Optimizing the Building Side of District Cooling

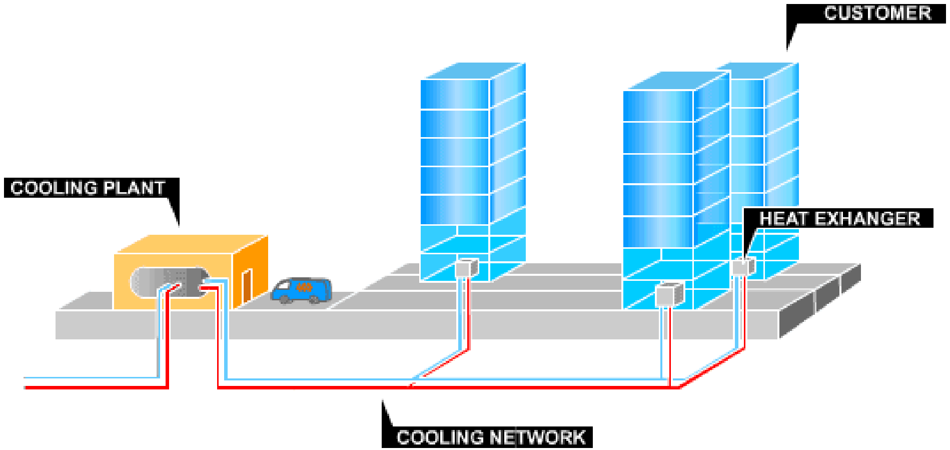
Eric Toback, PE, LEED AP – Director, Project Development

November 13, 2016

Optimizing the Building Side of District Cooling

Goals and Objectives

- Common Issues at Building Entry Connections
- New Construction Best Practices
- Optimization of Building Air Handlers



Common Issues at Building Entry Connections

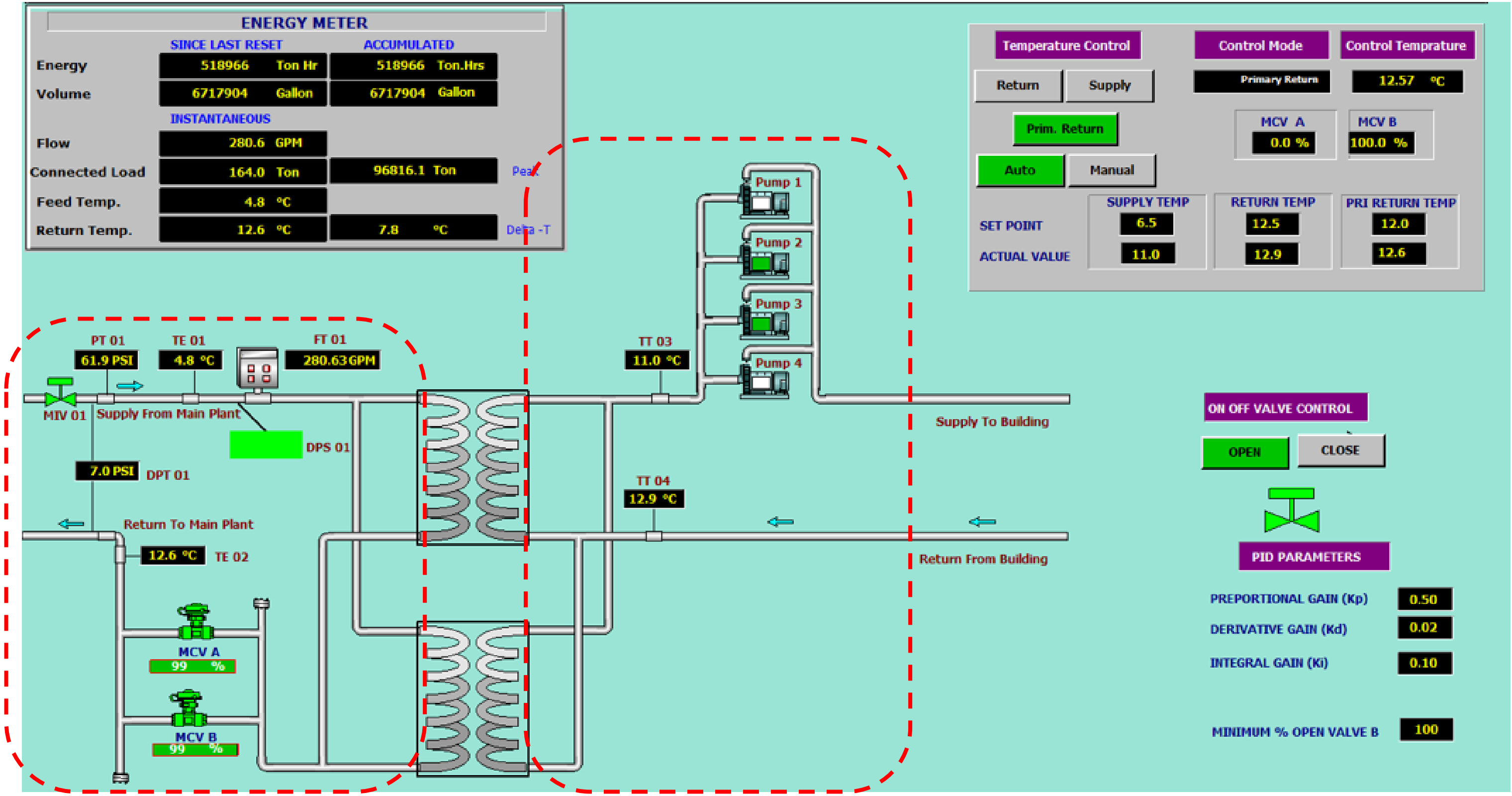
District Cooling Plant

Distribution Network

Energy Transfer Stations

Building Distribution

Energy Transfer Stations – Where the Handshake Takes Place

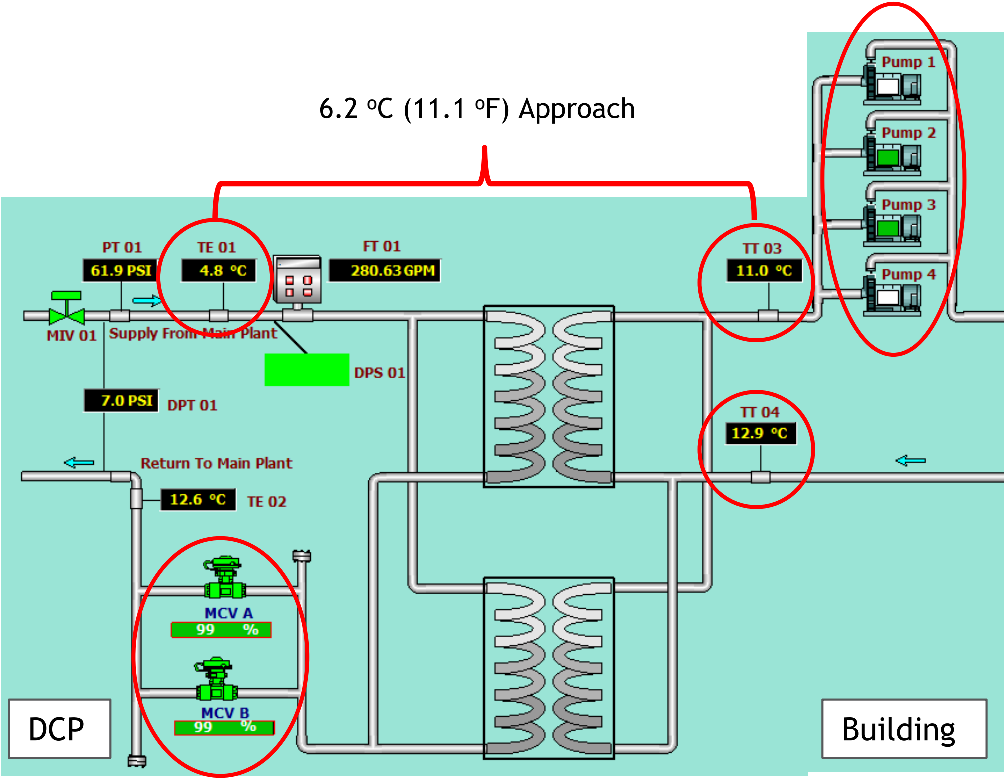


DCP

Building

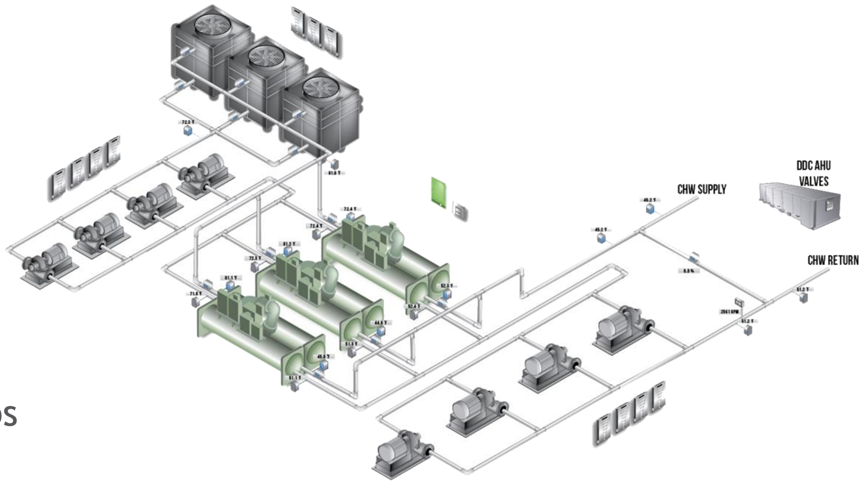
Energy Transfer Stations – Common Issues

- Systems designed for peak weather and load conditions that rarely occur (<1%)
- <u>Segmented Engineering</u> - Building systems and district plants rarely designed together
  - Does the building require 4.8 ºC water?
- Manual valve control or PID loops not tuned
  - Results in poor system delta T back to plant
- Lack of building side pump control
  - Constant speed pumping = wasted energy
  - Leads to poor heat transfer
  - Bad approach temperatures
  - Poor delta T



New Construction Best Practices

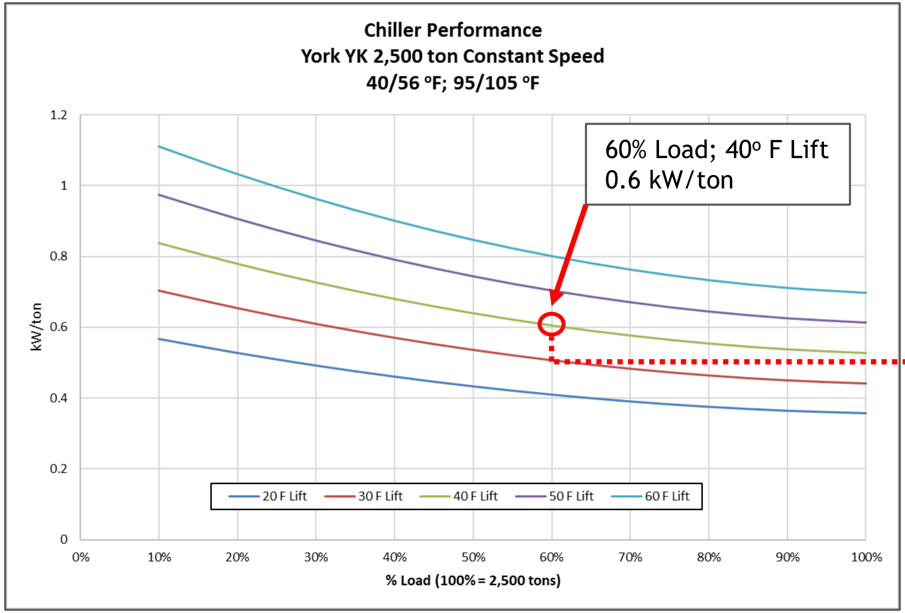
- Energy Transfer Stations
  - Low pressure drop heat exchangers <7 psi (50 kPa) reduces overall system pressure and improved chilled water pumping efficiency
  - Low approach temperatures < 1 ºC
  - Building side variable speed pumping

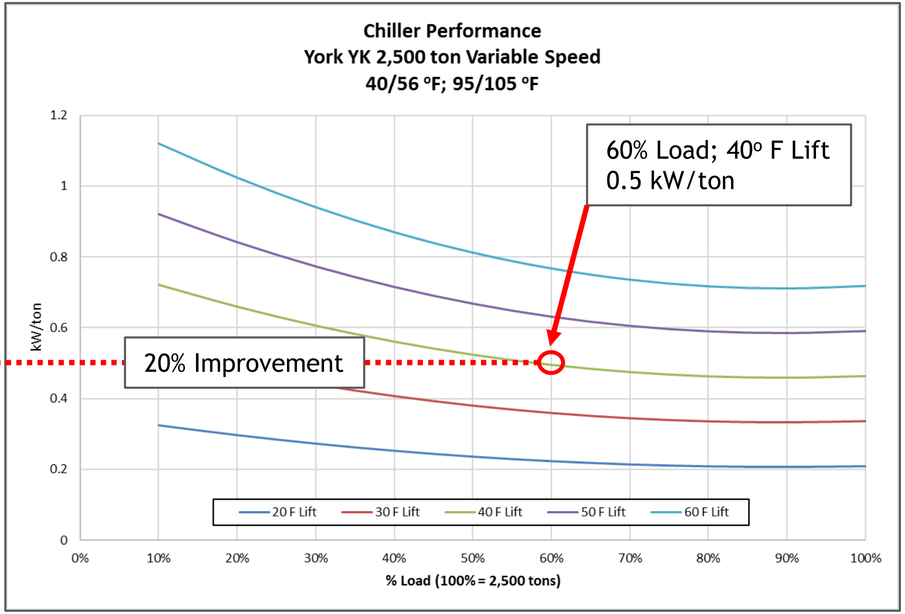


- District Cooling Plants
  - All-Variable Speed Systems
    - Headered VSD Cooling Towers
    - Headered VSD Condenser Water Pumps
    - Headered variable-primary Chilled Water Pumps
    - VSD Chillers

- Allow flexibility for chilled water temperature reset as weather conditions permit throughout the year

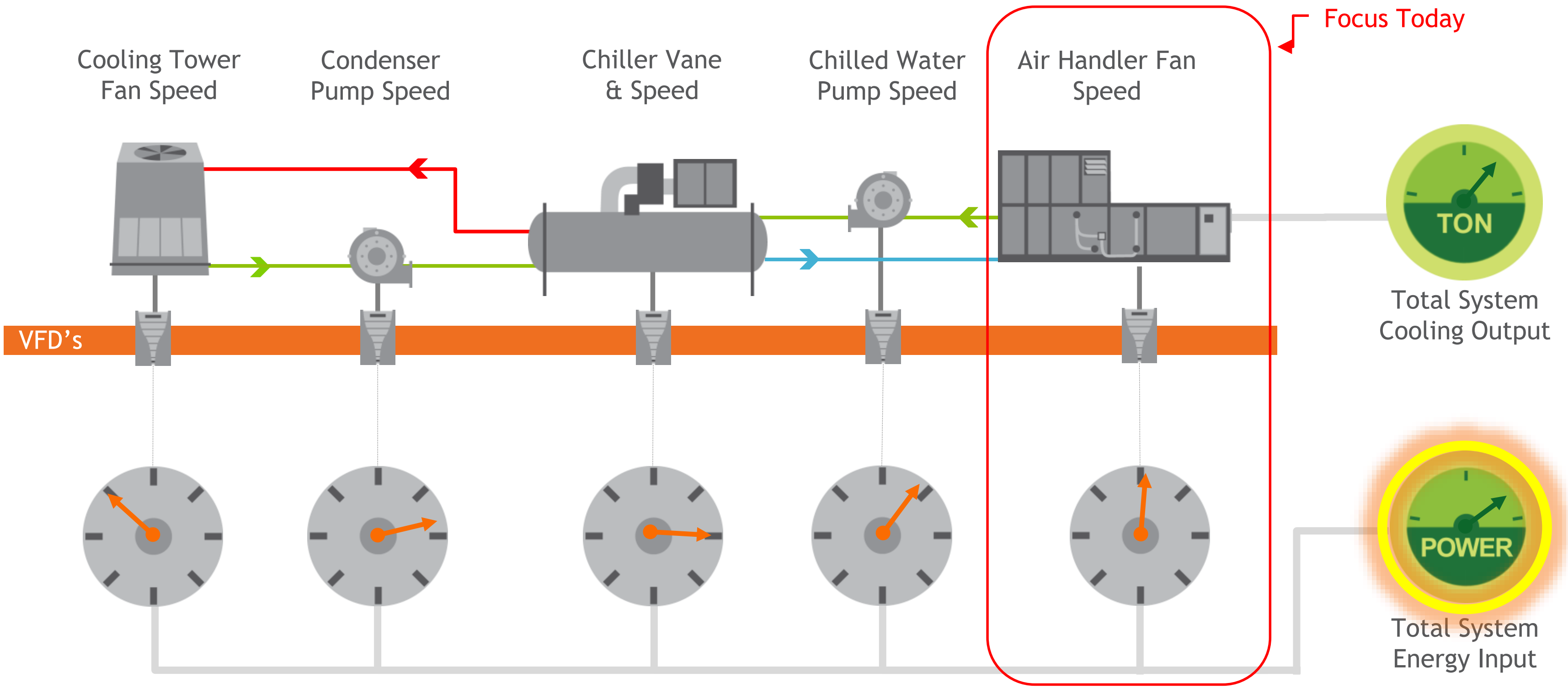
Chiller Efficiency – Lift is Key!!!





- Lift = Leaving CDW temp – Leaving CHW temp
- 1º chilled water temp <u>increase</u> = 1º condenser water temp <u>decrease</u>
- <u>Example:</u> 0.1 kW/ton x 10,000,000 ton-hrs = 1,000,000 kWh Saved!!!

Optimization of Building Air Handlers



Total System Schematic

Optimization of Building Air Handlers

Chiller Plant

Chiller Plant Optimization

Normal Building Load

Distance 100 miles

Chiller Plant Optimization improves the efficiency of the Chiller Plant Saving energy by improving kW/ton (or COP).

Building Load with AHU Optimization

Normal Building Load

AHU Optimization

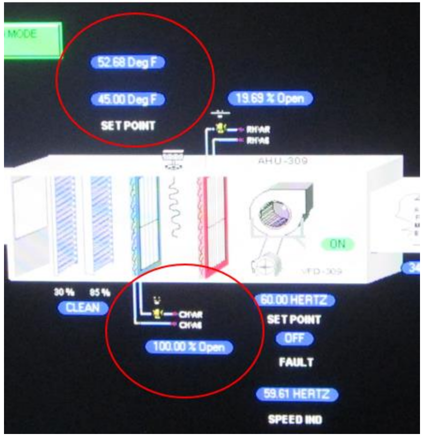
Distance 60 miles

Air Handling System Optimization, improves the efficiency and operation of the Air Handlers reducing the load on both the Chiller Plant and Heating System of the building.

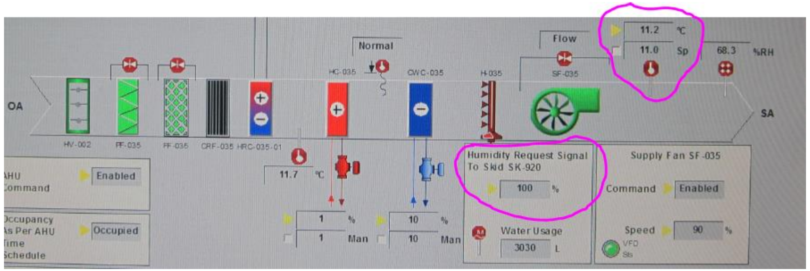
Building Load

Drivers of Poor AHU Performance

System Constraints

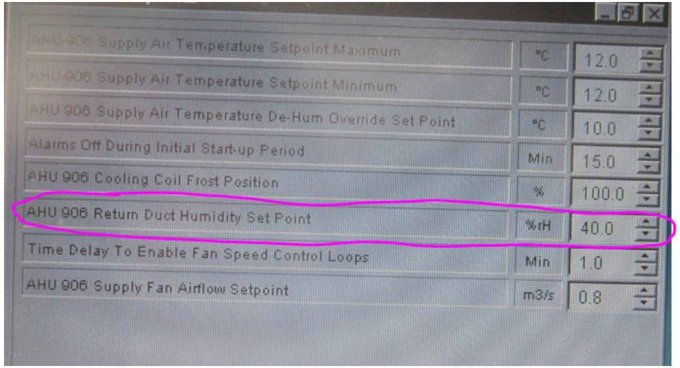


The coldest air possible via supply air temperature set point 45 deg F (7.2 deg C). Supply fan VFD in manual mode (100%).

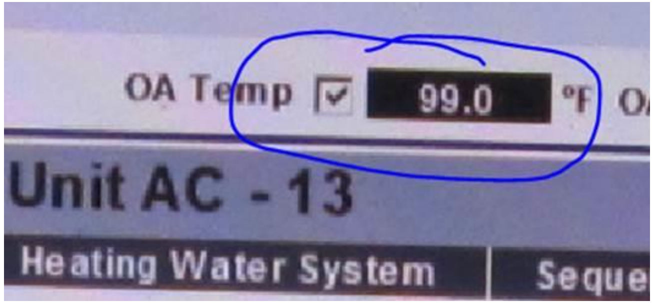


Broken sensors driving set points to minimum or maximum values

User Requirements



Human Behavior

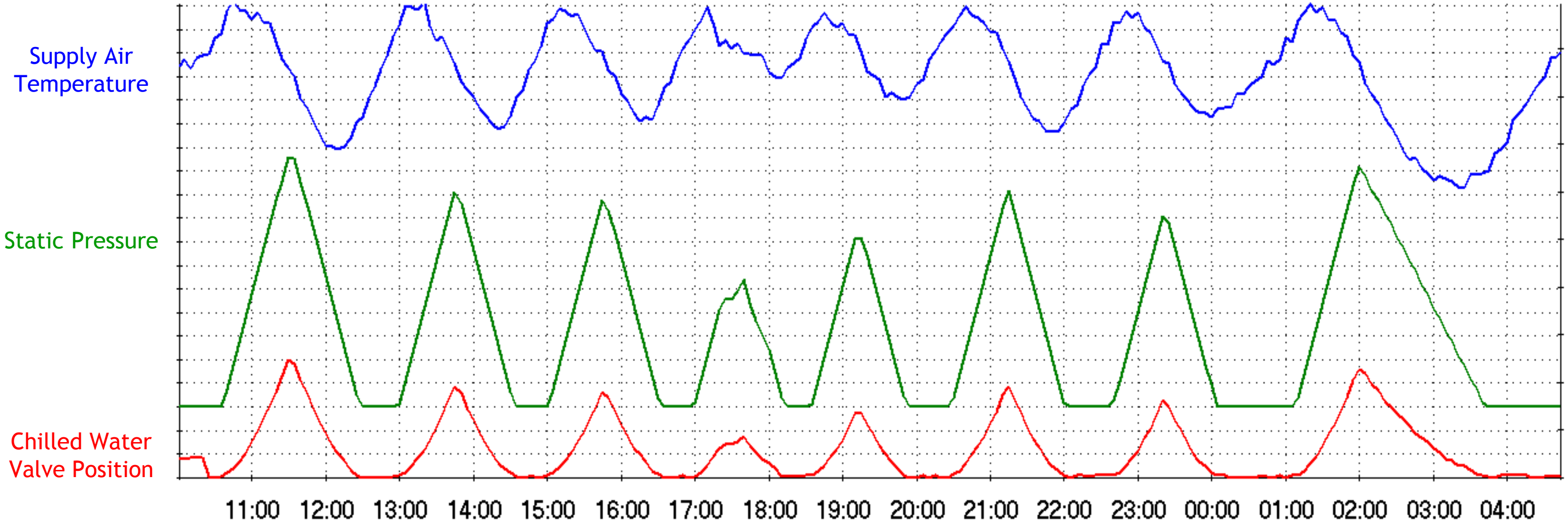


The coldest air possible and economizer disabled via outside air temperature sensor override

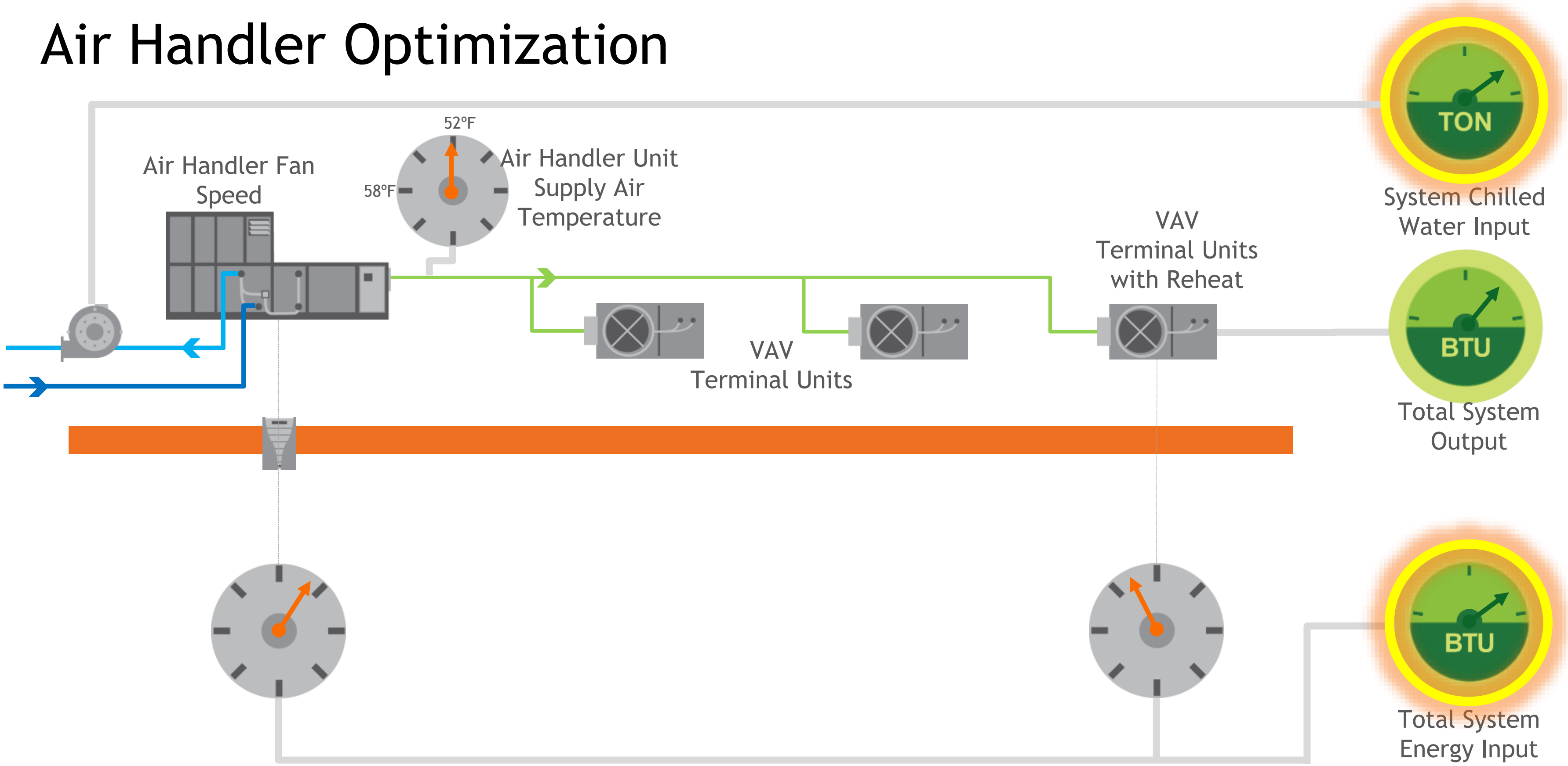
Typical Threats to HVAC Optimization

The biggest threat to effective optimization is occupancy comfort complaints… which causes facility operators to manually override automated settings or turn the optimization system off.

- Optimization - resetting AHU supply air temperature, and AHU static pressure simultaneously is a challenge that requires great algorithms and reliable instrumentation
- Hunting creates instability & discomfort; which leads to operator override of the system … and loss of savings



Air Handler Optimization

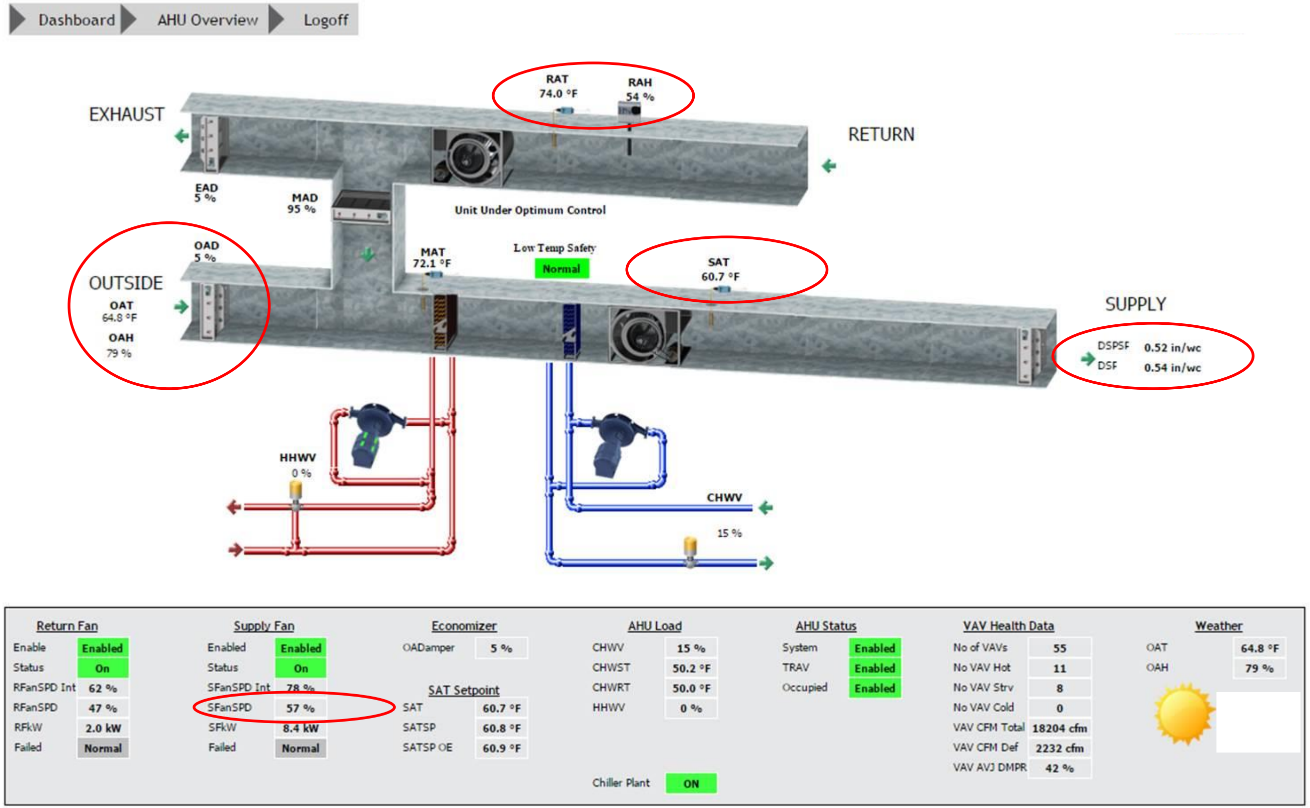


Total System Schematic

Air Handler Optimization Strategies

	Optimum Energy's Approach
Fan Control	• Standard VAV AHU with DDC down to the zone - Eliminate static pressure control and use VAV and CAV box info for control instead. • Standard VAV AHU – Static pressure reset • Labs and Manufacturing AHUs – no optimized control of fans; leave as is (flow set point or static pressure control).
Supply Air Temperature Control	• Standard VAV AHU - Continuous resetting of supply air temperature to maintain fan "sweet" spot, minimizing re-heat, while maintaining humidity and temperature in the spaces. • Lab and Manufacturing AHUs - Continuous resetting of supply air temperature to maintain humidity and temperature in the spaces. Use simple FDD to determine if space sensors are correct.
Energy Conservation Measures	• Reduce air changes per hour (ACH) • Reduce outside air; reduce leakage • Night set back • Retro-commissioning and test and balance
Results	• Most efficient air system possible, improving occupancy comfort, keep HVAC system healthy for the long term.

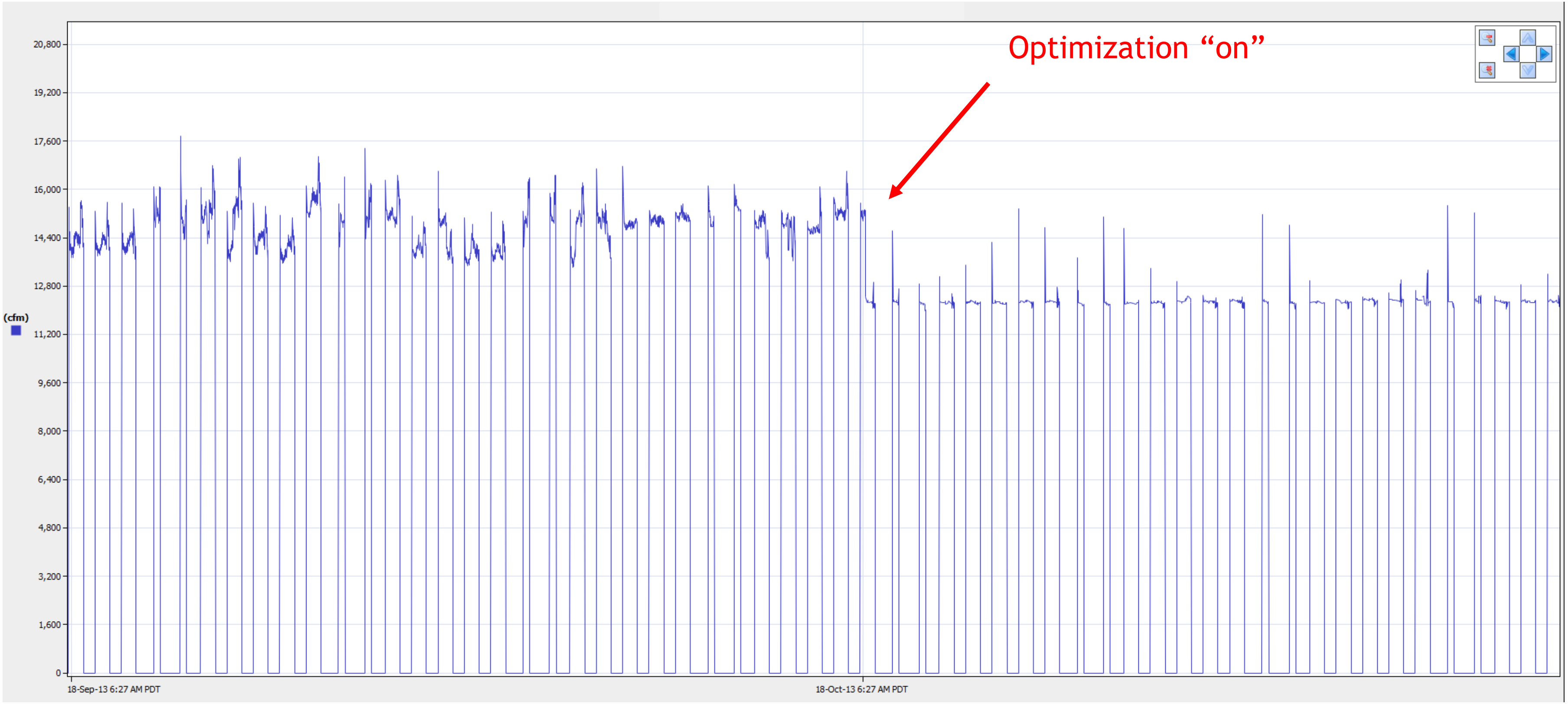
Air Handler Optimization Strategies (standard office unit)



How Air Handler Optimization Saves Energy & Costs

Source	Benefit
Fan Energy	Supply the required flow (cfm or l/s) at the lowest energy possible
Ton-hr Reduction (Chiller Plant Energy)	Reduce over humidification and simultaneous heating and cooling that is inherent of HVAC systems with perimeter reheat or relative humidity control
Heating Reduction (Gas or Electric)	Reduce the amount of heating produced by boilers or electric resistance heat
Cooling Tower Water Use	Reduced ton-hrs at the chiller plant reduced cooling tower evaporation
Reheat Energy	Reduce simultaneous heating and cooling that is inherent of HVAC systems with perimeter reheat or relative humidity control
More Efficient Source	Supply cooling from the most efficient source
Air Distribution Losses	Reduce the energy lost during air movement through ducts

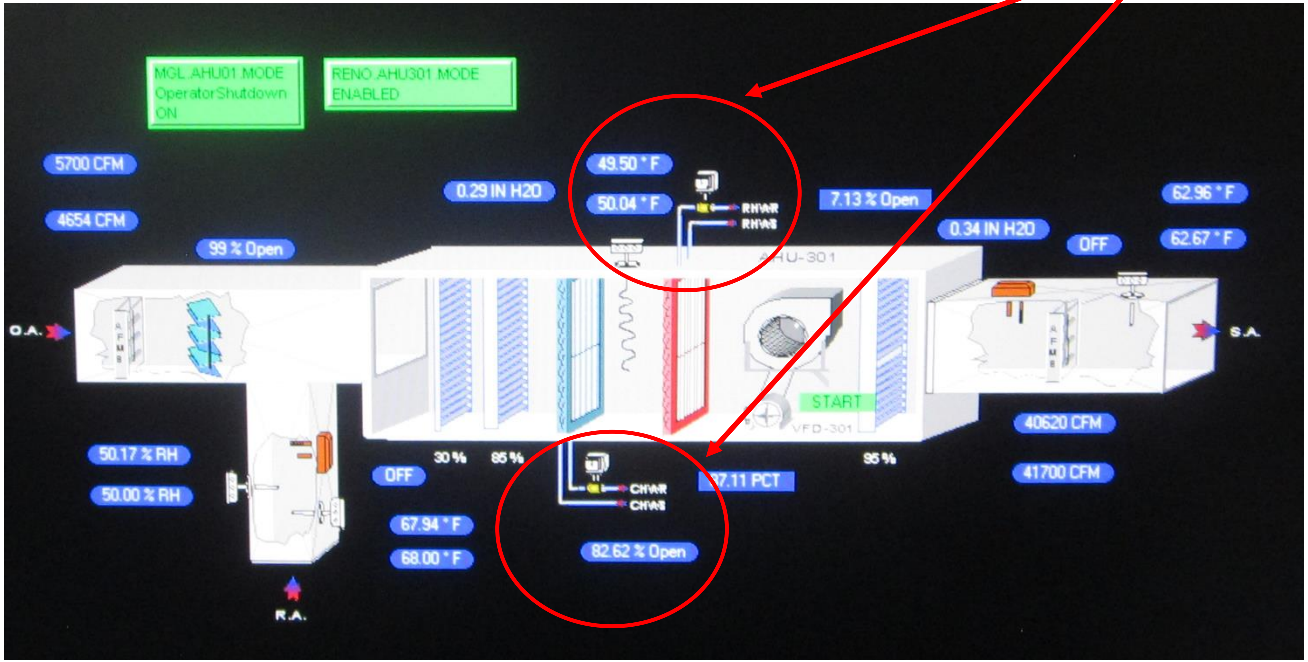
Less HVAC Air Flow



AHU Optimization Example - Before

50 ^oF (10 ^oC) supply air set point

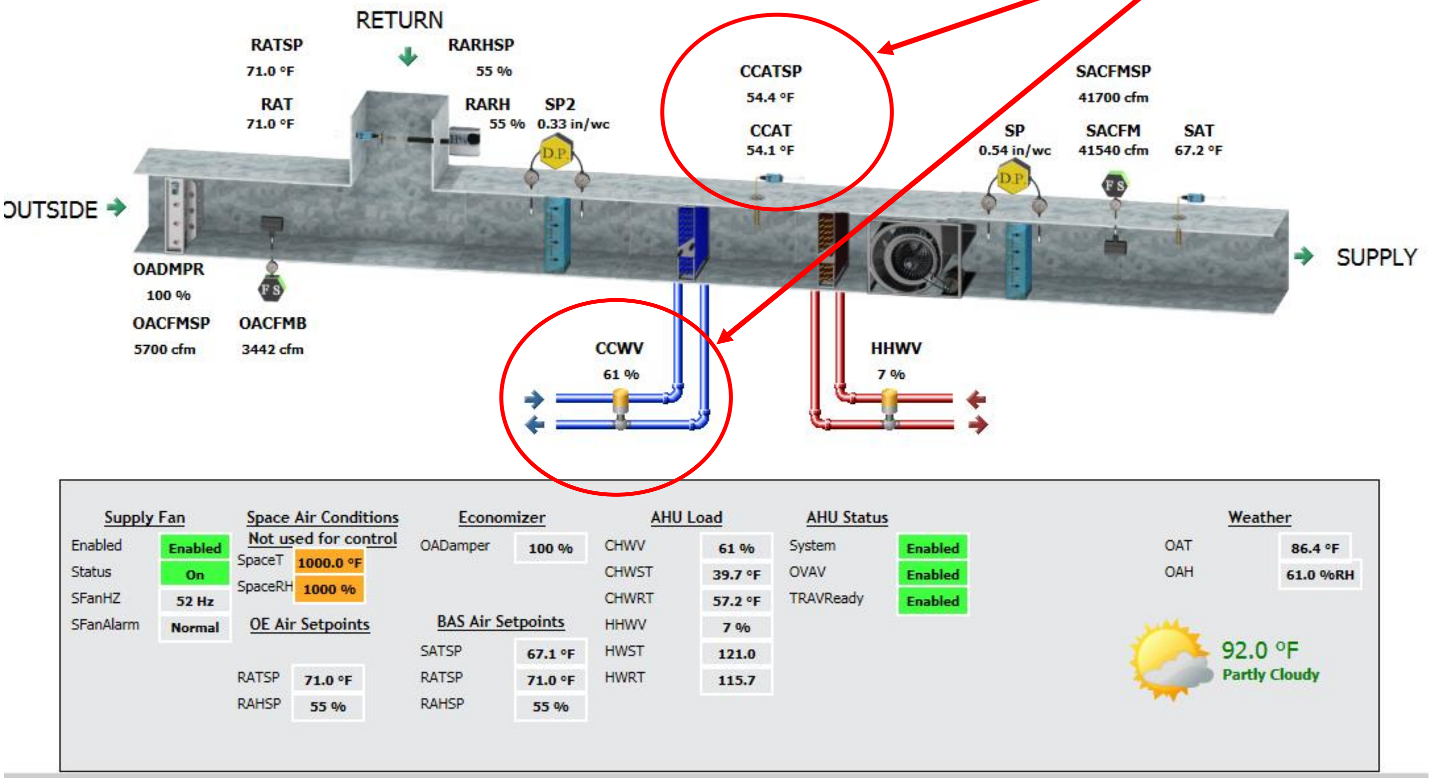
82% valve position



Enthalpy (h) = 19.9 Btu/lb

AHU Optimization Example - After

54.4 °F (12.4 °C) supply air set point
61% valve position



Enthalpy (h) = 22.4 Btu/lb

Airflow = 41,540 CFM

Δh = 2.5 Btu/lb

Savings = 38.9 tons

Annual Savings = 341,147 ton-hrs

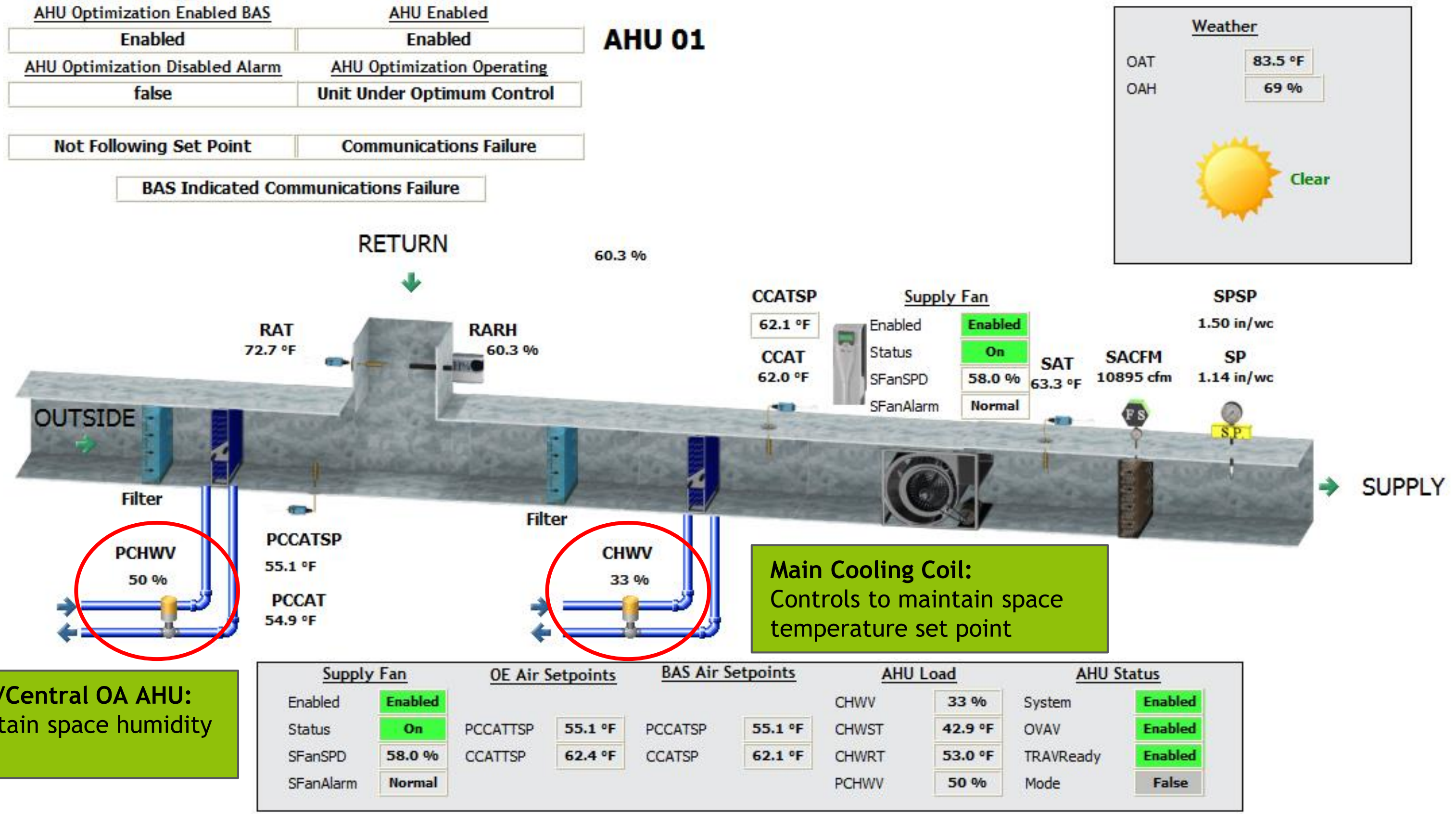
Air Handler Optimization Savings Example

San Diego Facility – Mix of Office and Lab AHUs

Time	Actual Load Savings	Actual Water Savings	Actual Electric Savings	Actual Gas Savings	Actual Costs Savings
Month	ton-hrs	Gallons	kWhs	therms	$
Jan-14	57,053	110,683	40,850	7,049	$9,019
Feb-14	50,635	98,232	30,381	5,405	$6,822
Mar-14	49,668	96,357	29,801	8,822	$9,156
Apr-14	65,413	126,902	29,763	9,419	$9,570
May-14	75,679	146,817	39,580	11,242	$11,827
Jun-13	101,480	196,872	66,490	14,412	$16,737
Jul-13	96,679	187,558	54,044	13,287	$14,705
Aug-13	91,070	176,676	50,999	12,133	$13,593
Sep-13	73,105	141,824	44,302	10,333	$11,663
Oct-13	75,273	146,030	43,659	11,291	$12,270
Nov-13	64,933	125,971	35,713	9,740	$10,389
Dec-13	46,390	89,997	27,834	5,557	$6,673
Total	847,379	1,643,917	493,416	118,690	$132,425

Energy calculated at $0.10/kWh, $0.70/therm, and $0.87 per kgal water.

Optimizing Outside Air & Floor by Floor AHUs



Main Cooling Coil:
Controls to maintain space temperature set point

Pre Cooling Coil/Central OA AHU:
Controls to maintain space humidity set point

Monitoring Key to Maintaining Savings Over Time

Summary

- Building ETS is key component of energy usage between building owners and district cooling providers

- District cooling system and building design should focus on operating conditions just as much as peak conditions

- Air handler optimization – Reduces BOTH <u>fan energy</u> & <u>cooling load</u>

- Continuous M&V a must to maintain savings

Eric Toback, PE, LEED AP
Optimum Energy LLC
Director, Project Development
eric.toback@optimumenergyco.com
917.512.2242

Thank you.

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