You Can't Manage What You Don't Measure – The Importance of TAB in Lab Commissioning

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B2Q

A Woman Business Enterprise (WBE)

Learning Objectives

- Review of industry standards for TAB and recommended Improvements
- Understand the role of the Testing, Adjusting, & Balancing (TAB) contractor in verifying laboratory safety and optimizing operating costs
- Explain the impact of proper TAB on laboratory buildings on the long-term safety, performance, operating costs of lab buildings and the wellbeing of its occupants
- Address importance of recurring TAB measurements in lab environments on the general lab ventilation systems, not just the fume hoods.

Role of TAB Contractor

FOREWORD

The purpose of the NEBB *Procedural Standards for Testing Adjusting and Balancing of Environmental Systems* is to establish a uniform and systematic set of criteria for the performance of the testing, adjusting and balancing of environmental or Heating, Ventilating and Air-conditioning (HVAC) systems.

Today's buildings provide highly controlled indoor environments. These conditions could not exist without sophisticated mechanical systems created by a team of skilled professionals. A key member of this team is the NEBB Certified Test, Adjust, and Balance (TAB) Firm.

Keys for Successful TAB

- Comprehensive, building- & controls-specific TAB spec
- Engineer & CxA should indicate how TAB to be performed
- Proper design & installation – duct layout, device sizing, proper balancing devices & located properly, accessible.
- Allow early / sufficient time for TAB and proper access
- Have the TAB contractor on site / at meetings earlier
- Engr & CxA should engage TAB – they're knowledgeable!

Flow Measurement Accuracy

- Industry standard for VAV flow station setup, calibration, balancing is at design max flow
- BUT….VAVs typically operate in mid- to low-range
- VAV k-factors should be setup across the range of the VAV
  - Or somewhere close to typical operating conditions
- If static reset or adjustment, should measure at lower static

VAV Flow Measurement Accuracy

- **Importance of Flow Measurement Accuracy**
- Lab ventilation and pressurization tracking controls are dependent upon accurate airflow measurements
- Accuracy = Safety

		Original K-Factor		New K-Factor	
		TAB Reading	Metasys Reading	TAB Reading	Metasys Reading
General Exhaust Flow	cfm	3,681	4,065	4,018	4,027
Total Fume Hood Flow	cfm	200	200	200	200
Total Supply Flow	cfm	4,091	3,786	3,696	3,751
Offset Setpoint	cfm	-500		-500	
Actual Measured Offset	**cfm**	**210**	**-479**	**-522**	**-476**

TAB Example – Baseline Phase

SUPPLY DEVICES			
Lab	Device	Average % Error	GEX or Supp
S560AB	S560B-SUPP	-29%	SUPP
S560CD	S560D-SUPP	-22%	SUPP
S570	SUPP	10%	SUPP
S340	SUPP	12%	SUPP
S463	SUPP	14%	SUPP
S330	SUPP	22%	SUPP
S350A	VAV SUPP	47%	SUPP

EXHAUST DEVICES			
Lab	Device	Average % Error	GEX or Supp
N350A	GEX	-19%	GEX
N260CD	North GEX	-14%	GEX
N340AB	Alcove Exhaust	10%	GEX
S461	GEX	10%	GEX
S320E	GEX	11%	GEX
N340AB	South GEX	12%	GEX
S340	GEX	21%	GEX
S330	GEX	24%	GEX

Sample Statistics	
Total Devices Sample	42
Total Above 10% Error	15
Percent Above 10% Error	**36%**
Excess Exhaust	6
Excess Supply	5
Under Exhaust	2
Under Supply	2

- 650 total devices
- At 36% → 234 devices need adj.

- Need to re-TAB
- Safety issues
- Energy waste

Sampling Approach

- You don't know what the end result is until the whole building is balanced
  - Exhaust – close to sample
  - Supply – not so much

Lab Building TAB Sample			
	Lab 1	Lab 2	Lab Total
# of Supply & General Exhaust Boxes Sampled	16	26	42
# of Supply & General Exhaust Boxes Within +/- 10%	11	19	30
Percent of Terminal Devices within +/- 10%	69%	73%	71%
Net Airflow Difference (cfm)	276	1,552	1,828

Building Level TAB Effort for Lab 1						
	Devices Measured	Devices Within of 10% Tolerance	Percent of Devices Within 10% Tolerance	Initial TAB Airflow Reading	Final TAB Airflow Reading	Airflow Difference
	#	#	#	cfm	cfm	cfm
Supply	84	33	39%	34,848	40,595	-5,747
Exhaust	110	79	72%	35,095	36,023	-928
Total	194	112	58%	69,943	76,618	-6,675

- Overpredicted savings by 5,700 cfm
  - At $4/cfm, $22,800 overpredicted savings

Sampling Approach – Identifying Patterns

Knowledgeable TAB Contractor

Patterns Between Similar Labs

More Effective Sampling

Lab Zone	Terminal Box Location	Original Airflow Difference	Initial TAB Reading	Final TAB Reading	Final Airflow Difference
-	-	-	cfm	cfm	%
####AB	West Supply	21%	701	899	-1%
####AB	East Supply	19%	734	855	-3%
####CD	West Supply	15%	757	965	1%
####CD	East Supply	20%	701	925	0%
####AB	West Supply	20%	749	931	1%
####AB	East Supply	22%	770	934	1%
####CD	West Supply	25%	732	996	3%
####CD	East Supply	23%	718	937	-4%

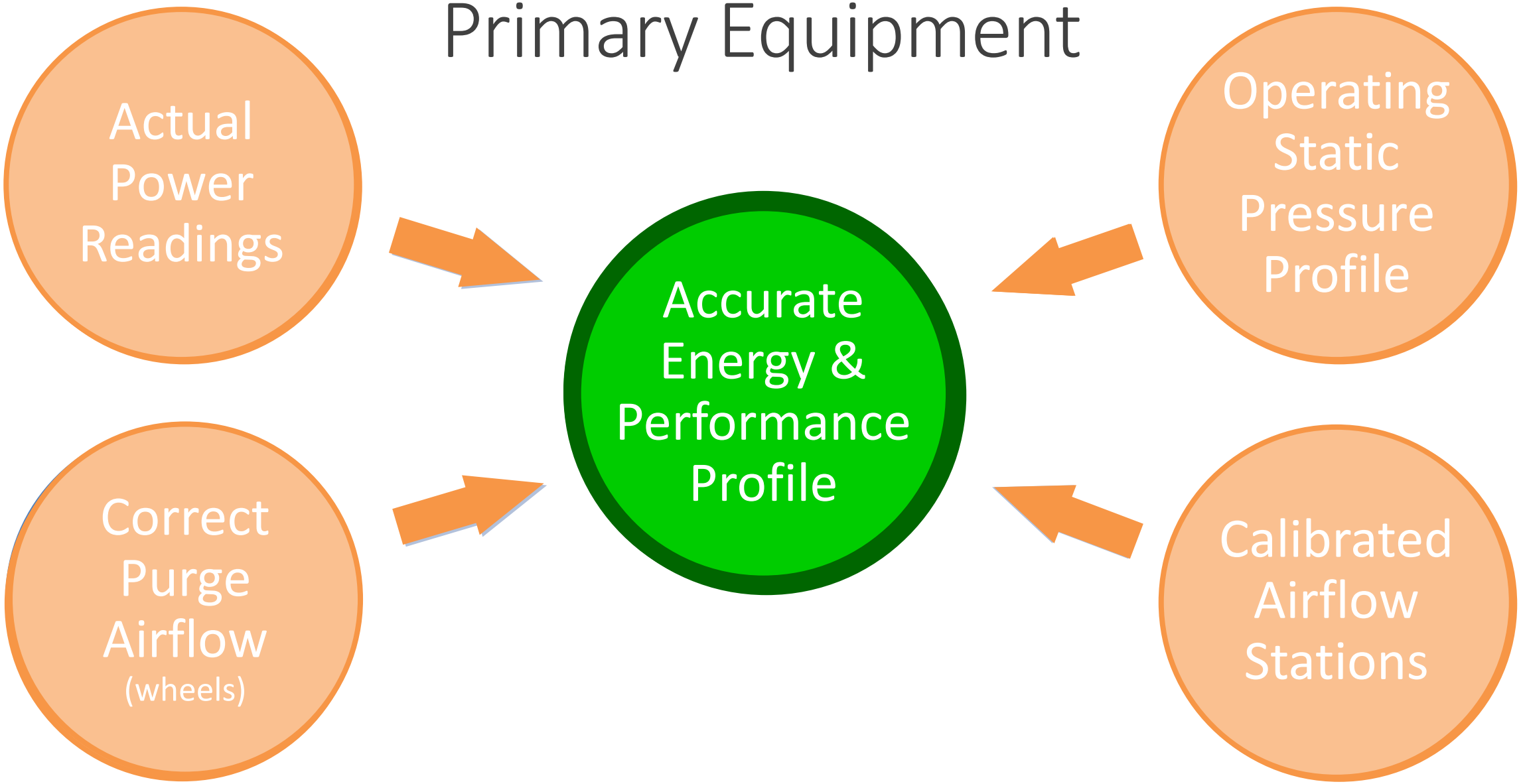
TAB Example – Re-commissioning VAVs

		Original K-Factor Values				New K-Factor Values				
Room	VAV Box	TAB Reading	Metasys Reading	Original K-Factor	Original Airflow Difference	TAB Reading	Metasys Reading	New K-Factor	New Airflow Difference	Airflow Savings
		cfm	cfm	--	cfm	cfm	cfm	--	cfm	cfm
465A	NNN-Exhaust	610	620	1.69	-10	--	--	No Change	-10	0
	NN-Exhaust	353	508	1.75	-155	525	470	2.70	55	-210
	N-Exhaust	547	610	1.73	-63	608	626	2.00	-18	-45
	S-Exhaust	420	485	1.82	-65	479	469	2.10	10	-75
	SS-Exhaust	585	602	1.82	-17	--	--	No Change	-17	0
	SSS-Exhaust	1,166	1,240	1.90	-74	1,211	1,240	1.90	-29	-45
	South Supply	2,115	1,911	1.32	204	1,813	1,851	1.10	-38	242
	North Supply	1,976	1,875	1.98	101	1,883	1,900	1.80	-17	118

Design Offset = -300
Tab Offset = 410
BAS Offset = -279

Design Offset = -300
Tab Offset = -322
BAS Offset = -276

Primary Equipment



Primary Equipment - Baseline

Air Handler Baseline TAB										
	100% Speed					75% Speed				
AHU 1	BAS Reading	TAB Filter Scan	Tab Coil Scan	Purge Airflow	**Percent Difference**	BAS Reading	TAB Filter Scan	Tab Coil Scan	Purge Airflow	**Percent Difference**
	cfm	cfm	cfm	cfm	**%**	cfm	cfm	cfm	cfm	**%**
Supply	25,757	31,668	25,345	6,323	**-23%**	10,260	12,096	7,030	5,066	**-18%**
Exhaust	26,891	29,094			**-8%**					
	100% Speed					75% Speed				
AHU 2	BAS Reading	TAB Filter Scan	Tab Coil Scan	Purge Airflow	**Percent Difference**	BAS Reading	TAB Filter Scan	Tab Coil Scan	Purge Airflow	**Percent Difference**
	cfm	cfm	cfm	cfm	**%**	cfm	cfm	cfm	cfm	**%**
Supply	27,686	32,000	27,565	4,435	**-16%**	11,420	13,524	9,158	4,366	**-18%**
Exhaust	30,188	28,438			**6%**					

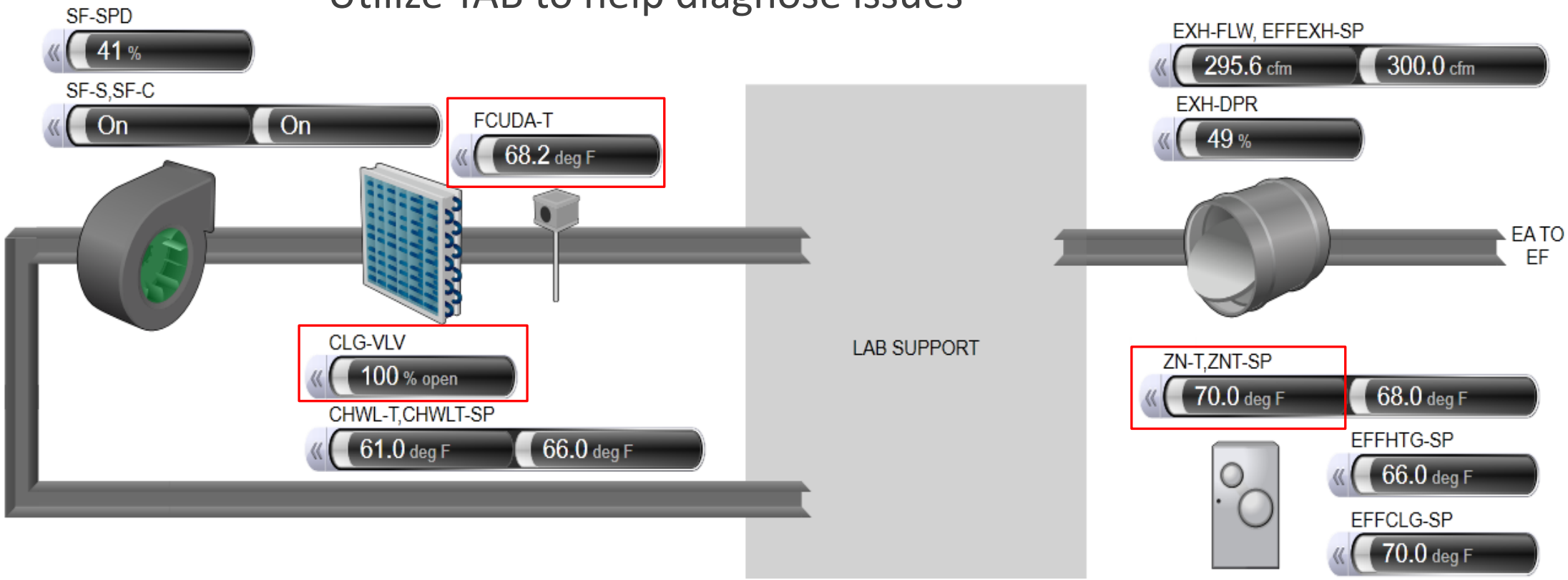
Primary Equipment – TAB of Temperatures

- Observing a temperature increase between the heating coil and cooling coil
  - Unsure what caused this – broken valve, broken temperature sensor
  - Could be contributing to wasted energy
- Solution – utilize TAB to confirm temperature profile

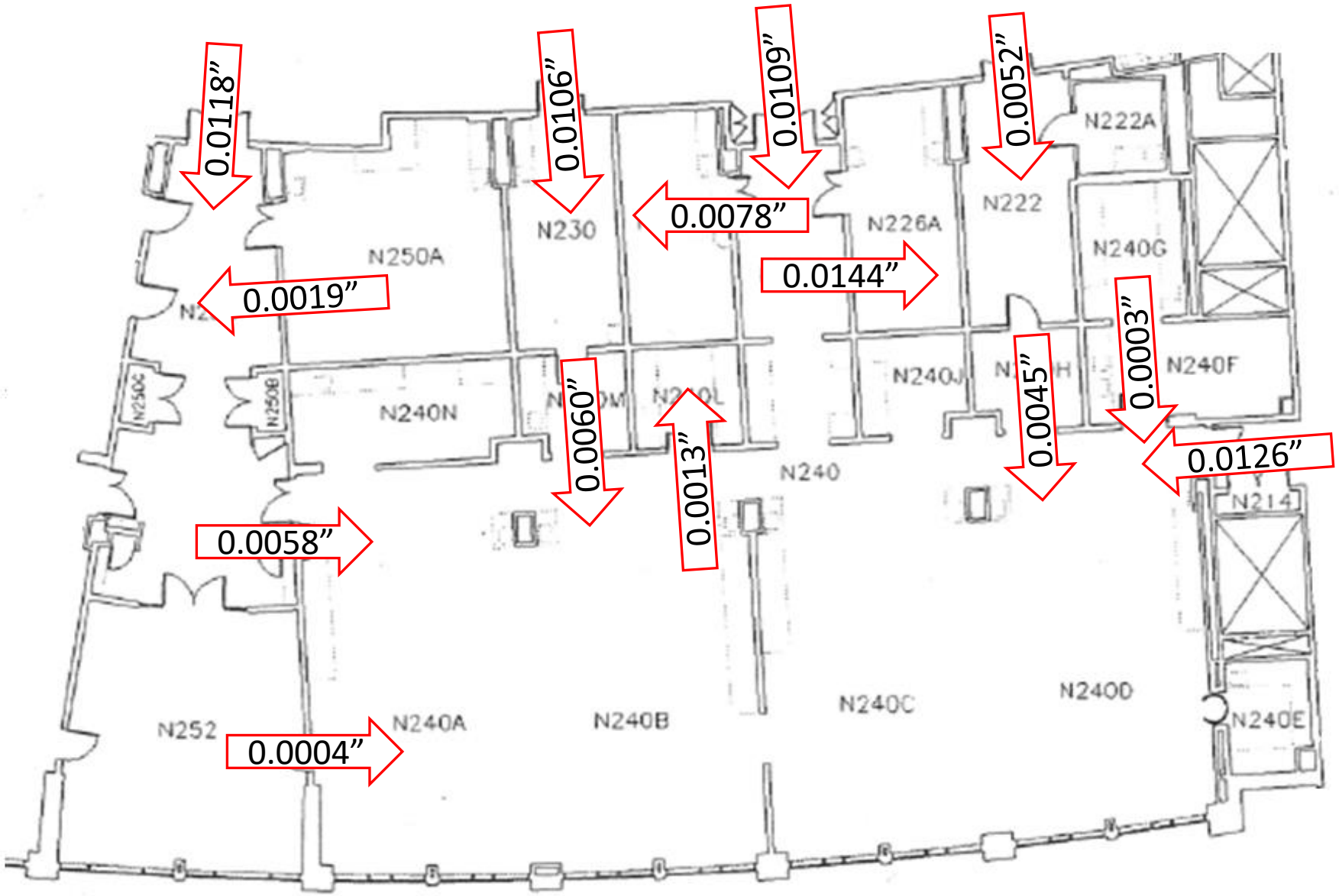
OAT Mid	Heat Rec. Supp. Temp.	Heating Valve	Heat Coil Temp.	Fan Energy Temp. Gain	Cooling Valve	Disch. Air Temp.	Disch. Air Temp. SP
°F	°F	%	°F	°F	%	°F	°F
48	60	0	57	1.8	20	55	55
42	58	0	55	1.8	15	56	56
37	56	4	54	1.8	9	57	57
33	54	9	53	1.8	9	57	57
28	51	17	53	1.8	2	59	58
23	47	20	52	1.8	2	58	58
18	44	20	50	1.8	4	56	57
14	41	30	52	1.8	0	58	58
8	37	34	50	1.8	0	57	58
3	34	38	50	1.8	0	57	58
	60	5	60	1.8	19	56	56

TAB as a Resource: Hydronic System

- Investigating hydronic fan coil reheat and cooling valves
  - Observed little to no temperature difference between lab temperature and FCU discharge temperature with valve at 100%
  - Utilize TAB to help diagnose issues



Room-Level Pressure Cascades

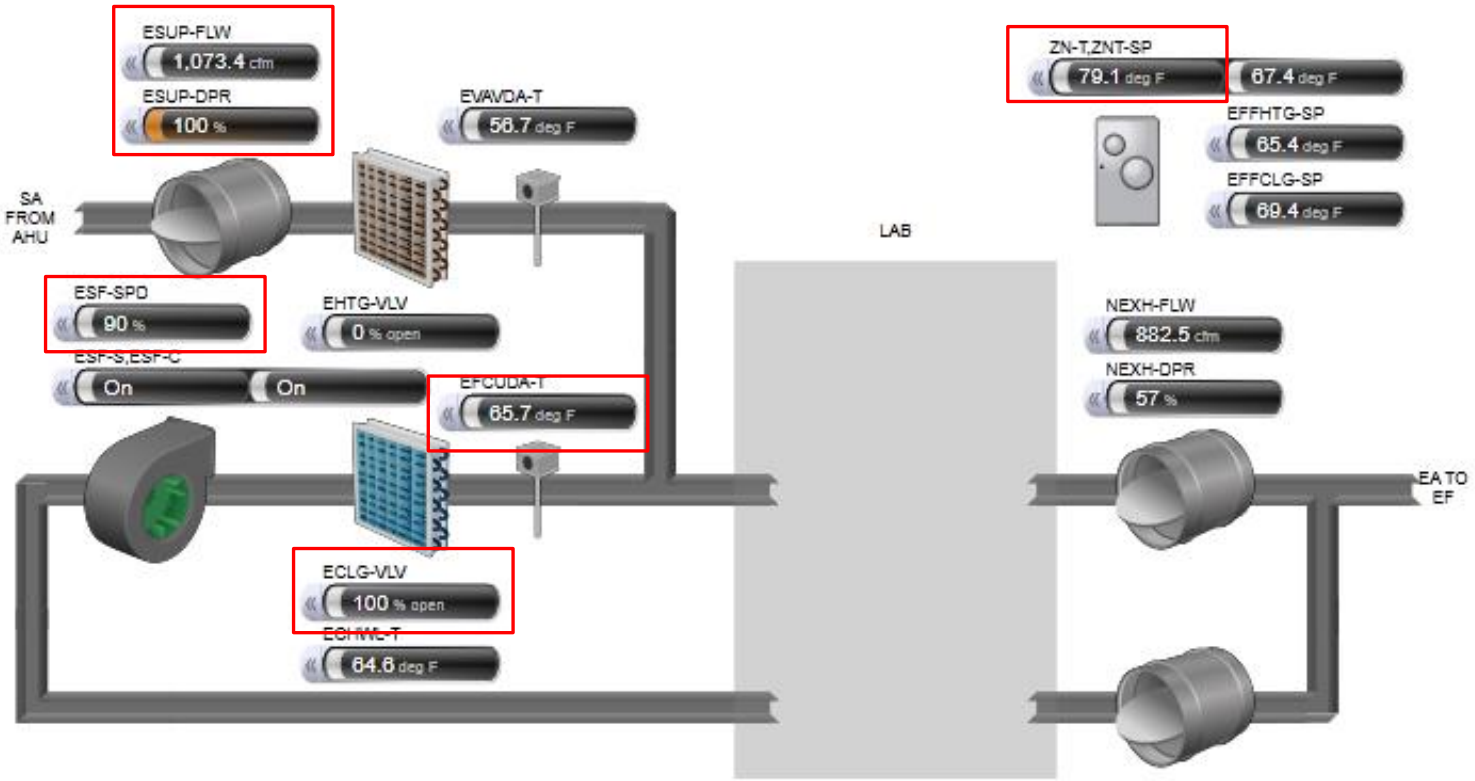


Unexpected Results of TAB

- TAB measured exhaust from 4 headered fans
  - 1 fan was significantly lower
  - More investigation → debris caught in bird screen blocked fan

Unexpected Results of TAB

- Receiving warm complaints in plant growth lab



- BAS investigation showed FCU's were at maximum capacity
- TAB measured airflow through FCU → 25% of design airflow
- Soil particles were clogging the fan filters

Economics 101

For a 150,000 ft² lab building → Proper TAB:

Energy Savings

- Baseline energy costs = $1,250,000 /year
- Assumed savings w/ improved TAB = 10%
- Annual Savings: $125,000
- 10-year savings w/ 2.5% degradation:
  - **$937,500**

Maintenance Savings

- Baseline maintenance= $250,000 /year
- Assumed savings w/ improved TAB = 10%
- Annual Savings: $25,000
- 10-year savings: **$250,000**

Total 10-year Cost Savings:

- $937,500 + $250,000 = **$1,187,500**

Incremental Cost of TAB

- Base TAB = $300,000 ($2.00 /ft2)
- Proposed TAB = $450,000 ($3.00 /ft2)

Project Payback

- Initial incremental cost: $150,000
- $300,000 /year savings / $150,000 cost
  - **~2-year payback**
- Gross benefit 10-year life w/ RCx/re-TAB at 5 years
  - $1,187,500 - $150,000 - $250,000
  - **$787,500 in savings**

Questions?

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