UC Davis Health Campus Education Building Retrocommissioning

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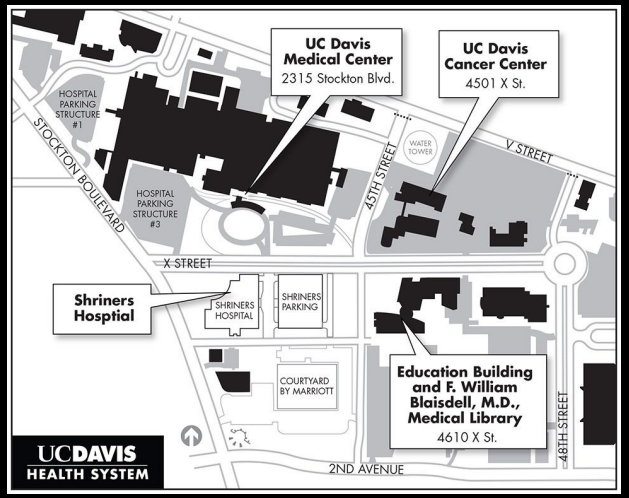
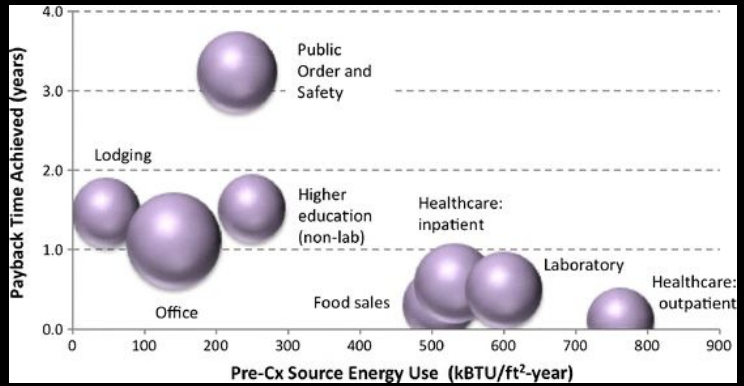
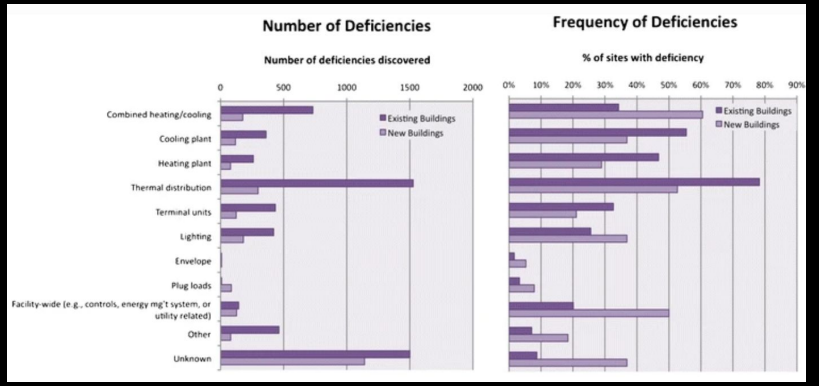
BACKGROUND

- UC Davis Health - critical facilities
- Education Building - Low-hanging fruit
- Energy Savings
- Retrocommissioning







PURPOSE

Control Programming

+

Equipment Failure

+

Schedule

=

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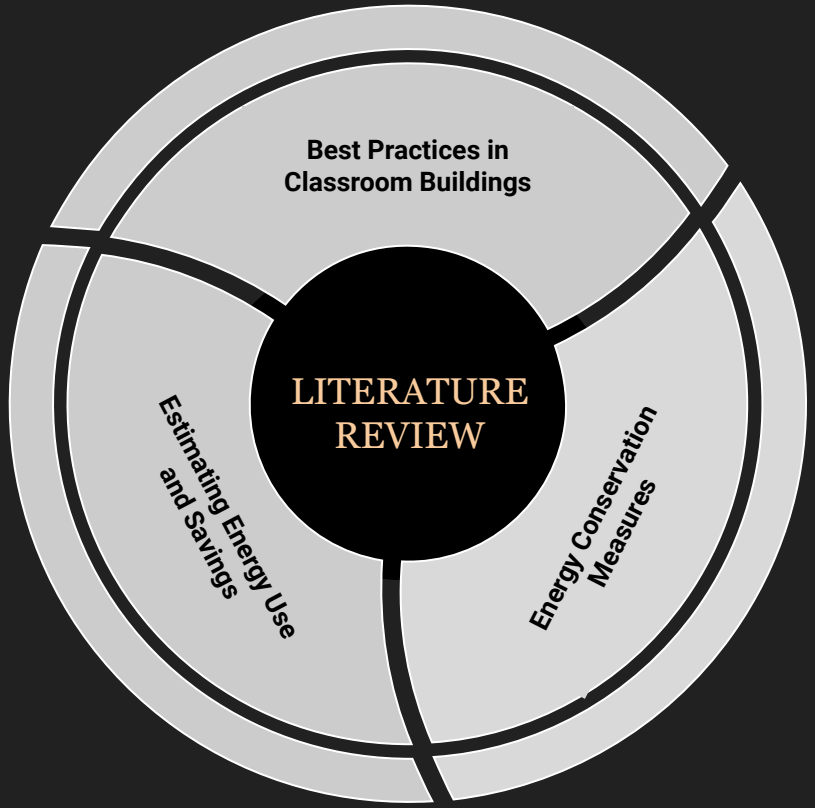
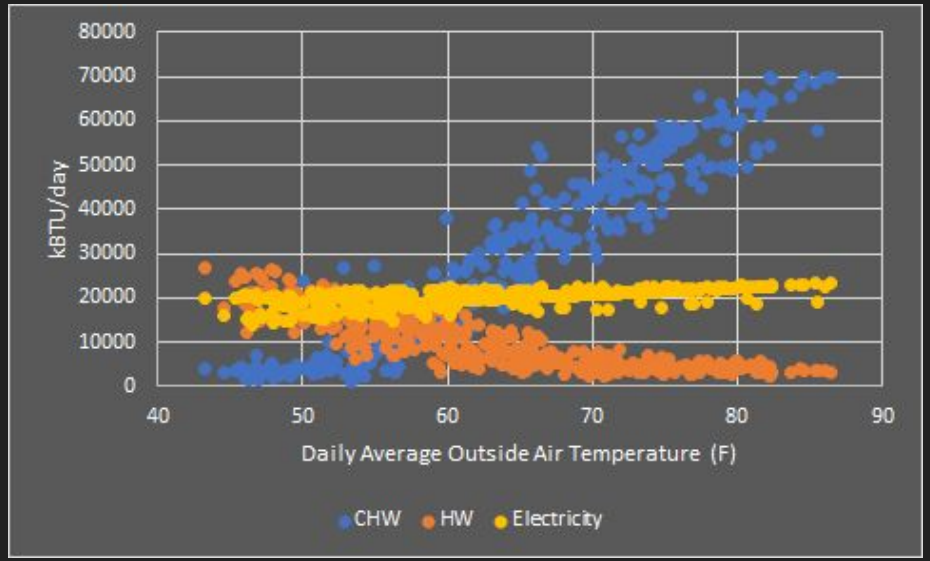

Best Practices in Classroom Buildings
LITERATURE REVIEW
Estimating Energy Use and Savings
Energy Conservation Measures

ENERGY PROFILE

- Baseline period: 4/3/2019-4/2/2020
- Electricity Data
  - Some missing data; created linear model (OAT + Weekday vs. Electricity) to fill in missing data
- Hot Water Data
  - Had flow, supply, and return temperature (necessary to calculate kBTU)
- Chilled Water Data
  - Missing flow data; had to sum up all equipment CHW flows to estimate total



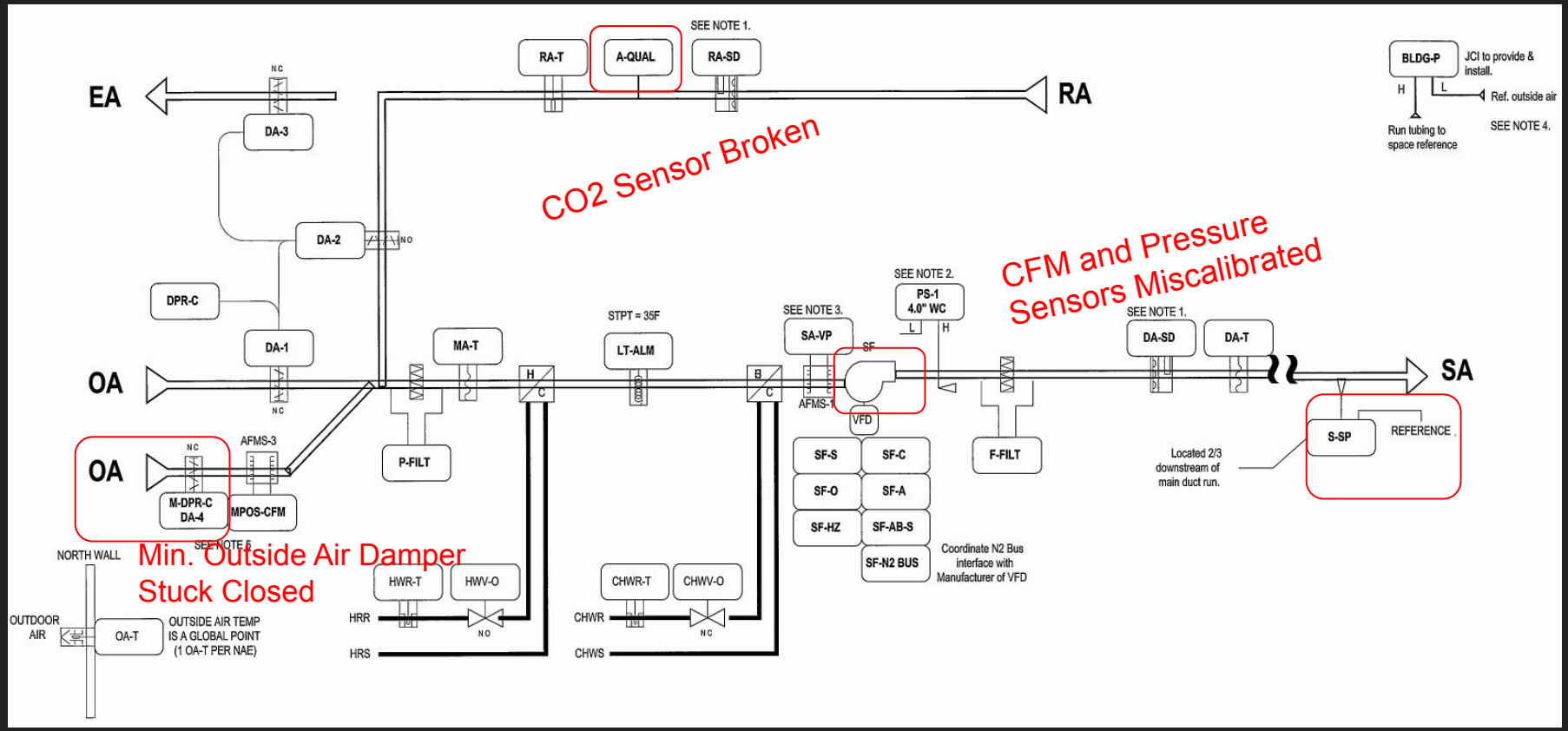
ENERGY PROFILE

- Average UC Davis classroom building EUI = 83 kBTU/sf

	Baseline			
	CHW	HW	Electricity	Total
Energy (MMBTU/year)	10,628	3,540	7,361	**21,529**
Cost ($/year)	$58,451	$26,553	$172,579	**$257,584**
EUI (kBTU/sf)				**119**
MTCO2e	63.8	187.6	194.2	**445.6**

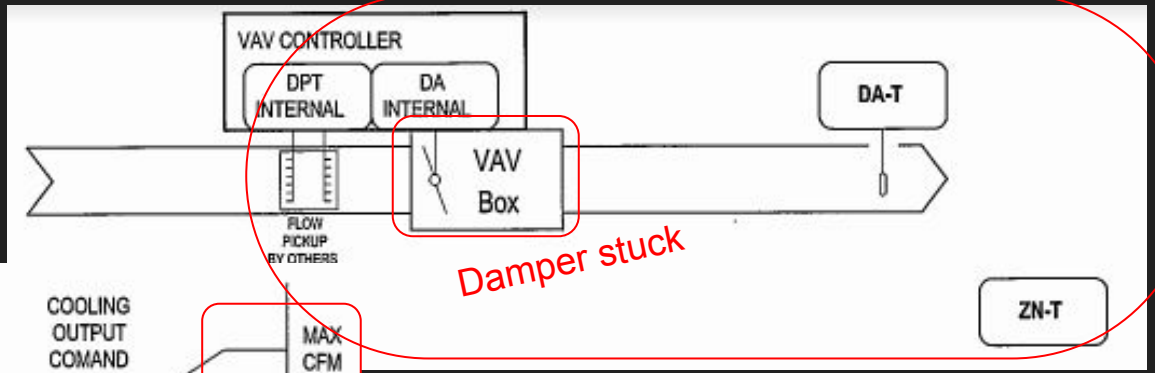
EQUIPMENT ANALYSIS - AHU

- Most common AHU issues



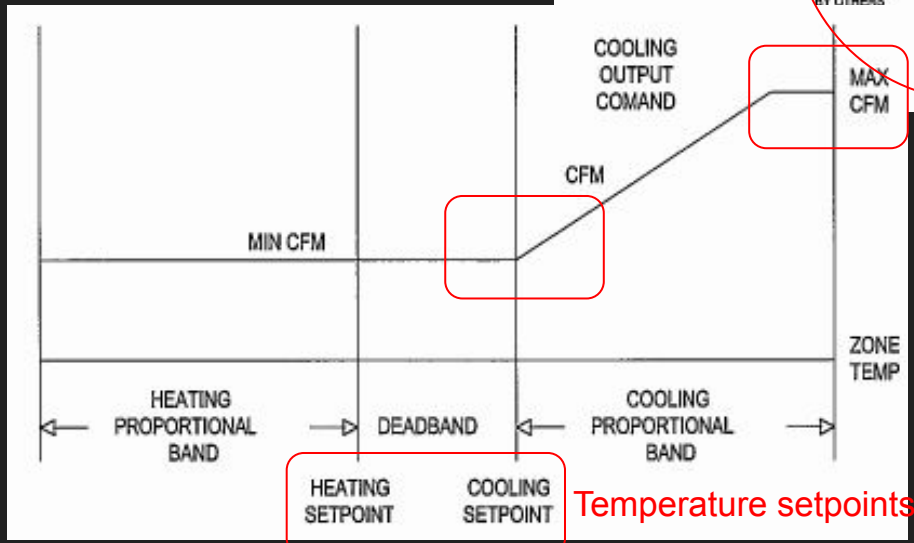
EQUIPMENT ANALYSIS - VAVs

- Most common VAV issues



Datapoints Offline

Damper stuck



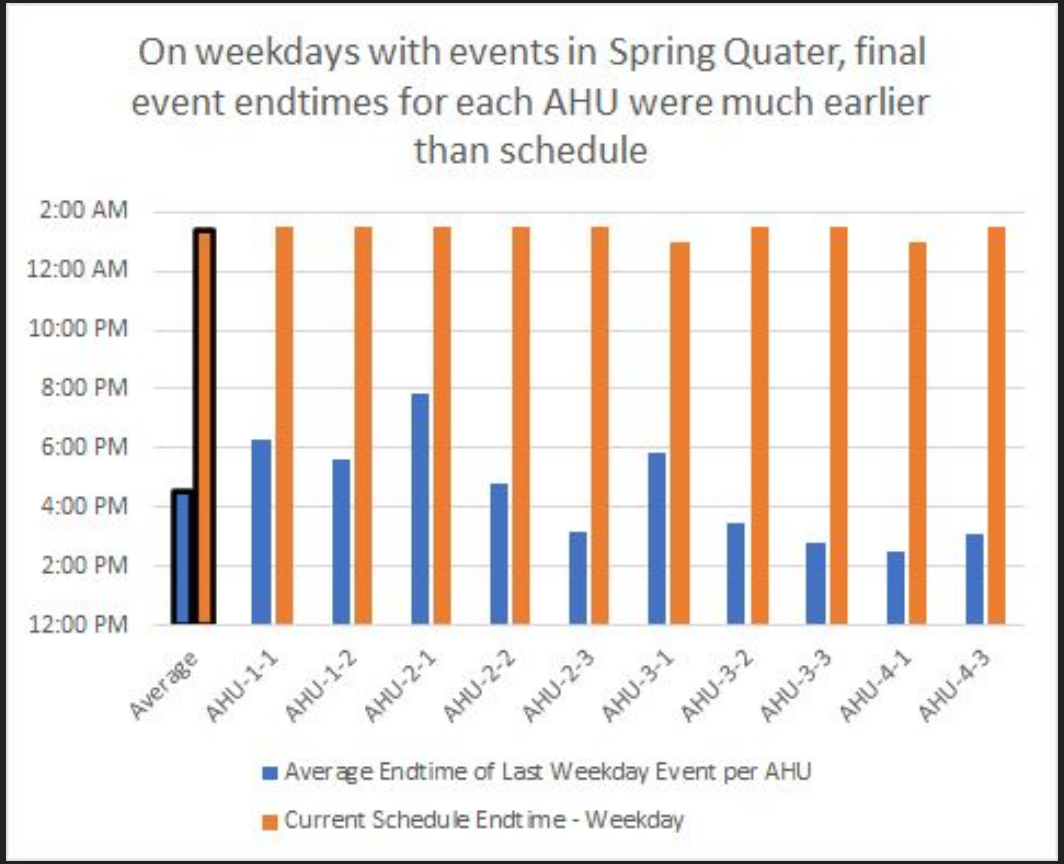
Minimum and maximum cooling flow setpoints overridden

Temperature setpoints too high or low

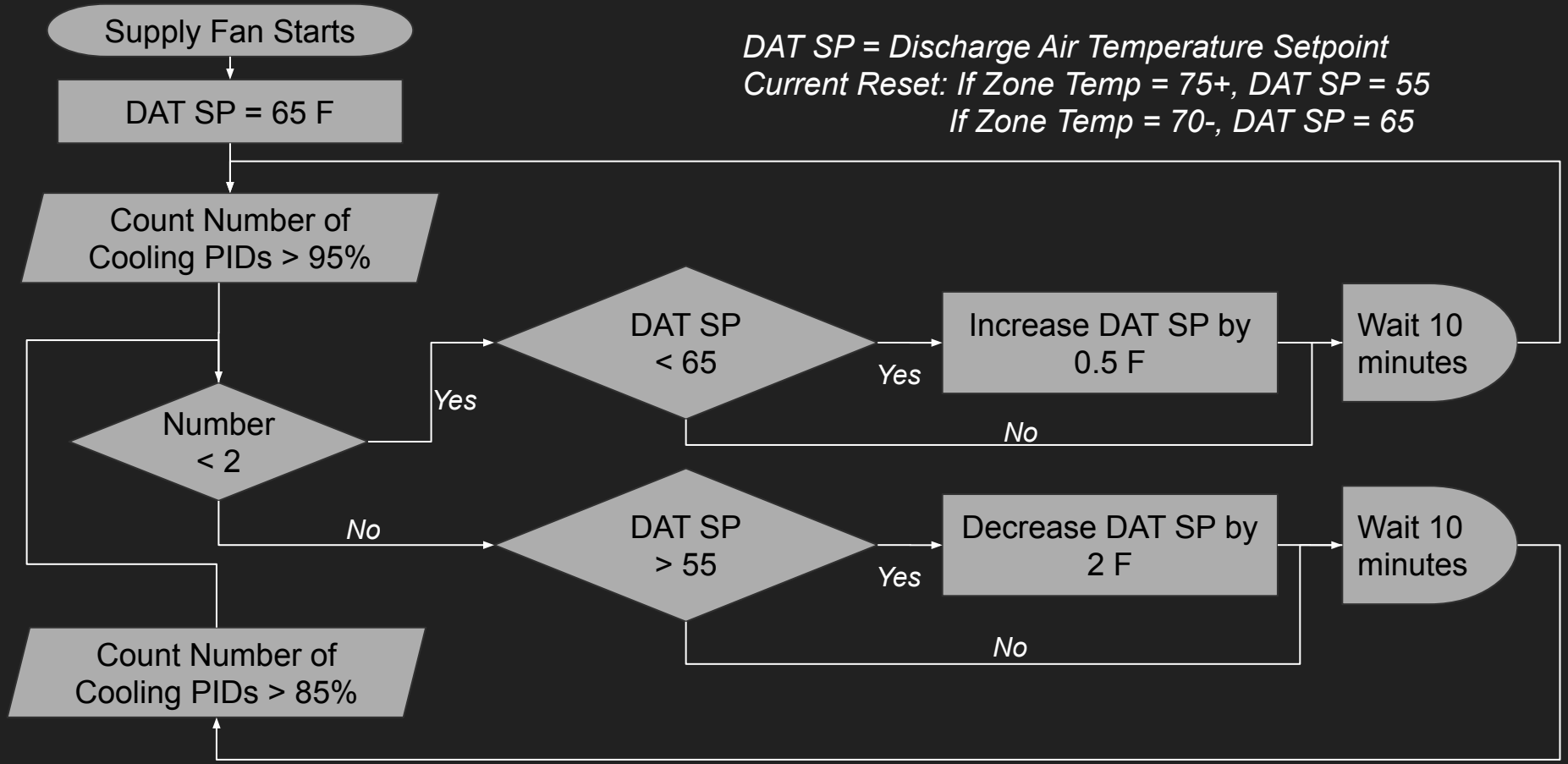
SAVINGS METHODOLOGY - BinSim Tool

OAT	Hrs/yr	RAT	SAT	MAT	% OSA	Total building load	Total AHU airflow	Average zone DAT	AHU cooling energy	AHU heating	Zone reheat	Fan speed	Supply Fan Power	Return Fan Power	Fan power	Fan energy
ºF		ºF	ºF	ºF		Btu/h	cfm	ºF	kBtu	kBtu	kBtu	%	kW	kW	kW	kWh
108	3	74.5	55.0	79.5	15%	201,586	9,572	55.0	735	0	0	68%	6.4	2.4	8.8	26
106	3	74.5	55.0	79.2	15%	201,586	9,572	55.0	726	0	0	68%	6.4	2.4	8.8	26
104	1	74.5	55.0	78.9	15%	201,586	9,572	55.0	346	0	0	68%	6.4	2.4	8.8	12
102	9	74.5	55.0	78.6	15%	201,586	9,572	55.0	2,100	0	0	68%	6.4	2.4	8.8	76
100	23	74.5	55.0	78.3	15%	193,008	9,165	55.0	5,287	0	0	65%	5.8	2.2	8.0	182
98	25	74.5	55.0	78.0	15%	184,430	8,757	55.0	5,444	0	0	62%	5.2	1.9	7.2	179
96	55	74.5	55.0	77.7	15%	175,852	8,350	55.0	11,271	0	0	59%	4.7	1.7	6.4	353
94	58	74.5	55.0	77.4	15%	167,274	7,943	55.0	11,138	0	0	56%	4.2	1.6	5.7	332
92	71	74.5	55.0	77.1	15%	158,696	7,535	55.0	12,856	0	0	53%	3.7	1.4	5.1	365
90	81	74.5	55.0	76.8	15%	150,117	7,128	55.0	13,559	0	0	51%	3.3	1.2	4.6	368
88	98	74.5	55.0	76.5	15%	141,539	6,721	55.0	15,296	0	0	48%	3.0	1.1	4.1	398
86	49	74.5	55.0	76.2	15%	132,961	6,313	55.0	7,034	0	0	45%	2.6	1.0	3.6	177
84	114	74.5	55.0	75.9	15%	124,383	5,906	55.0	15,162	0	0	42%	2.4	0.9	3.3	371
82	98	74.5	55.0	75.6	15%	115,805	5,499	55.0	11,991	0	0	39%	2.2	0.8	3.0	290
80	127	74.5	55.0	75.3	15%	107,227	5,091	55.0	14,205	0	0	36%	2.0	0.7	2.7	346
78	162	74.5	56.3	75.0	15%	98,649	5,028	56.3	16,453	0	0	36%	2.0	0.7	2.7	436
76	121	74.5	57.7	74.7	15%	90,070	4,954	57.7	11,017	0	0	35%	1.9	0.7	2.7	320
74	116	74.5	59.0	74.0	100%	81,492	4,868	59.0	9,125	0	0	35%	1.9	0.7	2.6	303
72	102	74.5	60.3	72.0	100%	72,914	4,766	60.3	6,131	0	0	34%	1.9	0.7	2.6	263
70	121	74.5	61.7	70.0	100%	64,336	4,642	61.7	5,042	0	0	33%	1.8	0.7	2.5	305
68	54	74.5	63.0	68.0	100%	55,758	4,489	63.0	1,299	0	0	32%	1.8	0.7	2.5	133
66	134	74.5	64.3	66.0	100%	47,180	4,297	64.3	1,033	0	0	30%	1.8	0.7	2.4	325
64	151	74.5	65.0	65.0	90%	38,602	3,762	65.0	0	0	0	27%	1.7	0.6	2.4	359
62	161	74.5	65.0	65.0	76%	30,023	3,503	66.6	0	0	954	25%	1.7	0.6	2.4	384
60	241	74.5	65.0	65.0	66%	21,445	3,503	68.8	0	0	3,488	25%	1.7	0.6	2.4	573
58	207	74.5	65.0	65.0	58%	12,867	3,503	71.1	0	0	4,778	25%	1.7	0.6	2.4	493
56	183	74.5	65.0	65.0	51%	4,289	3,503	73.4	0	0	5,788	25%	1.7	0.6	2.4	436
54	204	70.5	65.0	65.0	33%	-4,289	3,503	71.6	0	0	5,127	25%	1.7	0.6	2.4	486
52	165	70.5	65.0	65.0	30%	-12,867	3,503	73.9	0	0	5,556	25%	1.7	0.6	2.4	393
50	112	70.5	65.0	65.0	27%	-21,445	3,503	76.2	0	0	4,736	25%	1.7	0.6	2.4	267
48	144	70.5	65.0	65.0	24%	-30,023	3,503	78.4	0	0	7,299	25%	1.7	0.6	2.4	342
46	116	70.5	65.0	65.0	22%	-38,602	3,503	80.7	0	0	6,873	25%	1.7	0.6	2.4	275
44	94	70.5	65.0	65.0	21%	-47,180	3,503	83.0	0	0	6,411	25%	1.7	0.6	2.4	225
42	81	70.5	65.0	65.0	19%	-55,758	3,503	85.2	0	0	6,232	25%	1.7	0.6	2.4	194
40	35	70.5	65.0	65.0	18%	-64,336	3,503	87.5	0	0	2,980	25%	1.7	0.6	2.4	83
38	39	70.5	65.0	65.0	17%	-72,914	3,503	89.8	0	0	3,618	25%	1.7	0.6	2.4	92
36	30	70.5	65.0	65.0	16%	-81,492	3,503	92.0	0	0	3,069	25%	1.7	0.6	2.4	71
34	34	70.5	65.0	65.0	15%	-90,070	3,503	94.3	0	0	3,803	25%	1.7	0.6	2.4	82
32	19	70.5	65.0	64.7	15%	-98,649	3,503	96.6	0	19	2,222	25%	1.7	0.6	2.4	44
30	10	70.5	65.0	64.4	15%	-107,227	3,503	98.8	0	22	1,280	25%	1.7	0.6	2.4	24
28	1	70.5	65.0	64.1	15%	-115,805	3,503	101.1	0	5	191	25%	1.7	0.6	2.4	3
TOTALS	3650								177,252	46	74,406					10,412

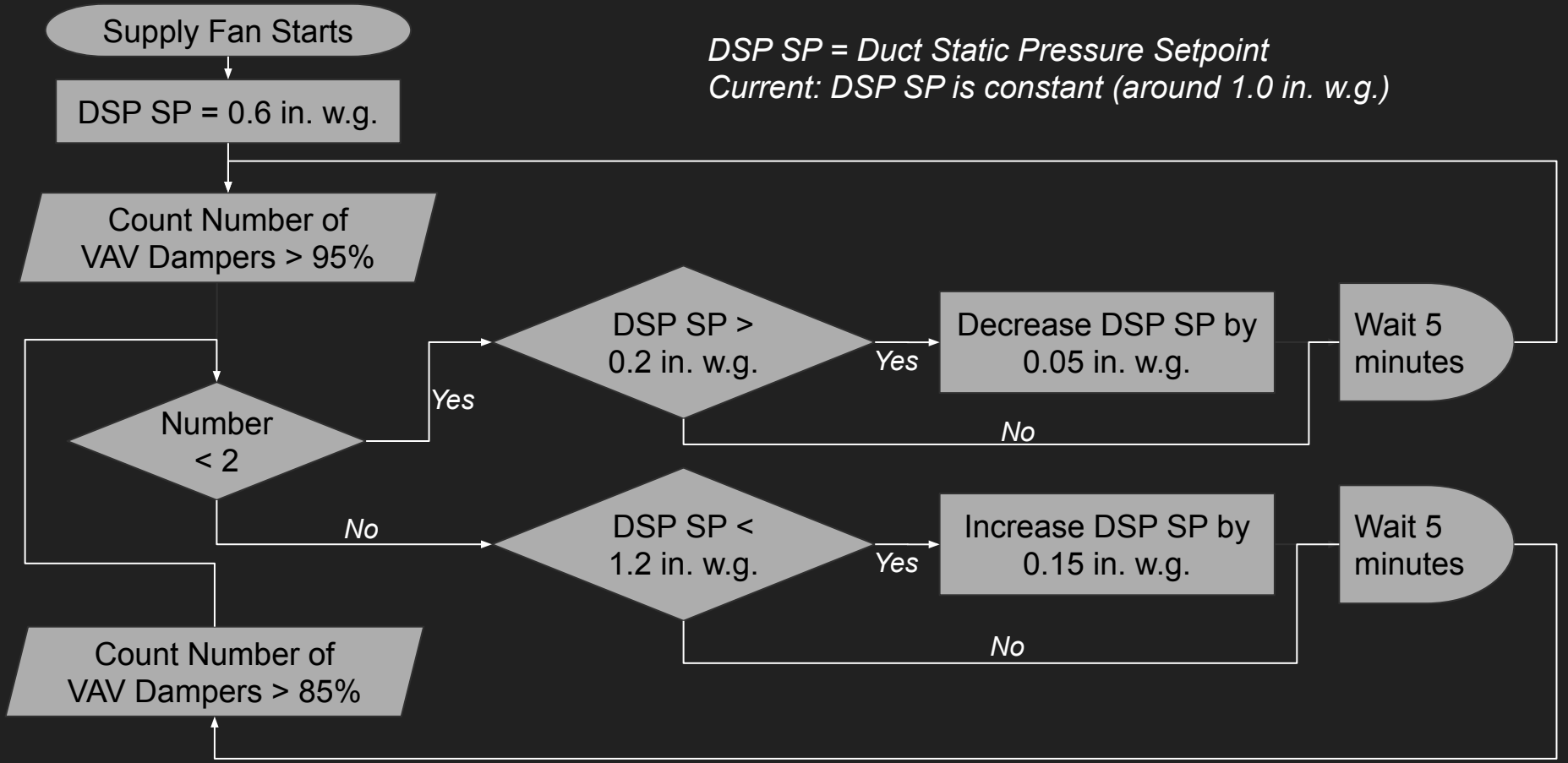
SCHEDULING - AHU



DISCHARGE AIR TEMPERATURE RESET



DUCT STATIC PRESSURE RESET



FAN COIL & AIR CONDITIONING UNIT SETPOINTS

- Based on a linear model created for temperature vs. unit runtime, **each degree that the setpoint is increased** results in a **decrease of ~200 hours of annual run time**

- We recommend raising the setpoints for all units to at least **78 degrees**
  - ASHRAE 2015 provides a maximum server room temperature recommendation of 80 degrees for critical equipment, with higher allowable levels for most equipment - savings shown below

	Current Estimated Setpoint	Suggested Setpoint	Current Run Hours/Year	Estimated New Run Hours/Year	% Reduction
FC11	72	78	3,154	1,840	42%
FC12	72	78	8,760	7,446	15%
FC21	69	78	8,760	6,920	21%
FC22	74	78	8,760	7,972	9%
FC23	67	78	5,694	3,416	39%
FC41	72	78	0	438	0%
FC42	75	78	3,592	2,978	17%
AC11	73	78	788	438	46%
AC21	60	78	8,760	4,993	43%
AC22	59	78	4,555	526	88%
AC31	68	78	3,767	1,752	53%
AC32	71	78	3,416	2,015	40%
AC41	68	78	3,154	1,226	63%
AC42	63	78	8,760	5,606	36%

RESULTS - ALL SPECIFIC RECOMMENDATIONS

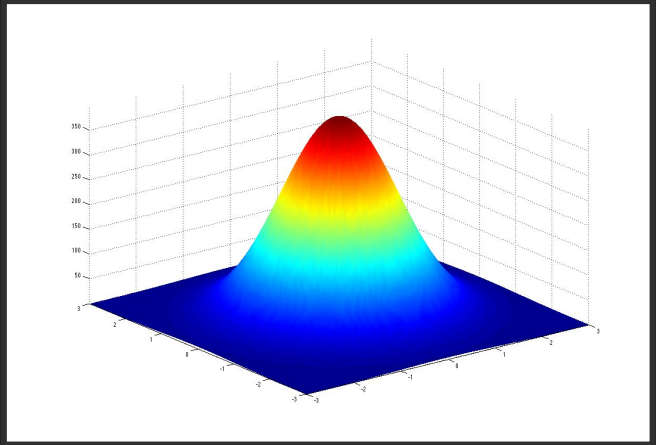
Payback for Recommendations								
	Measure	Hours	Cost/ Hour	Labor Cost	Equipment/ Capital Cost	Ongoing Cost	Total Annual Savings	Payback (Years)
1	Equipment Issues	20	$125	$2,500	$2,500	$0	$0	NA
2	Scheduling	10	$125	$1,250	$0	$300	$19,037	0.3
3	DAT Reset	30	$125	$3,750	$0	$0	$3,269	1.1
4	DSP Reset	50	$125	$6,250	$0	$0	$3,302	1.9
5	FCU/ACU Setpoints	5	$125	$625	$0	$0	$2,203	0.3
	All	**115**	**$125**	**$14,375**	**$2,500**	**$300**	**$27,811**	0.6

RESULTS- OVERALL SAVINGS

Potential Annual Savings				
	CHW	HW	Electricity	Total Annual Savings
Energy (MMBTU/year)	794	1,668	466	**2,928**
Cost ($/year)	$4,365	$12,513	$10,932	**$27,811**
MTCO2e	4.8	88.4	12.3	**105.5**

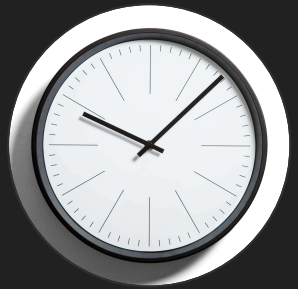
Pre vs. Post			
	Baseline	Post	Percent Decrease
Energy (MMBTU/year)	21,529	18,610	**14%**
Cost ($/year)	$257,584	$230,013	**11%**
EUI (kBTU/sf)	119	103	**14%**
MTCO2e	445.6	340.3	**24%**

LONG-TERM RECOMMENDATIONS



ONGOING MEASUREMENT & VERIFICATION

MAINTENANCE PLAN



SCHEDULING

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