



AMCA International

Optimizing an Existing Air System for Performance and Energy Efficiency

Steve Wiggins

Director of Commissioning, Newcomb & Boyd, Atlanta, Georgia

swiggins@newcomb-boyd.com

Air System Engineering & Technology (ASET) Conference-US

San Antonio, TX • Hyatt Regency San Antonio Riverwalk • March 6 - 7, 2018

Professional Development Hours (PDH) Certificates

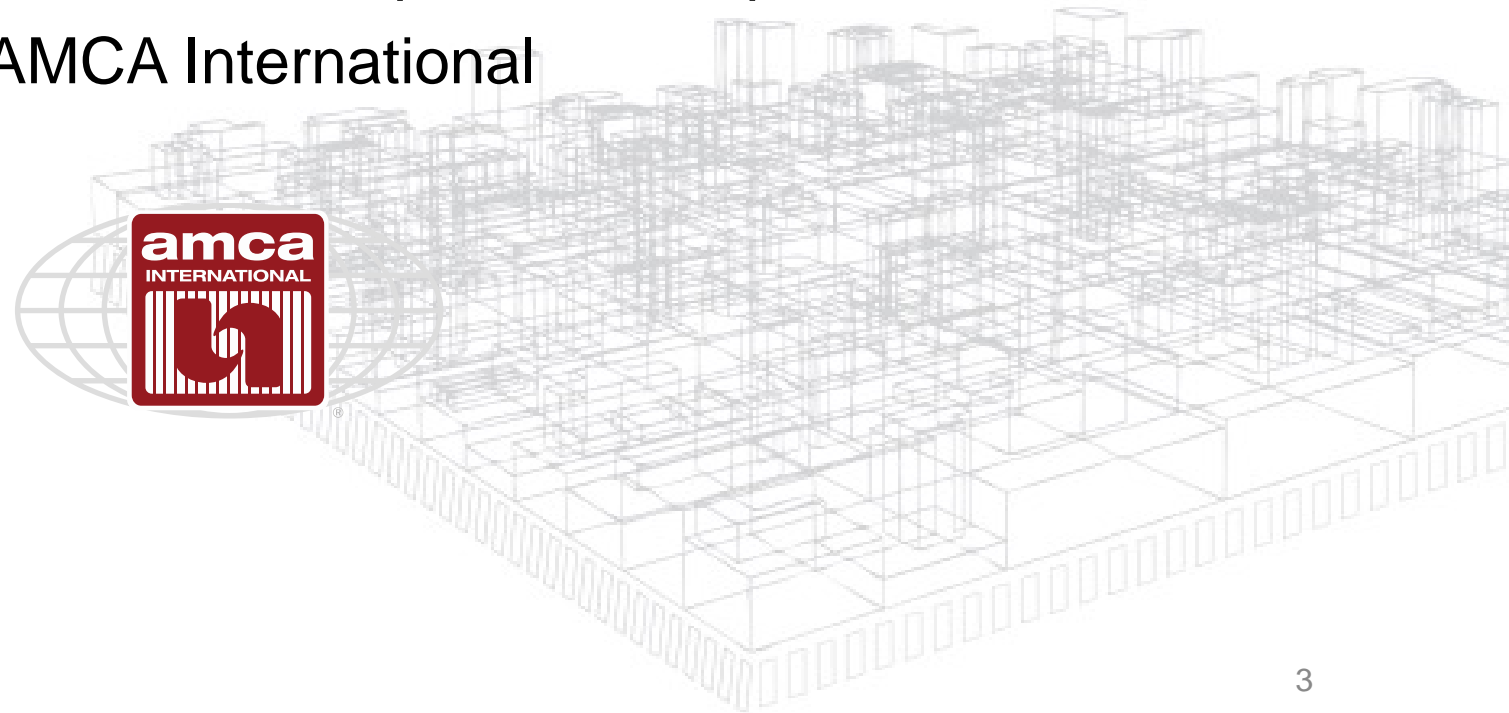
The Air Movement and Control Association International (AMCA), has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to the RCEP. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by NCEES or RCEP.



Copyright Materials

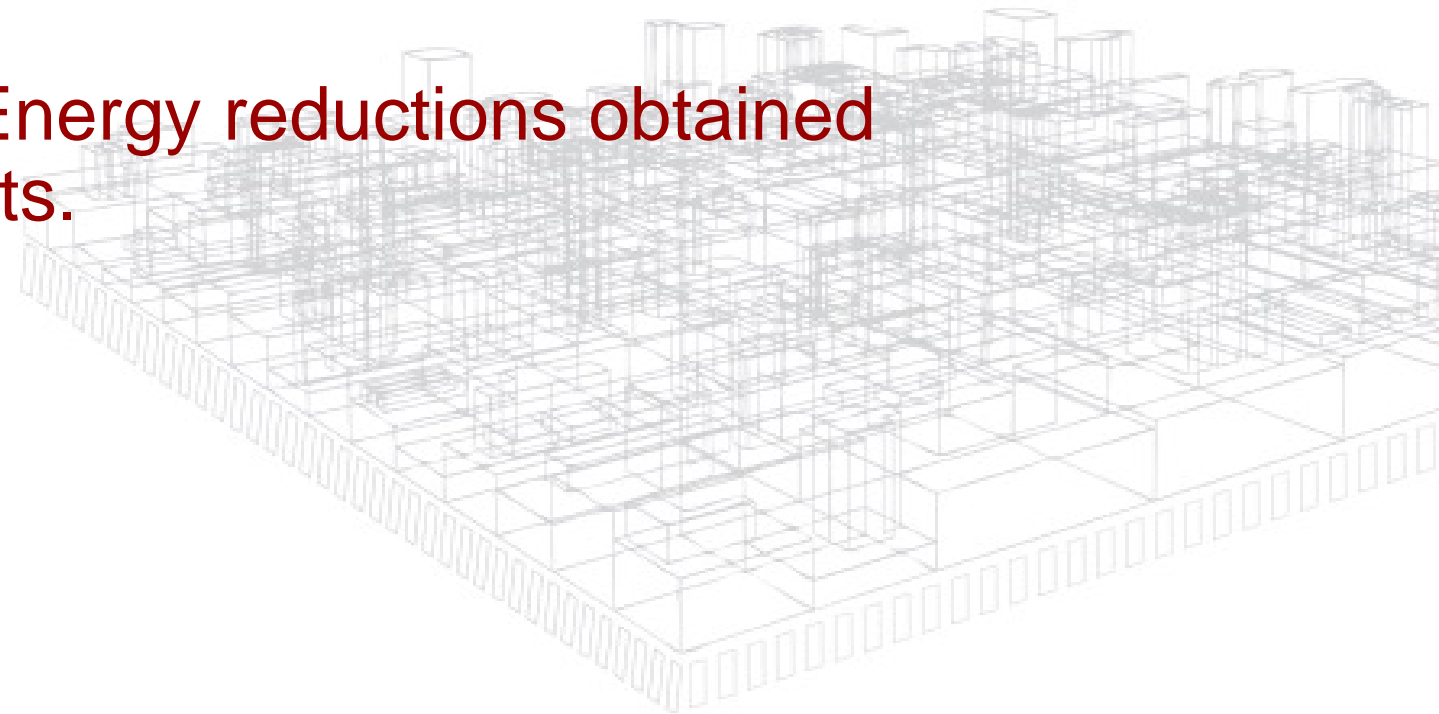
This educational activity is protected by U.S. and International copyright laws. Reproduction, distribution, display, and use of the educational activity without written permission of the presenter is prohibited.

© AMCA International



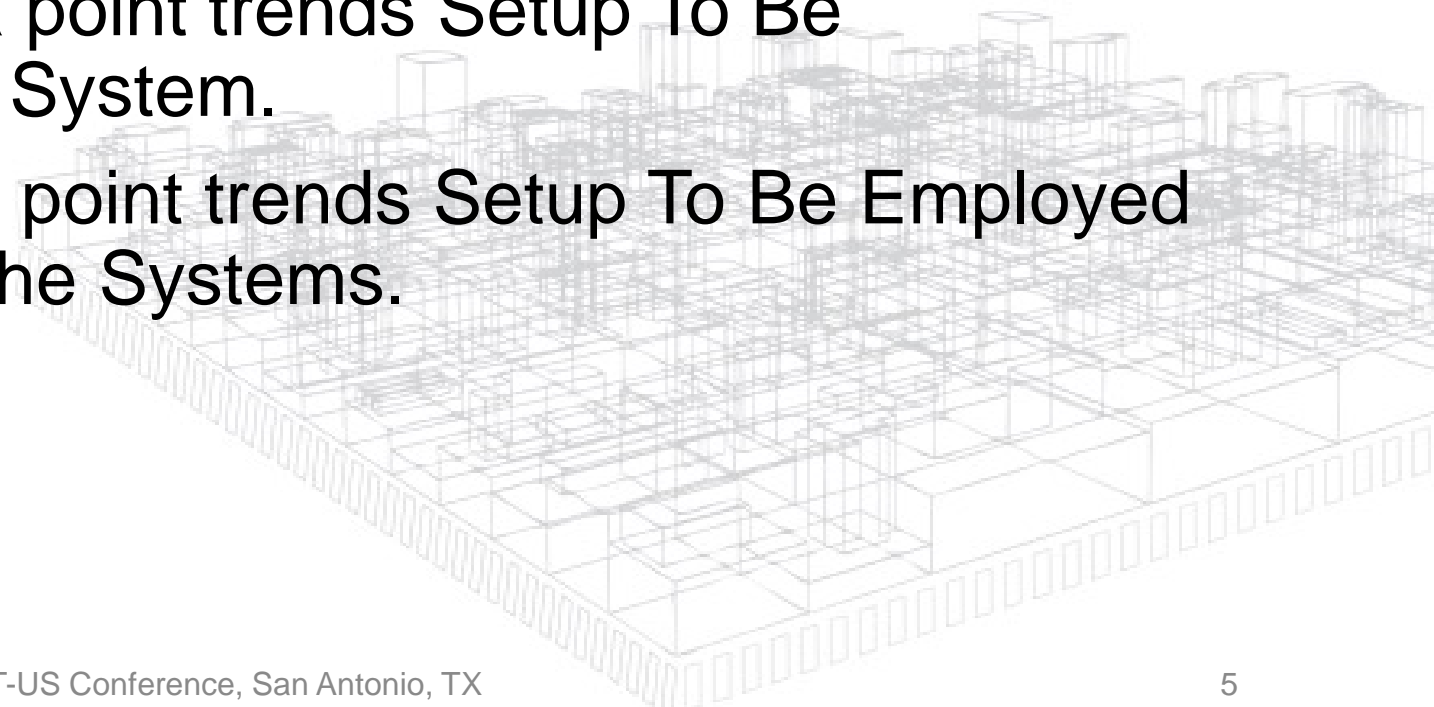
Learning Objectives

- What is Air Handling Unit Optimization?
- How to Optimize AHU systems and verify proper operation.
- How to document Energy reductions obtained during these projects.



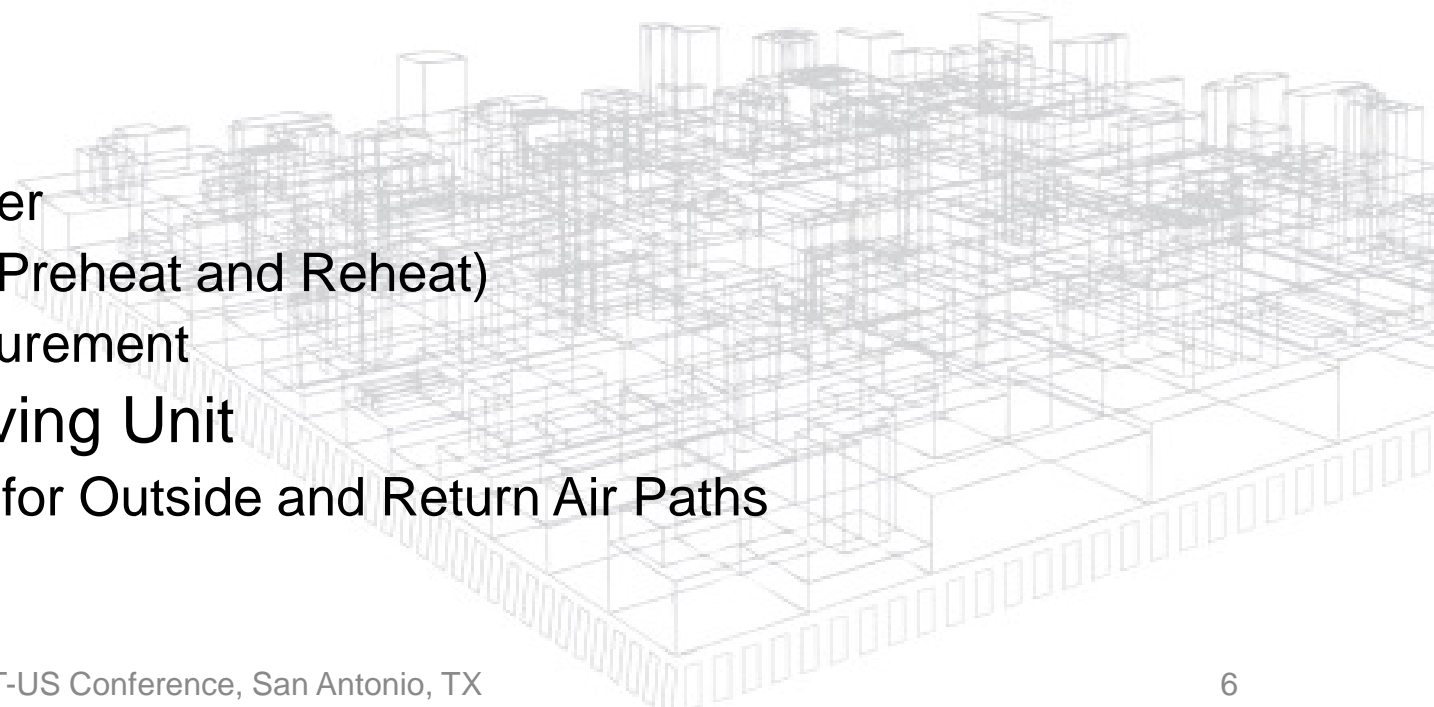
Definitions

- **Optimization** - Adjust And Control Each System To Consume The Least Energy Possible To Meet The Owner's Project Requirements (OPR) or Current Facility Requirements (CFR).
- **Long Term Trends** – Data point trends Setup To Be Permanently Active In The System.
- **Short Term Trends** - Data point trends Setup To Be Employed During The Validation Of The Systems.

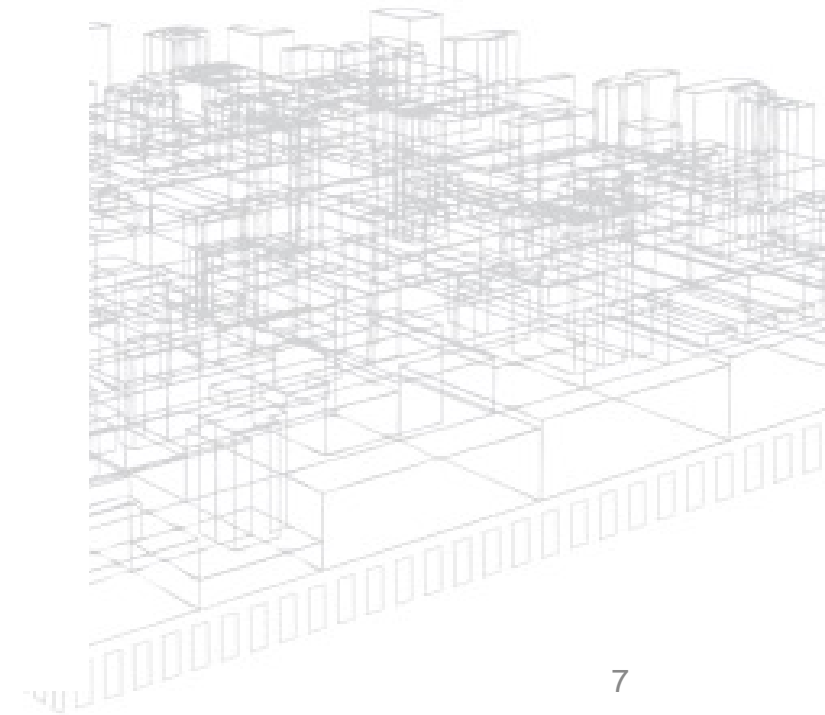


Establishing System Level Baselines

- Performance Elements
 - Electrical Energy Consumed
 - If Submetering Exists
 - BAS/Drive Info if incorporated
 - Independent Datalogging
 - Coil Energy
 - Entering/Leaving Chilled Water
 - Entering/Leaving Hot Water (Preheat and Reheat)
 - If Electric Heat Current Measurement
 - All Airstreams Entering/Leaving Unit
 - Sensible Temps Only Except for Outside and Return Air Paths



Establishing System Level Baselines

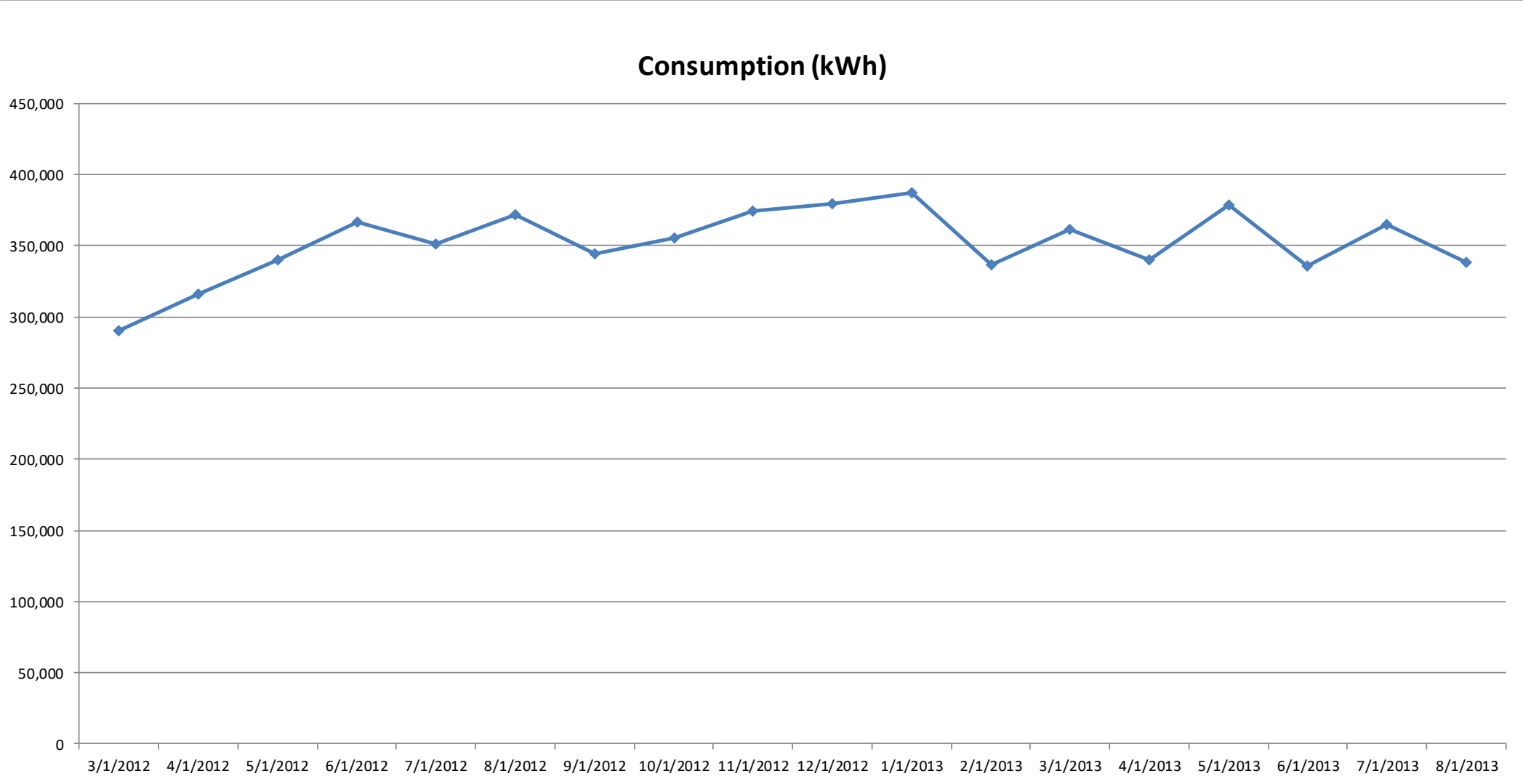


Establishing System Level Baselines

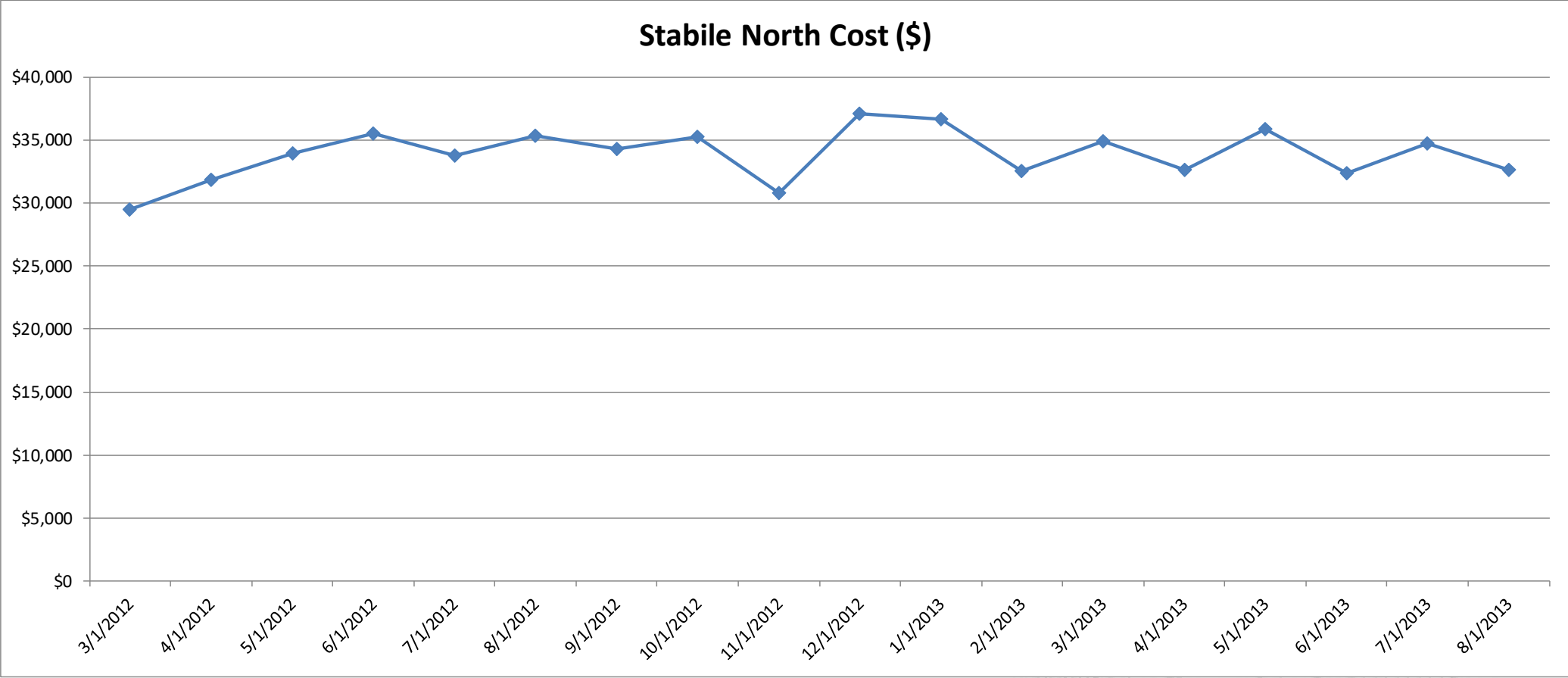


- Develop Current Facilities Requirements Document
 - Kickoff Meeting and Interviews With Key Stakeholders
 - Identify Today's the Facility Systems
 - Identify Areas Of Concern
 - Develop Logging Plan (Energy Consumption and Environmental Conditions)
 - Launch Loggers "Let'em Cook!!"
 - Obtain Historical Energy Data

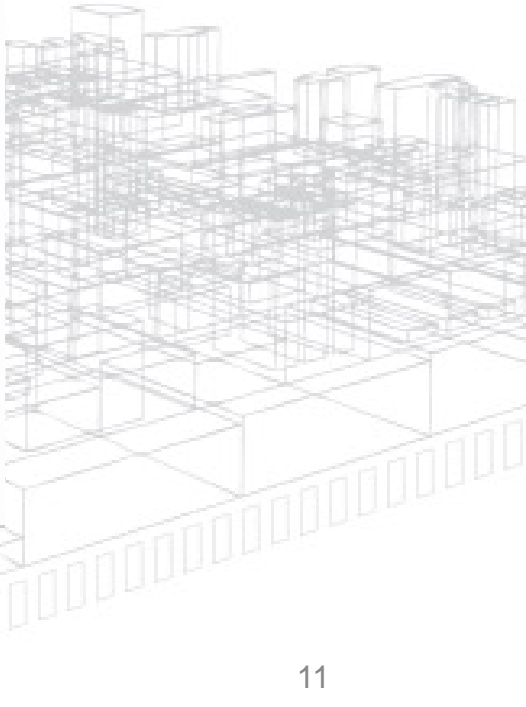
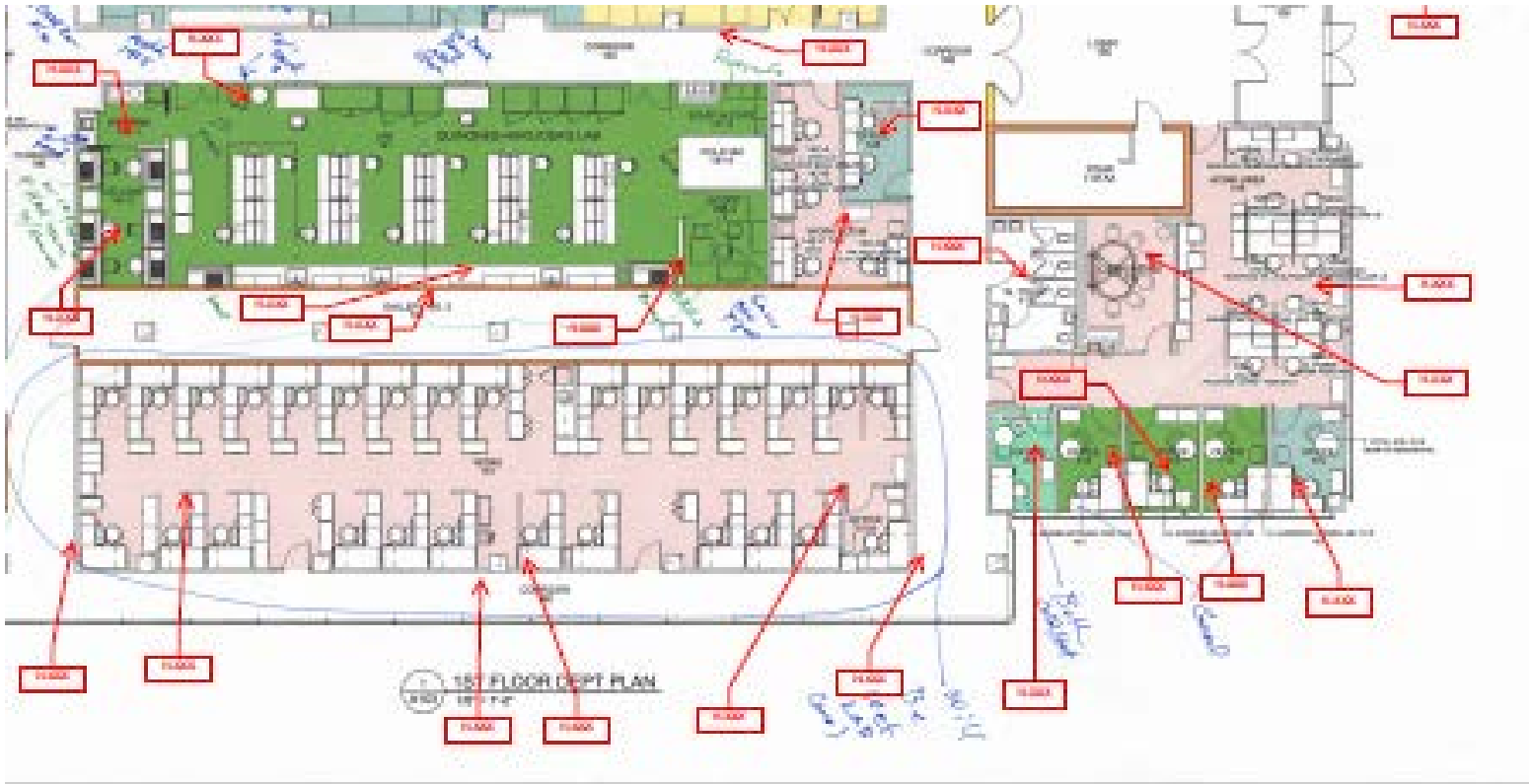
Establishing System Level Baselines



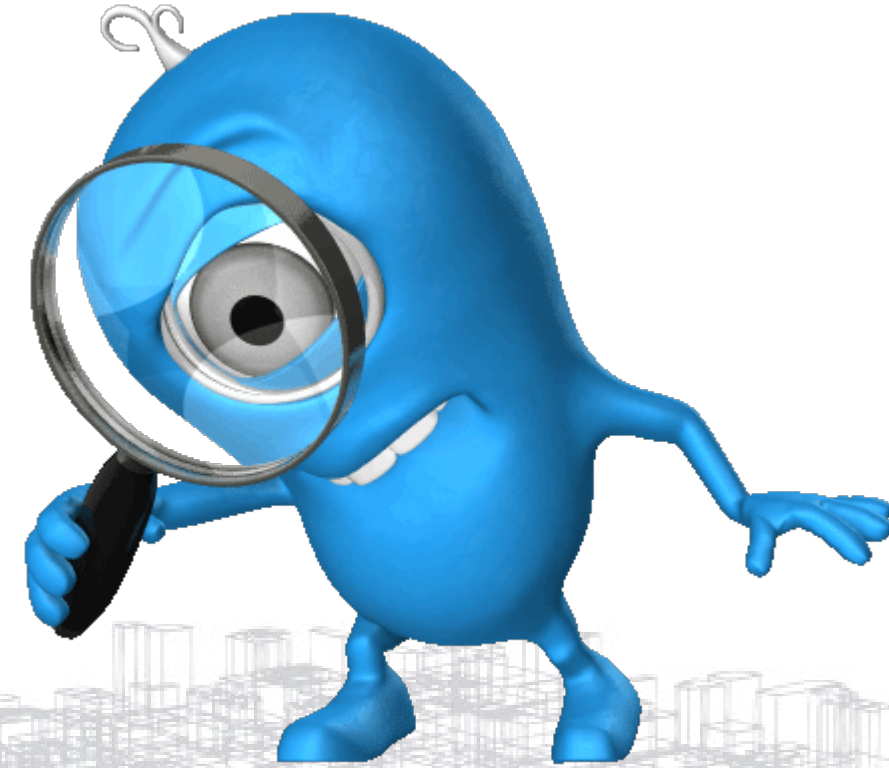
Establishing System Level Baselines



Establishing System Level Baselines



System As Found



Plot Title: AHU-1-5

#	Date	Time	Curr (Amps)	CHWS	CHWR	SA Temp	MA Temp	RA Temp
1	9/25/2012	11:00:00	22.857	46.391	61.761	50.709	72.523	70.072
2	9/25/2012	11:05:00	24.322	46.301	61.677	50.664	72.523	70.115
3	9/25/2012	11:10:00	23.297	46.301	61.72	50.664	72.437	70.072
4	9/25/2012	11:15:00	21.538	46.301	61.977	50.621	72.567	70.158
5	9/25/2012	11:20:00	26.081	46.301	61.977	50.621	72.567	70.243
6	9/25/2012	11:25:00	24.615	46.301	62.019	50.621	72.48	70.201
7	9/25/2012	11:30:00	24.322	46.301	61.977	50.621	72.48	70.158
8	9/25/2012	11:35:00	23.883	46.301	61.848	50.621	72.394	70.115
9	9/25/2012	11:40:00	24.615	46.301	61.633	50.621	72.48	70.158
10	9/25/2012	11:45:00	24.762	46.301	61.72	50.621	72.437	70.115
11	9/25/2012	11:50:00	23.443	46.301	61.677	50.621	72.394	70.029
12	9/25/2012	11:55:00	24.615	46.256	61.677	50.576	72.394	70.029
13	9/25/2012	12:00:00	24.176	46.211	61.891	50.576	72.351	69.901
14	9/25/2012	12:05:00	24.615	46.211	61.934	50.576	72.437	69.901
15	9/25/2012	12:10:00	25.055	46.256	62.148	50.621	72.394	69.901
16	9/25/2012	12:15:00	24.176	46.256	62.019	50.621	72.351	69.901
17	9/25/2012	12:20:00	24.469	46.301	62.019	50.621	72.48	69.901
18	9/25/2012	12:25:00	24.322	46.301	61.934	50.621	72.264	69.858
19	9/25/2012	12:30:00	24.322	46.211	61.891	50.533	72.264	69.814
20	9/25/2012	12:35:00	23.443	46.211	61.59	50.533	72.221	69.771
21	9/25/2012	12:40:00	24.322	46.211	61.761	50.533	72.264	69.858
22	9/25/2012	12:45:00	24.322	46.211	61.804	50.533	72.264	69.942
23	9/25/2012	12:50:00	24.615	46.166	61.848	50.488	72.221	69.942
24	9/25/2012	12:55:00	25.348	46.166	61.848	50.488	72.307	69.985
25	9/25/2012	13:00:00	24.762	46.166	61.804	50.488	72.221	70.029
26	9/25/2012	13:05:00	24.176	46.211	62.105	50.533	72.221	70.029
27	9/25/2012	13:10:00	24.322	46.166	61.633	50.533	72.136	69.985
28	9/25/2012	13:15:00	23.443	46.211	61.891	50.533	72.093	69.901
29	9/25/2012	13:20:00	24.469	46.166	61.891	50.533	72.136	69.985
30	9/25/2012	13:25:00	24.908	46.166	61.72	50.488	72.136	70.072
31	9/25/2012	13:30:00	23.736	46.166	61.633	50.488	72.178	70.115
32	9/25/2012	13:35:00	26.52	46.121	61.891	50.445	72.093	70.072
33	9/25/2012	13:40:00	24.322	46.076	61.891	50.445	71.964	69.901
34	9/25/2012	13:45:00	24.176	46.121	61.848	50.445	71.92	69.901
35	9/25/2012	13:50:00	24.469	46.121	61.891	50.488	71.964	69.942
36	9/25/2012	13:55:00	24.322	46.121	61.934	50.488	71.92	69.942
37	9/25/2012	14:00:00	23.883	46.166	61.934	50.488	71.964	69.901
38	9/25/2012	14:05:00	26.081	46.121	61.934	50.488	71.791	69.771
39	9/25/2012	14:10:00	25.348	46.076	61.72	50.4	71.791	69.771
40	9/25/2012	14:15:00	24.762	46.121	61.506	50.4	71.748	69.771
41	9/25/2012	14:20:00	25.055	46.076	61.934	50.4	71.791	69.814
42	9/25/2012	14:25:00	25.055	46.076	61.848	50.4	71.92	70.029

Data Analysis

AHU Energy Consumption MASTER - Excel

File Home Insert Page Layout Formulas Data Review View Help BLUEBEAM Acrobat Tell me what you want to do

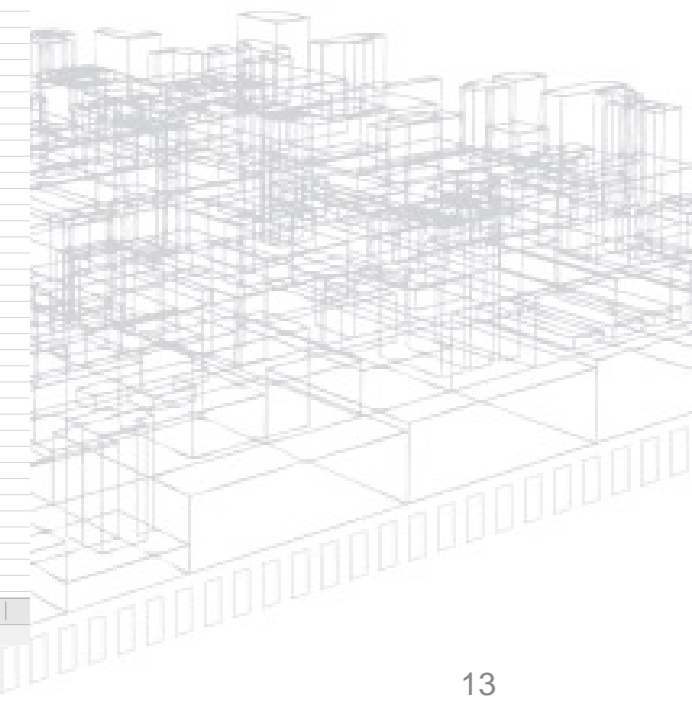
Clipboard Font Alignment Number Styles

AutoSave 139

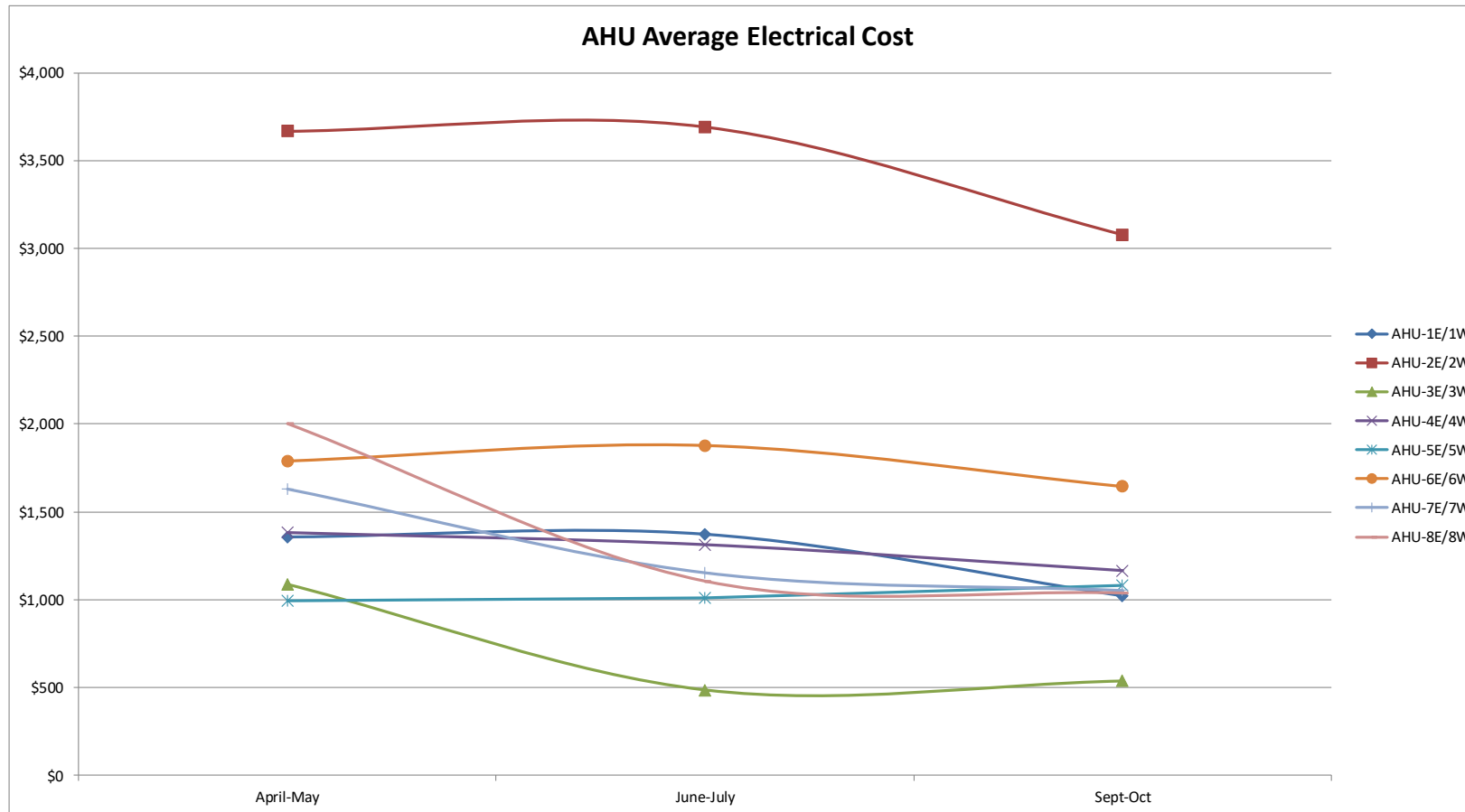
#	Date Time, GMT-04:00	AC Curr, Amps	Temp, °F	Temp, °F	Temp, °F																
CALCULATED MONTHLY TOTALS						AHU ENERGY COST															
1	9/13/2013 0:00	0.098	73.256	59.83	60.647	Fan Power =	1,152	kWh	Electrical cost/month =	\$115											
2	9/13/2013 0:05	0.134	73.256	59.788	60.647	Cooling =	13,087	ton-hours	CHW cost/month =	\$942											
3	9/13/2013 0:10	0.208	73.256	59.788	60.69	Heating =	613	therm-hours	HHW cost/month =	\$398											
4	9/13/2013 0:15	0.183	73.342	59.873	60.733	Cost/month =						\$1,456									
5	9/13/2013 0:20	0.171	73.213	59.873	60.69	INPUT VALUES															
6	9/13/2013 0:25	0.085	73.213	59.873	60.775	Design Airflow	15,431	CFM	9/13/2013 0:00	START											
7	9/13/2013 0:30	0.171	73.256	59.916	60.818	Voltage	460	V	10/20/2013 16:20	END											
8	9/13/2013 0:35	0.134	73.213	59.916	60.861	Fan Power	16.66	HP	37.7	DAYS											
9	9/13/2013 0:40	0.147	73.17	59.959	60.818	Electric Cost	\$0.10	kWh	904.3	HOURS											
10	9/13/2013 0:45	0.11	73.126	59.959	60.861	Chilled Water Cost	\$0.07	ton-hour	54,260	MINUTES											
11	9/13/2013 0:50	0.159	73.083	59.959	60.904	Hot Water Cost	\$0.65	therm-hour	10,852	5-MINUTE BLOCKS											
12	9/13/2013 0:55	0.147	73.083	60.003	60.948	Mixed Air WB	63.0	°F	500	ELEVATION (FT)											
13	9/13/2013 1:00	0.147	73.083	60.003	60.948	Supply Air WB	53.6	°F	8.1	Avg. Reheat delta-T (°F)											
14	9/13/2013 1:05	0.147	73.17	60.003	60.904	SUM TOTALS OF 5-MINUTE INTERVALS															
15	9/13/2013 1:10	0.098	73.256	60.003	60.948	AC Curr, Amps	21,785		Return Air, °F	788,036		Mixed Air, °F	662,329		Supply Air, °F	1,083,008					
16	9/13/2013 1:15	0.183	73.126	60.046	60.948	AVERAGES															
17	9/13/2013 1:20	0.183	73.213	60.003	60.948	AC Curr, Amps	2.0	kW	1.6	BHP	2.1										
18	9/13/2013 1:25	0.134	73.17	60.046	60.948	Return Air, °F	72.6		Mixed Air, °F	71.7		Supply Air, °F	55.6		Delta-T, °F	16.1					
19	9/13/2013 1:30	0.134	73.213	60.003	61.032																
20	9/13/2013 1:35	0.11	73.126	60.046	61.032																
21	9/13/2013 1:40	0.147	73.126	60.003	60.991																
22	9/13/2013 1:45	0.134	73.083	60.046	61.032																
23	9/13/2013 1:50	0.171	73.04	60.046	60.991																
24	9/13/2013 1:55	0.159	73.083	60.046	61.032																
25	9/13/2013 2:00	0.122	73.083	60.046	61.032																
26	9/13/2013 2:05	0.147	72.997	60.046	61.032																
27	9/13/2013 2:10	0.134	72.955	60.089	61.032																
28	9/13/2013 2:15	0.183	73.04	60.046	61.075																
29	9/13/2013 2:20	0.073	73.04	60.046	61.032																
30	9/13/2013 2:25	0.147	72.955	60.046	61.075																
31	9/13/2013 2:30	0.134	72.997	60.046	61.075																
32	9/13/2013 2:35	0.11	72.997	60.046	61.075																
33	9/13/2013 2:40	0.122	72.997	60.046	61.119																
34	9/13/2013 2:45	0.134	72.997	60.046	61.075																
35	9/13/2013 2:50	0.134	72.997	60.003	61.119																
36	9/13/2013 2:55	0.122	72.997	60.046	61.119																
37	9/13/2013 3:00	0.098	72.955	60.046	61.119																
38	9/13/2013 3:05	0.085	72.869	60.089	61.075																
39	9/13/2013 3:10	0.134	72.912	60.089	61.119																
40	9/13/2013 3:15	0.134	72.912	60.046	61.119																
41	9/13/2013 3:20	0.122	72.869	60.089	61.075																
42	9/13/2013 3:25	0.134	72.997	60.046	61.119																

SUMMARY AHU-1E AHU-1W AHU-2E AHU-2W AHU-3E AHU-3W AHU-4E AHU-4W AHU-5E AHU-5W AHU-6E AHU-6W AHU-7E AHU-7W AHU-8E AHU-8W

Ready Calculate

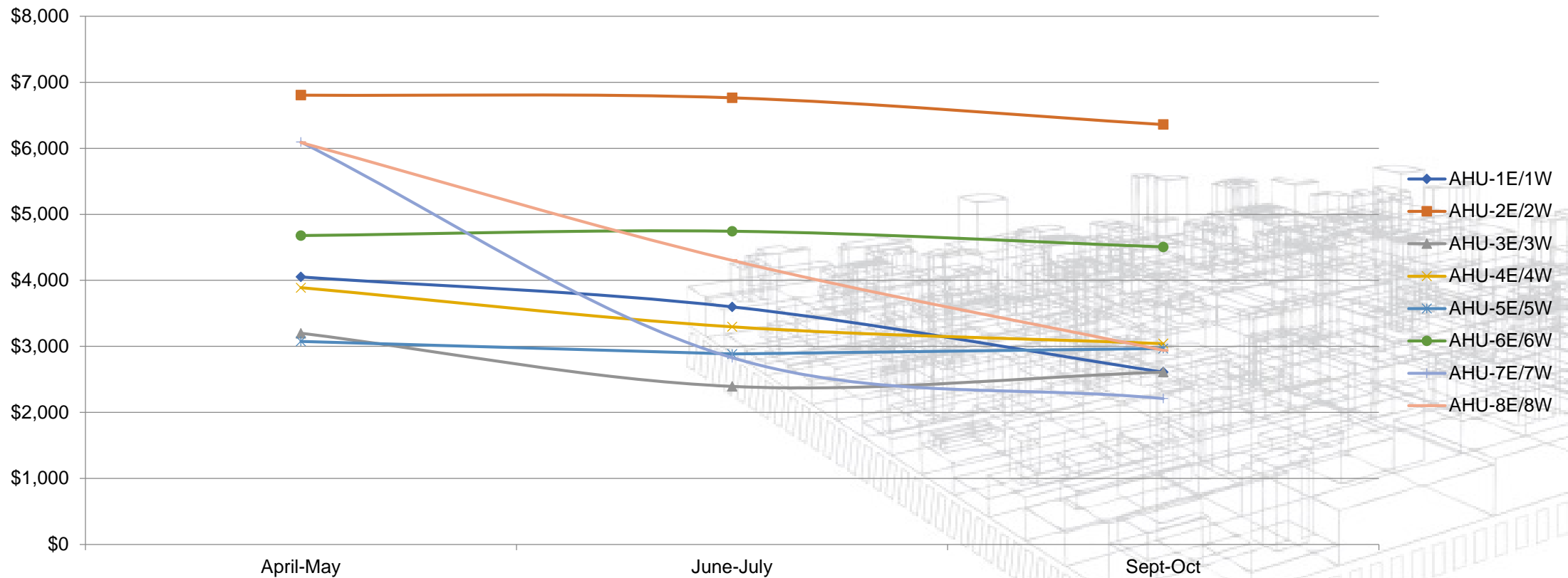


Verifying Results



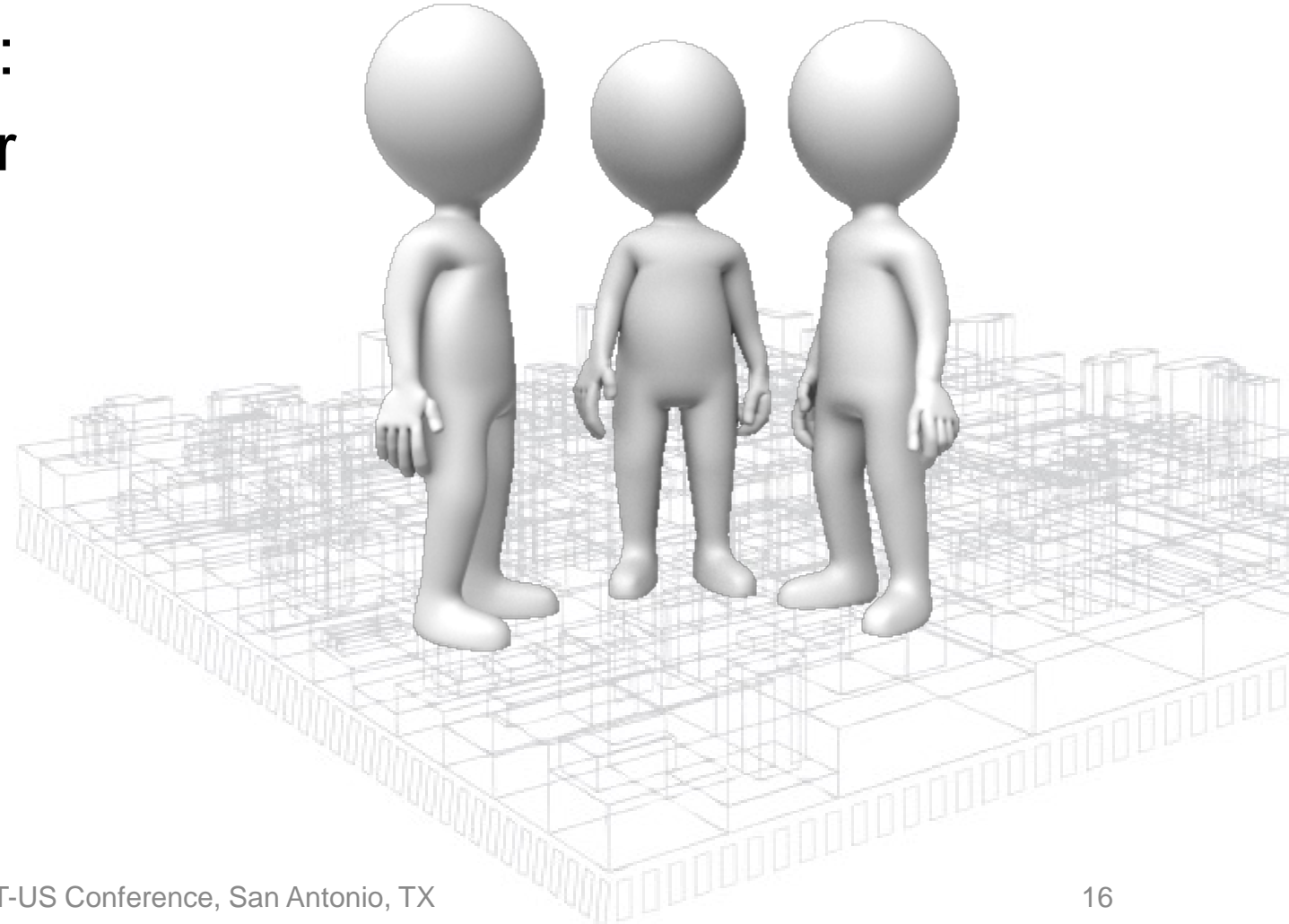
Verifying Results

AHU Average CHW Cost



Verifying Results

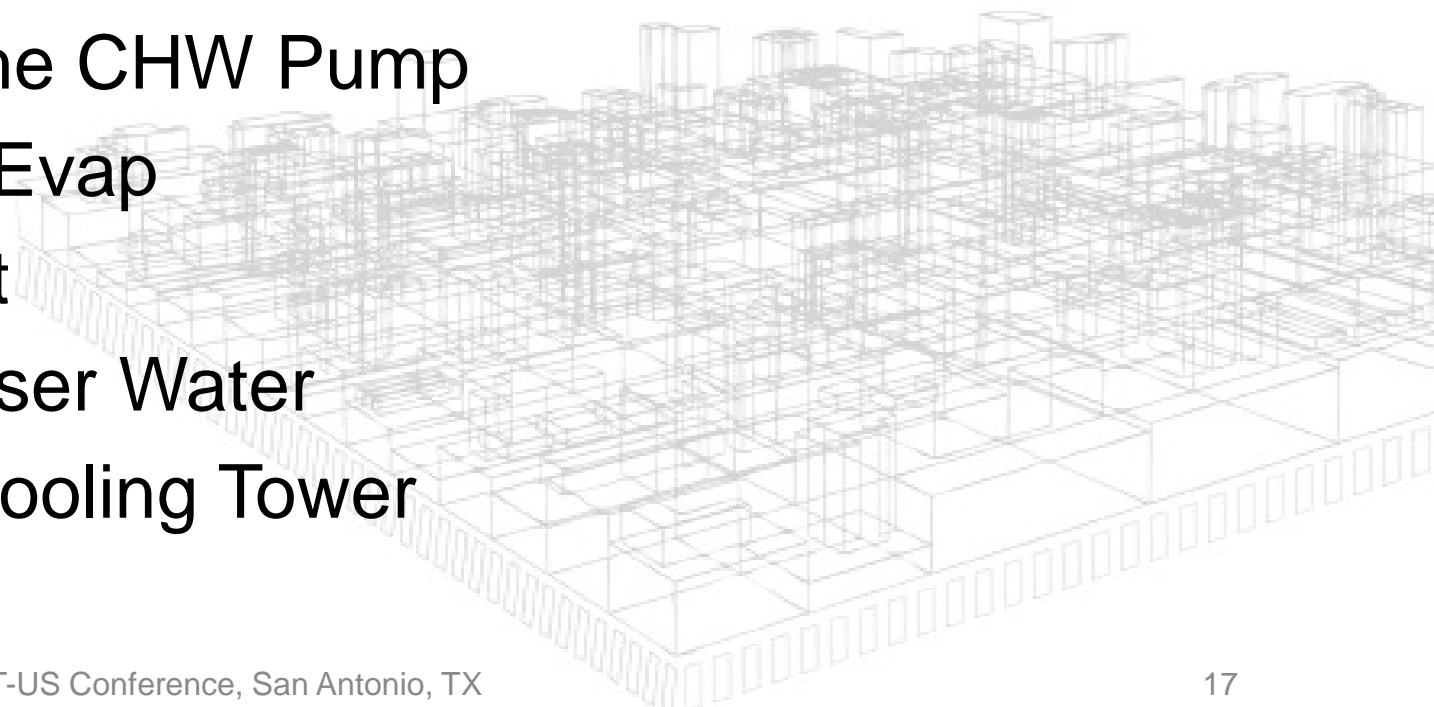
- Estimated Energy Savings:
 - ~ \$11,750 Per Month, or
 - ~ \$141,000 Per Year



Heat Transfer

"From The Beginning To The End"

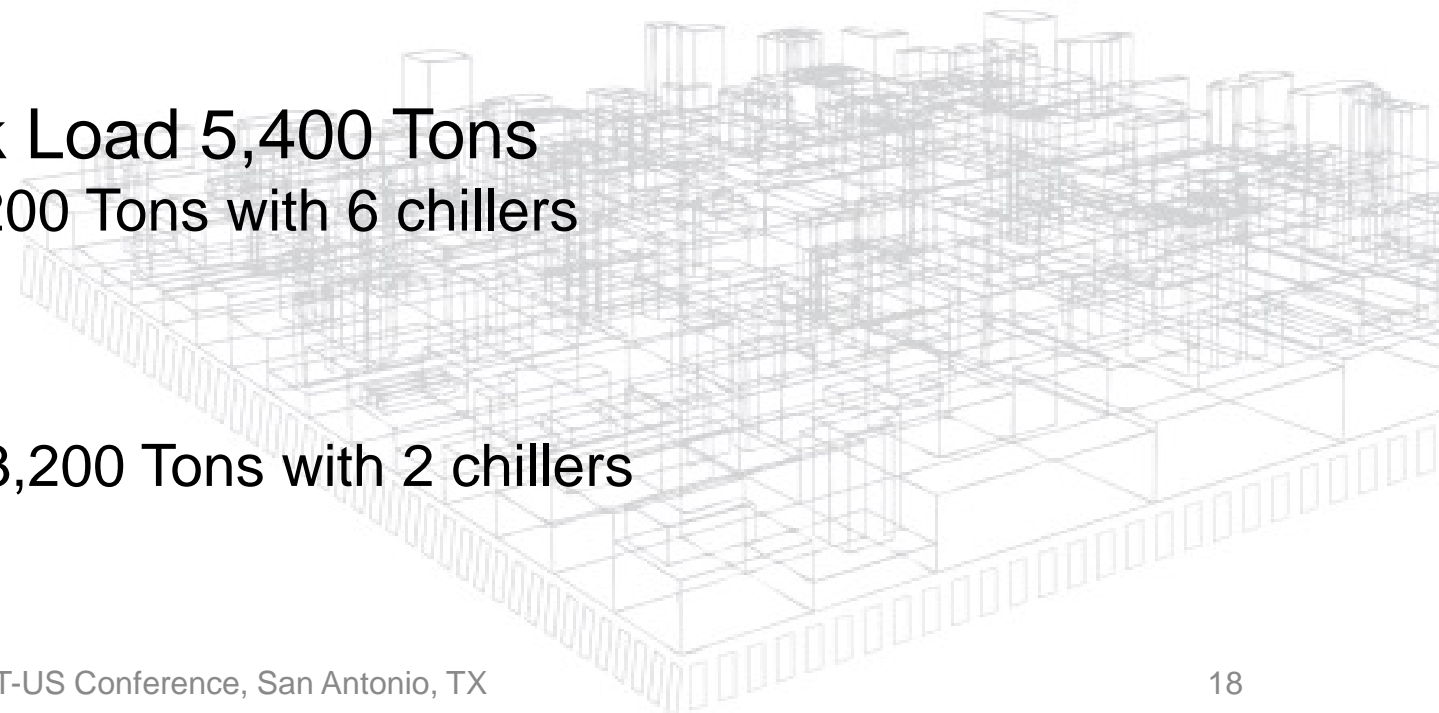
- VAV Terminal Unit To The AHU AHU To The Central Plant
- Room Air To Cooling Coil
- Cooling Coil To Chilled Water Return
- Chilled Water Return To The CHW Pump
- CHW Pump To the Chiller Evap
- Chiller Evap To Refrigerant
- Refrigerant To the Condenser Water
- Condenser Water To the Cooling Tower



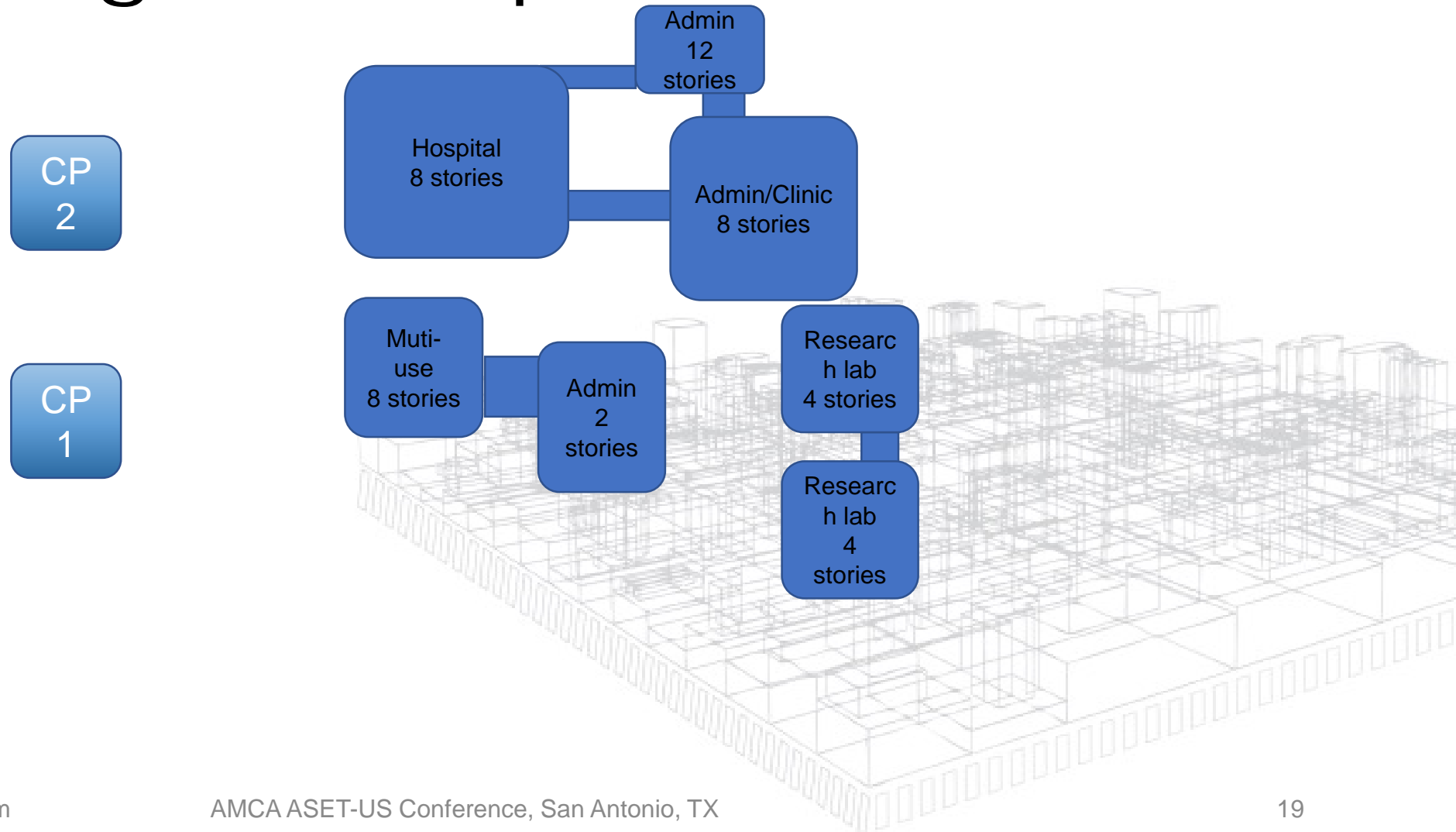
Optimizing A Campus

Chiller Staging Example

- Large Hospital Campus
 - Main Hospital
 - Admin Buildings
 - Research Buildings
- 2 chilled water plants – Peak Load 5,400 Tons
 - CP1 - (primary/secondary) 6,200 Tons with 6 chillers
 - 4 x 1,100 tons
 - 1 x 1,000 tons
 - 1 x 800 tons
 - CP2 - (variable flow primary) 3,200 Tons with 2 chillers
 - 2 x 1,600 tons



Optimizing A Campus



Optimizing A Campus

Chiller Staging Example

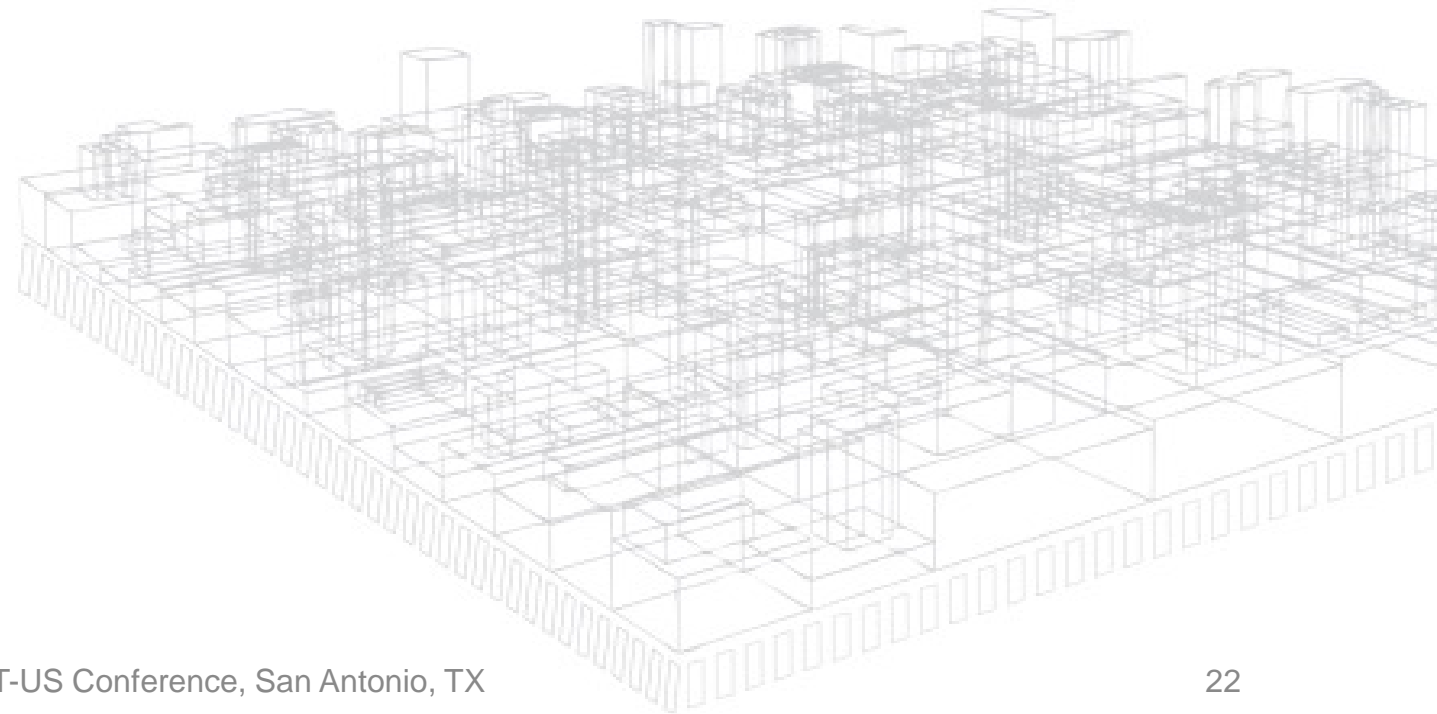
- Sequence of operation
 - Load Primary/Secondary System Trim With Variable Flow Primary
 - CP-1
- Optimization
 - To Truly Optimize A Central Plant System The Served Facilities Should be Optimized First.
 - Optimize Air Side First, Then Optimize Water Side
 - CP-1 When in “Flow” mode, Pumps fixed CHW flows to each chiller, These flows will be adjusted during Cx to ensure chillers are fully loaded
 - CP-2 Chiller CHW flow Is varied per facility load demand when in “Pressure” Mode.

Optimizing A Campus

- Each Building has “MM” Riser Setup To Flow ONLY the water that is needed for that facility.
- With Properly Operating AHUs Monitor Valve Positions and Control Central Pumping to keep most open valve 90-95 open.
- Each “MM” riser valve position is monitored and current “Lead” building valve should be 100% open. All other valves should be partially closed.
- Central Utility Pumps are controlled to maintain “0” vote at worst facility.

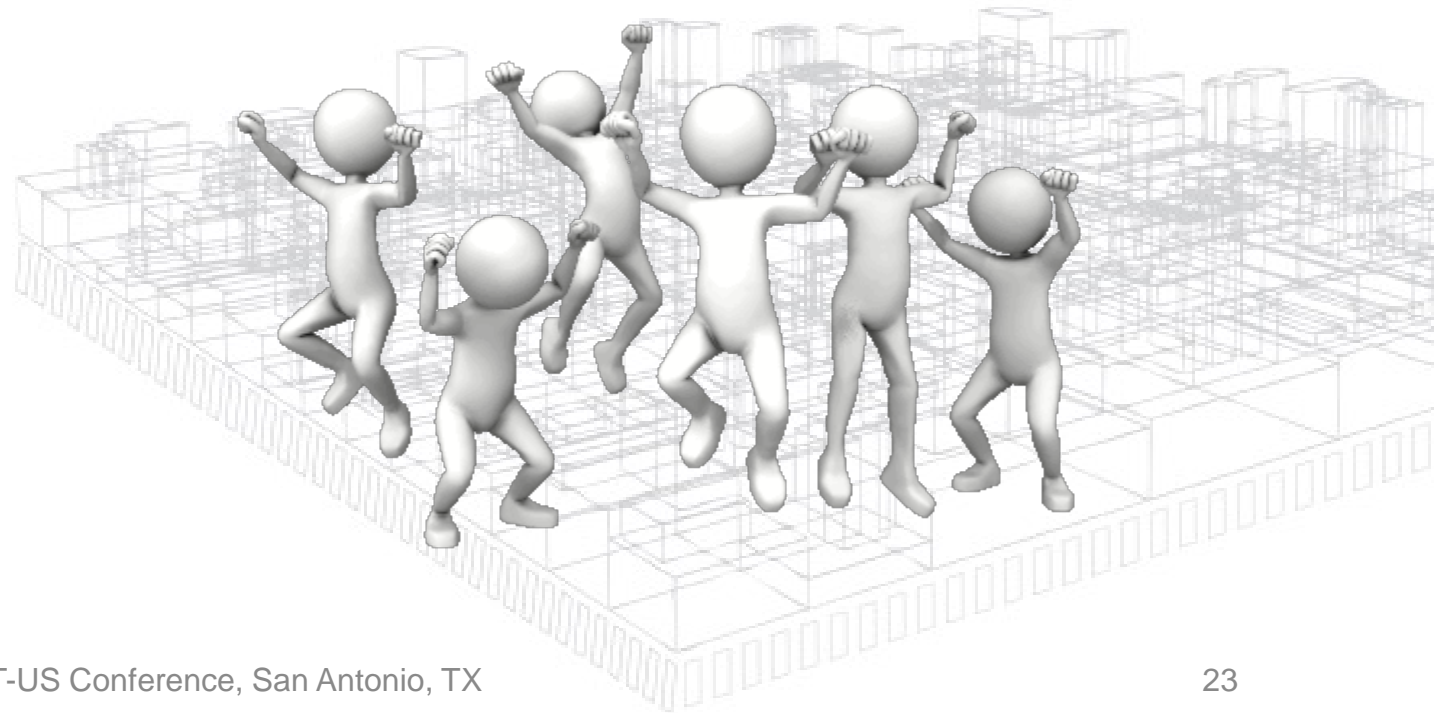
Optimization

- Condenser water temperature reset
- Chilled Water differential pressure reset
- Increase water side economizer operation
- Make-up water
 - Non-potable water
 - Stuck fill valve



Verifying results

- Campus Utility Costs were at \$8,000,00 annually
- With addition of four floors of buildings annual cost have dropped \$1,500,000



Questions?

Steve Wiggins

Director of Commissioning

Newcomb & Boyd

swiggins@newcomb-boyd.com

