CV	PHR	PHR mV Rise	TTP	2 Min THR	PHR/THR Ratio	5 Min THR	THR Delta
Chamber CFM	-0.8	-0.6	-0.8	0.1	0.9	-0.4	-0.4	-0.8	-0.9	0.4	-0.8	-0.4	-0.8	-0.8	-0.6	-0.6	-0.5	-0.6	0.2	0.7	0.3	0.3
Bypass CFM	-0.5	0.1	-0.3	0.7	0.5	-0.9	0.1	-0.6	-0.4	0.5	-0.5	-0.6	-0.4	-0.4	-0.9	-0.9	-0.8	-1.0	-0.2	0.6	-0.4	-0.4
Total CFM	-0.6	-0.1	-0.4	0.5	0.6	-0.8	0.0	-0.7	-0.6	0.5	-0.6	-0.6	-0.6	-0.6	-0.8	-0.9	-0.8	-0.9	-0.1	0.7	-0.2	-0.2
Chamber SCFM	-0.9	-0.6	-0.8	0.1	0.9	-0.4	-0.4	-0.9	-0.9	0.5	-0.9	-0.4	-0.9	-0.9	-0.6	-0.7	-0.5	-0.6	0.1	0.7	0.3	0.3
Bypass SCFM	-0.6	0.0	-0.5	0.7	0.3	-0.9	0.1	-0.8	-0.6	0.8	-0.7	-0.5	-0.6	-0.6	-0.9	-1.0	-0.9	-1.0	-0.5	0.4	-0.4	-0.4
Total SCFM	-0.6	-0.1	-0.5	0.6	0.6	-0.8	0.0	-0.8	-0.6	0.7	-0.7	-0.5	-0.6	-0.6	-0.9	-0.9	-0.8	-0.9	-0.2	0.6	-0.3	-0.2
Min	-0.6	-0.1	-0.4	0.5	0.6	-0.8	0.0	-0.7	-0.6	0.5	-0.6	-0.6	-0.6	-0.6	-0.8	-0.9	-0.8	-0.9	-0.1	0.7	-0.2	-0.2
Max	-0.6	-0.1	-0.5	0.5	0.7	-0.8	0.0	-0.7	-0.6	0.6	-0.6	-0.5	-0.6	-0.6	-0.8	-0.9	-0.8	-0.9	-0.1	0.7	-0.2	-0.2
Delta	0.5	-0.1	0.2	-0.6	-0.4	0.9	0.0	0.6	0.4	-0.4	0.4	0.8	0.4	0.3	1.0	0.9	0.6	0.8	0.0	-0.7	0.4	0.5
Bypass %	0.7	0.9	0.9	0.6	-0.9	-0.3	0.7	0.6	0.9	-0.2	0.8	0.0	0.8	0.8	0.0	0.0	0.0	0.0	-0.4	-0.4	-0.9	-0.9
Chamber %	-0.7	-0.9	-0.9	-0.6	0.9	0.3	-0.7	-0.6	-0.9	0.2	-0.8	0.0	-0.8	-0.8	0.0	0.0	0.0	0.0	0.4	0.4	0.9	0.9
Ratio (3:1)	0.7	1.0	0.9	0.6	-0.9	-0.3	0.7	0.7	0.9	-0.2	0.8	0.0	0.8	0.8	0.0	0.0	0.0	-0.1	-0.4	-0.4	-0.9	-0.9
Airflow Temp	0.7	0.5	0.7	-0.2	-0.5	0.3	0.1	0.9	0.8	-0.9	0.9	0.1	0.8	0.8	0.5	0.8	0.8	0.6	0.6	-0.1	0.0	-0.1
Airflow % RH	0.8	0.4	0.7	-0.1	-0.8	0.5	0.5	0.7	0.8	-0.3	0.7	0.6	0.7	0.7	0.7	0.6	0.4	0.6	-0.3	-0.9	-0.2	-0.2
Interspace Area	0.6	0.2	0.3	0.4	0.1	0.0	0.8	0.5	0.4	0.0	0.4	0.7	0.4	0.4	0.5	0.1	-0.2	-0.2	-0.1	-0.3	0.0	0.0
Lower Plenum	-0.8	-0.6	-0.8	-0.1	0.4	-0.1	-0.4	-0.9	-0.8	0.8	-0.9	-0.2	-0.9	-0.9	-0.5	-0.6	-0.5	-0.3	-0.5	0.1	0.2	0.3
Press Ratio	0.8	0.3	0.5	0.3	0.0	0.1	0.7	0.6	0.6	-0.2	0.6	0.7	0.6	0.6	0.5	0.3	-0.1	-0.1	0.0	-0.3	0.0	0.0
Upstream Pressure	-0.5	-0.6	-0.7	0.1	0.8	-0.1	0.0	-0.7	-0.7	0.6	-0.7	0.3	-0.7	-0.7	-0.1	-0.4	-0.6	-0.5	-0.2	0.2	0.4	0.5
Downstream Pressure	-0.4	-0.8	-0.7	-0.7	0.2	0.7	-0.4	-0.5	-0.5	0.4	-0.6	0.5	-0.6	-0.6	0.4	0.2	0.1	0.4	-0.3	-0.4	0.7	0.8
Differential Pressure	0.1	0.5	0.3	0.8	0.3	-0.8	0.4	0.1	0.1	0.0	0.2	-0.4	0.2	0.2	-0.5	-0.5	-0.5	-0.8	0.2	0.6	-0.5	-0.5
Lab Temp	0.5	0.1	0.4	-0.6	-0.5	0.7	-0.2	0.8	0.6	-0.8	0.6	0.4	0.6	0.6	0.8	1.0	0.9	0.9	0.5	-0.3	0.3	0.3
Lab % RH	0.9	0.7	0.9	0.1	-0.9	0.2	0.5	0.9	1.0	-0.5	0.9	0.3	0.9	0.9	0.5	0.5	0.4	0.5	0.0	-0.6	-0.4	-0.4
Lab Press	0.4	0.3	0.4	-0.3	-0.9	0.5	0.1	0.4	0.5	-0.1	0.4	0.2	0.4	0.4	0.4	0.4	0.4	0.6	-0.4	-0.8	-0.2	-0.2
WTM Water Temp	0.7	0.6	0.8	-0.1	-0.6	0.2	0.1	0.9	0.8	-0.9	0.9	0.0	0.8	0.8	0.4	0.7	0.7	0.6	0.5	-0.1	-0.2	-0.3
WTM WVP	0.6	0.5	0.7	-0.3	-0.7	0.4	0.0	0.9	0.8	-0.9	0.8	0.0	0.8	0.8	0.4	0.7	0.8	0.7	0.4	-0.2	-0.1	-0.2

ISOLATING BY MANUFACTURER:

A different manufacturer of OSU machines shows similar trend that correlations decrease as the amount of reported data increased.

		Flow Data													
Code	Manufacturer	Chamber CFM	Bypass CFM	Total CFM	Chamber SCFM	Bypass SCFM	Total SCFM	Min	Max	Delta	Bypass %	Chamber %	Ratio (3:1)	Airflow Temp	Airflow % RH
Ca	C	16.18	78.35	94.53	15.89	76.94	92.82	94.24	94.83	0.59	0.83	0.17	4.84	70.10	0.00
Cb	C	20.02	71.86	91.89	19.81	71.10	90.91	89.84	93.28	3.44	0.78	0.22	3.59	71.41	1.00
Cc	C	19.61	76.15	95.76	19.31	74.97	94.28	94.94	96.39	1.44	0.80	0.20	3.88	70.12	1.20
Cd	C	16.36	77.52	93.88	16.36	77.54	93.90	93.54	94.24	0.70	0.83	0.17	4.74	71.56	1.58
Ce	C	22.92	71.41	94.33	22.42	69.86	92.28	94.02	94.57	0.55	0.76	0.24	3.12	72.81	17.14
Cf	C	18.01	77.76	95.77	17.79	76.79	94.58	95.50	96.05	0.55	0.81	0.19	4.32	69.32	0.90
Cg	C	17.10	67.57	84.66	17.01	67.21	84.22	82.36	85.25	2.89	0.80	0.20	3.95	68.15	3.13

	PHR	PHR CV	PHR mV Rise	TTP	TTP CV	Rate of Rise	Rate of Fall	2 Min THR	2 Min THR CV	PHR/THR Ratio	5 Min THR	5 Min THR CV	THR Delta	Ending Avg HRR	Ending Avg HRR CV	PHR	PHR mV Rise	TTP	2 Min THR	PHR/THR Ratio	5 Min THR	THR Delta
Chamber CFM	-0.5	-0.2	-0.4	0.0	0.4	0.5	-0.5	-0.4	0.4	-0.4	-0.4	0.0	-0.4	-0.4	-0.2	0.0	-0.1	-0.7	0.3	0.6	0.0	0.0
Bypass CFM	0.2	0.1	0.2	-0.1	-0.1	-0.4	0.2	0.0	-0.3	0.6	0.0	0.2	0.1	0.1	0.4	-0.3	-0.3	0.4	-0.6	-0.6	-0.4	-0.3
Total CFM	-0.4	-0.1	-0.3	-0.2	0.4	0.0	-0.3	-0.7	0.1	0.7	-0.7	0.6	-0.6	-0.6	0.5	-0.7	-0.8	-0.4	-0.7	-0.1	-0.7	-0.7
Chamber SCFM	-0.5	-0.2	-0.4	0.0	0.4	0.5	-0.4	-0.4	0.4	-0.3	-0.4	0.0	-0.4	-0.4	-0.2	0.0	0.0	-0.6	0.3	0.7	0.1	0.0
Bypass SCFM	0.4	0.2	0.3	-0.1	-0.1	-0.4	0.4	0.1	-0.3	0.7	0.2	0.3	0.2	0.2	0.4	-0.3	-0.3	0.5	-0.5	-0.5	-0.3	-0.2
Total SCFM	0.1	0.2	0.1	-0.2	0.3	0.0	0.1	-0.3	0.1	0.9	-0.3	0.7	-0.3	-0.3	0.8	-0.7	-0.7	0.0	-0.6	-0.1	-0.5	-0.5
Min	-0.4	0.1	-0.3	-0.1	0.4	-0.1	-0.3	-0.7	0.3	0.6	-0.7	0.6	-0.7	-0.7	0.5	-0.7	-0.8	-0.4	-0.8	-0.2	-0.7	-0.7
Max	-0.3	-0.3	-0.1	-0.3	0.3	0.2	-0.3	-0.6	-0.1	0.7	-0.5	0.5	-0.5	-0.5	0.5	-0.7	-0.7	-0.4	-0.6	0.0	-0.6	-0.6
Delta	0.4	-0.5	0.5	-0.2	-0.5	0.3	0.3	0.6	-0.6	-0.4	0.7	-0.6	0.7	0.7	-0.5	0.6	0.7	0.3	0.7	0.4	0.6	0.6
Bypass %	0.5	0.2	0.4	-0.1	-0.3	-0.5	0.4	0.3	-0.4	0.4	0.3	0.0	0.4	0.4	0.2	-0.1	0.0	0.6	-0.4	-0.6	-0.1	-0.1
Chamber %	-0.5	-0.2	-0.4	0.1	0.3	0.5	-0.4	-0.3	0.4	-0.4	-0.3	0.0	-0.4	-0.4	-0.2	0.1	0.0	-0.6	0.4	0.6	0.1	0.1
Ratio (3:1)	0.4	0.2	0.3	0.0	-0.3	-0.5	0.4	0.3	-0.3	0.4	0.3	0.1	0.3	0.3	0.2	-0.1	-0.1	0.6	-0.4	-0.7	-0.2	-0.1
Airflow Temp	-0.2	0.5	-0.1	0.1	0.1	0.3	-0.2	0.0	0.7	-0.5	-0.1	0.1	-0.1	-0.1	0.0	0.0	0.1	-0.2	0.2	0.3	0.1	0.0
Airflow % RH	-0.7	0.3	-0.6	0.3	0.5	0.2	-0.5	-0.6	0.8	-0.4	-0.7	0.3	-0.7	-0.7	0.0	-0.2	-0.3	-0.6	0.0	0.3	-0.2	-0.2
Interspace Area	0.2	0.2	0.2	-0.2	-0.6	-0.3	0.0	0.2	-0.2	-0.1	0.3	-0.1	0.4	0.4	-0.1	0.0	0.1	0.4	-0.5	-0.9	-0.3	-0.2
Lower Plenum	-0.3	-0.1	-0.5	0.6	0.9	-0.3	0.0	-0.4	0.1	0.3	-0.6	0.0	-0.7	-0.7	0.0	0.0	-0.1	-0.2	0.3	0.5	0.3	0.2
Press Ratio	0.2	0.2	0.3	-0.2	-0.7	-0.2	0.0	0.2	-0.2	-0.2	0.4	-0.1	0.5	0.4	-0.1	0.0	0.1	0.3	-0.5	-0.9	-0.3	-0.2
Upstream Pressure	0.4	-0.4	0.2	0.1	0.3	0.2	0.4	0.3	-0.3	0.2	0.2	-0.2	0.1	0.1	0.0	0.3	0.3	0.1	0.7	0.9	0.6	0.6
Downstream Pressure	0.4	-0.3	0.3	0.0	0.3	0.2	0.5	0.3	-0.2	0.4	0.2	0.0	0.1	0.1	0.2	0.1	0.1	0.2	0.6	0.9	0.4	0.4
Differential Pressure	0.0	-0.6	-0.2	0.4	-0.1	-0.2	0.0	0.3	-0.5	-0.7	0.3	-0.9	0.3	0.3	-0.8	0.8	0.8	0.0	0.8	0.3	0.8	0.7
Lab Temp	0.5	0.5	0.5	0.0	-0.2	0.2	0.4	0.6	0.3	-0.4	0.6	0.0	0.5	0.5	0.0	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Lab % RH	0.1	-0.2	-0.2	0.5	0.6	-0.5	0.4	0.0	-0.3	0.5	-0.2	-0.1	-0.3	-0.3	0.0	0.2	0.0	0.2	0.3	0.3	0.3	0.4
Lab Press	0.8	0.7	0.7	0.0	-0.1	-0.1	0.8	0.8	0.2	0.3	0.7	0.2	0.5	0.5	0.4	0.1	0.2	0.8	0.2	0.3	0.3	0.3
WTM Water Temp	0.8	0.4	0.8	-0.3	-0.4	0.0	0.7	0.7	-0.2	0.4	0.7	0.2	0.7	0.7	0.5	0.0	0.0	0.8	-0.1	-0.2	0.0	0.1
WTM WVP	0.8	0.3	0.9	-0.4	-0.6	0.0	0.6	0.7	-0.3	0.3	0.8	0.1	0.8	0.7	0.4	0.0	0.1	0.8	-0.1	-0.2	0.0	0.1

Discussion:

- No root cause regarding industry HRR variability is evident in the data captured during the 2016 round robin. Observed correlations (airflow to HRR) presented during previous meetings not evident in this data with industry as a whole.

- An increase in correlations among OSU parameters occurs when analyzing data per manufacturer – suggesting another source of variability can be introduced during the manufacturing of individual OSU equipment.

- However, as more laboratories reported data from OSUs made by the same manufacturer, the observed correlations decreased in values – suggesting variability is individualized per machine (equipment manufacturing, operation, system set up, local conditions etc….)

- If variability is unique to each machine, resolving it becomes extremely difficult.

- A recent Technical Note published by FAA has the potential of unlocking some mysteries….

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Effect of Airflow and Measurement Method on the Heat Release Rate of Aircraft Cabin Materials in the Ohio State University Apparatus

Richard E. Lyon
Matthew Fulmer
Richard Walters
Sean Crowley

April 2016

DOT/FAA/TC-TN15/34

This document is available to the U.S. public through the National Technical Information Services (NTIS), Springfield, Virginia 22161.

This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov.

U.S. Department of Transportation
Federal Aviation Administration

Conclusion:

"The test chamber airflows varied from 495–768 L/min for the three Ohio State University (OSU) fire calorimeters in this study compared to the nominal 600 L/min of Title 14 Code of Federal Regulations (CFR) Part 25.853. However, despite the 25% difference in the combustion chamber flow rates, all three OSU calorimeters calibrated to within the error limits of kh by 14 CFR 25.853. These widely different chamber airflows did not significantly affect the repeatability of any individual OSU calorimeter by either the O2 or thermopile (TP) methods.

However, the different airflow rates in the OSU calorimeters did affect the average value of the heat release rate (HRR) and heat release (HR) measured by the TP method in the different apparatuses, though these differences could not be explained by airflow alone. Consequently, the variability in the TP results is probably because of differences in the thermal response dynamics of the individual apparatus [10].

The reproducibility of the O2 method, which is not susceptible to apparatus thermal dynamics, was two to three times better than the TP method based on the overall coefficient of variation of 5% and 13% for O2 and TP, respectively."

Conclusion:

- Excellent work by FAA/Industry teams capturing individual OSU data for 2016 Round Robin. However, at the time of authoring this presentation, no definitive conclusion can be made.

- Observation that significant variability still exists among machines; perhaps due to manufacturing or operational differences.

- Discussion for next steps to follow in task group

Thank you for your participation and attention !

Backup Slides (Additional Information):

Its June – OSU / HR2 Team
Annual Fishing Excursion !


YOU'RE DOING IT WRONG.