Heating Water System Optimization

Coil Performance and Medical Center Project Results

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FLOW CONTROL
INDUSTRIES, INC.

CampusEnergy2019
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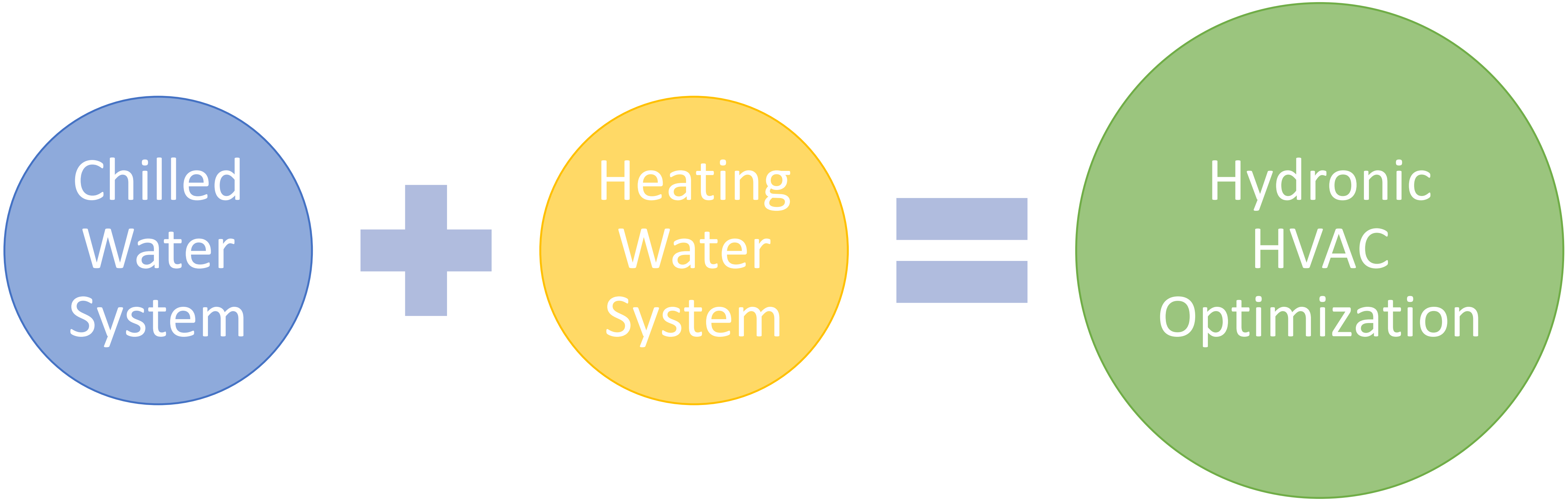
Total System Optimization

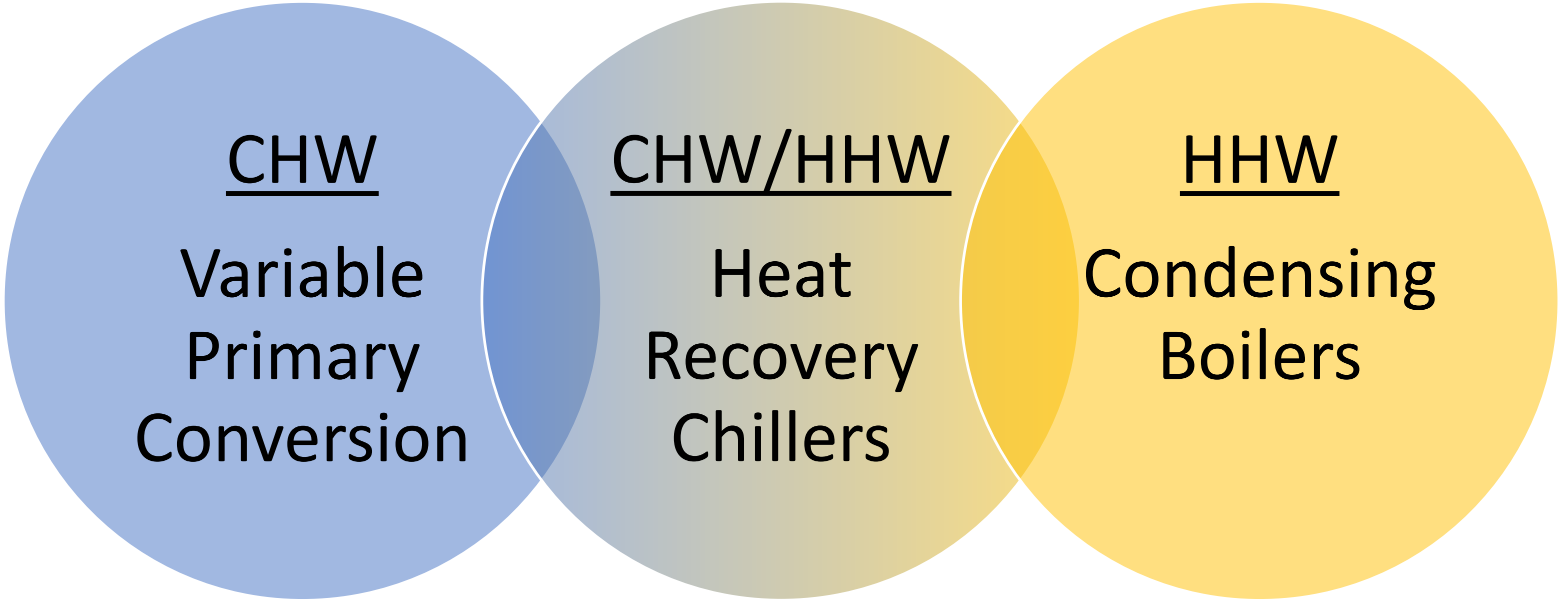


Why focus on HHW performance?

- Heating water coils have greater part load potential than chilled water coils
- More available HW production sources, but many require lower temperature return water to maximize efficiency
- Many HHW coils are in locations with limited access, with limited operational visibility, and get little attention
- Terminal reheat systems are the last component of comfort control prior to delivering conditioned air to the space

Project Discussion

- Midwestern medical center
- Major renovation & expansion, including new 115,000 SF patient tower and 60,000 SF of surgery suites



Goals and Challenges

- High existing system flow rates for CHW and HHW
- Multiple chillers running lightly loaded – flow limited
- Demand limiting AHUs above 85°F OAT
- Existing heating coils designed for 180°F HWST; new coils designed for 140°F HWST
- Heat recovery chillers were incorrectly selected, requiring lower entering condenser/heating water temperature

CHW vs. HHW Coil Comparison

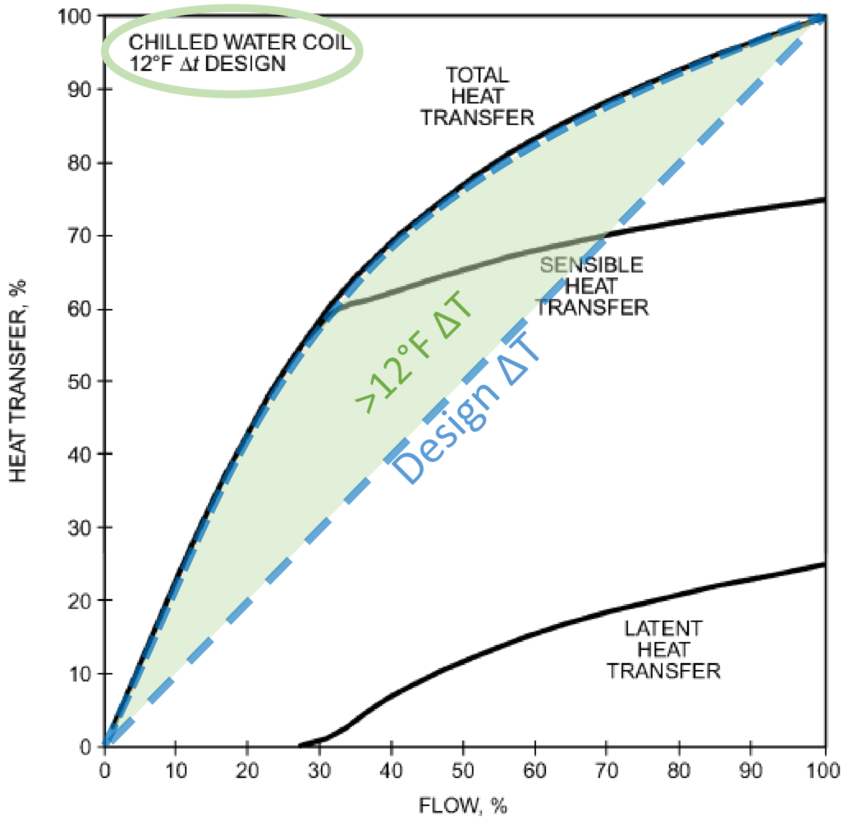


Fig. 24 Chilled-Water Coil Heat Transfer Characteristic

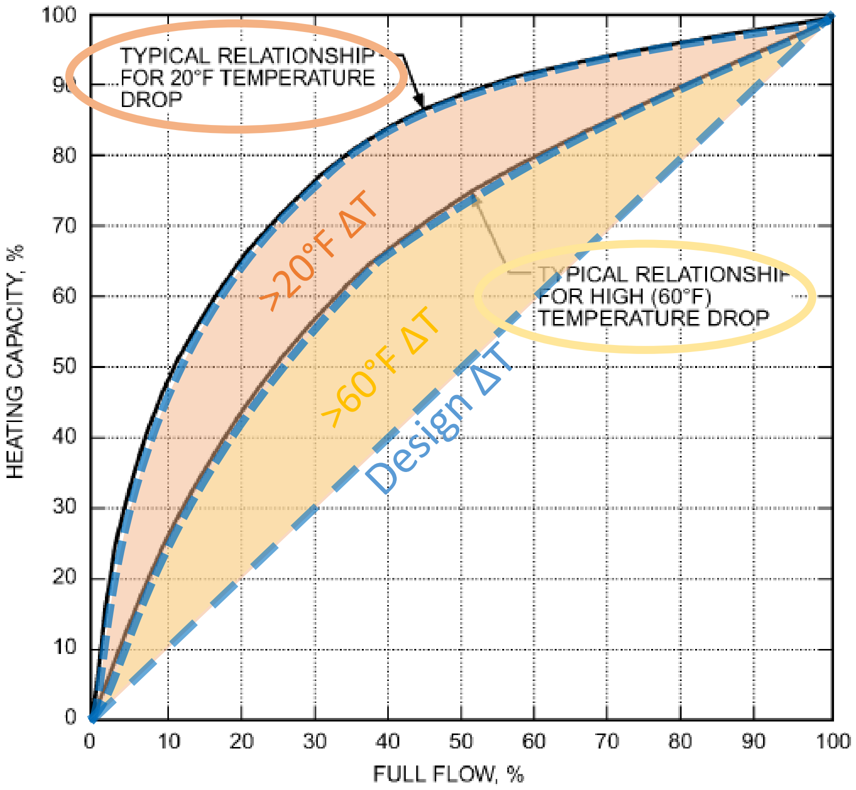
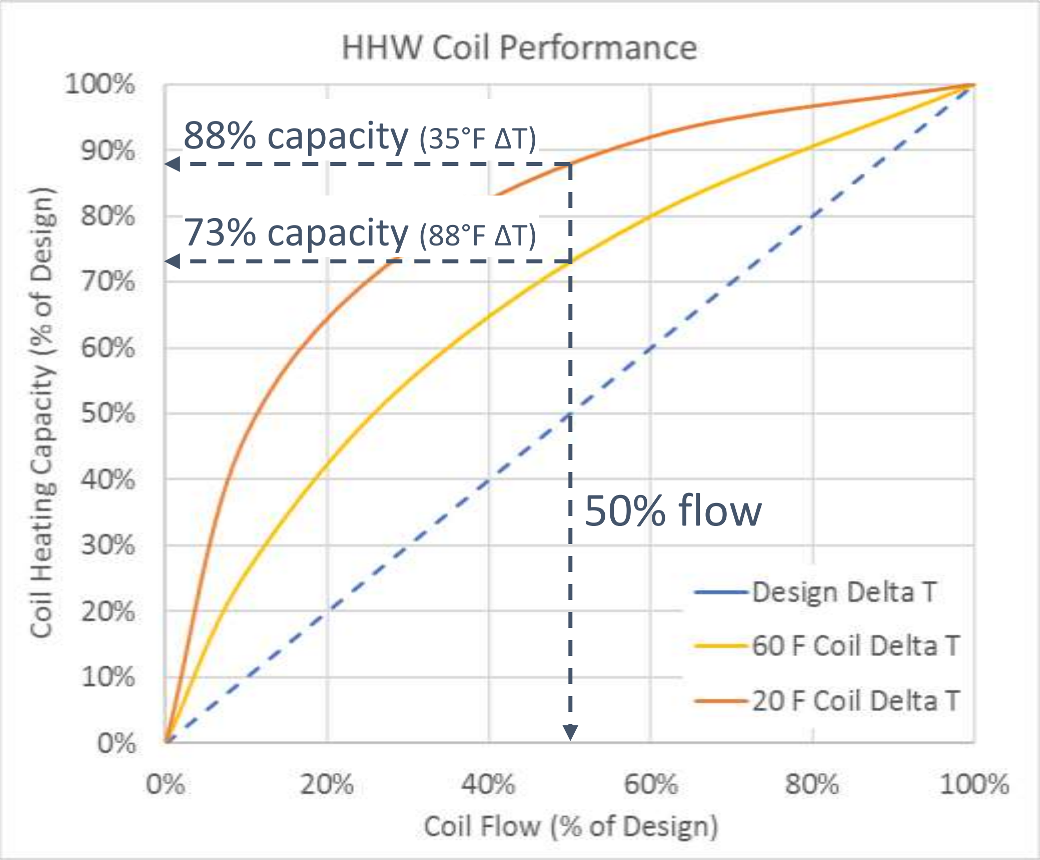
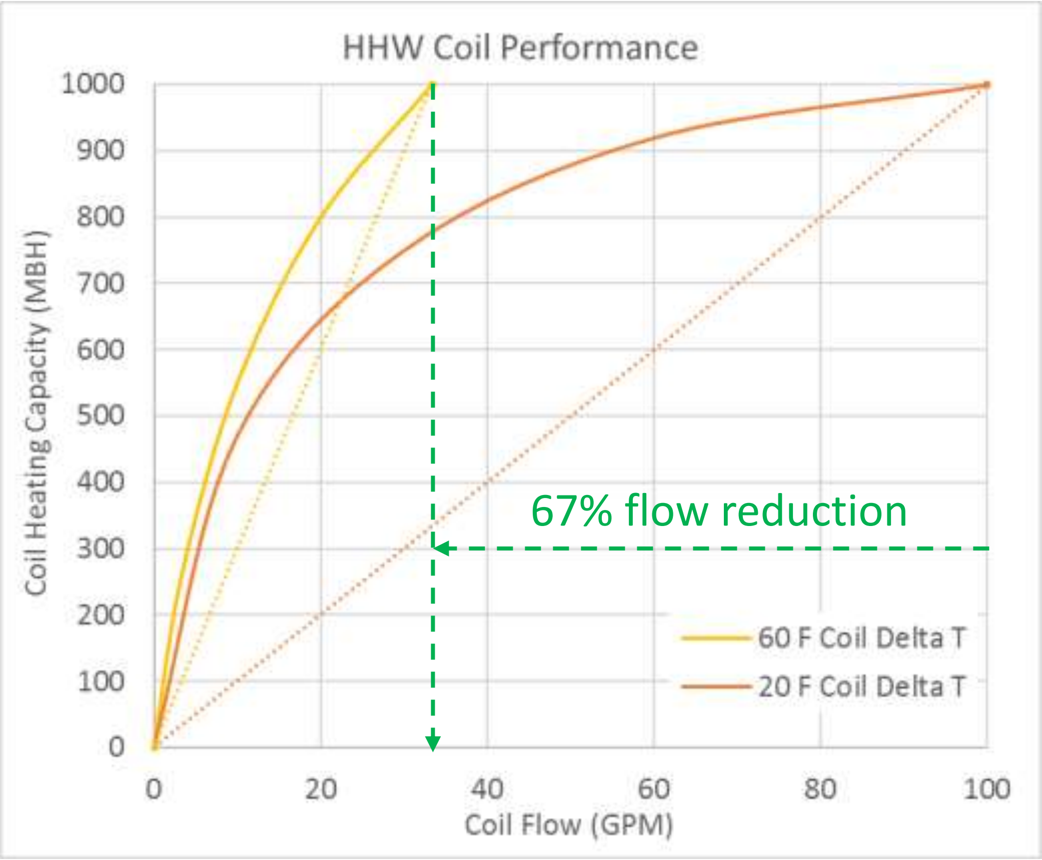


Fig. 32 Heat Emission Versus Flow Characteristic of Typical Hot-Water Heating Coil

HHW Coil Performance

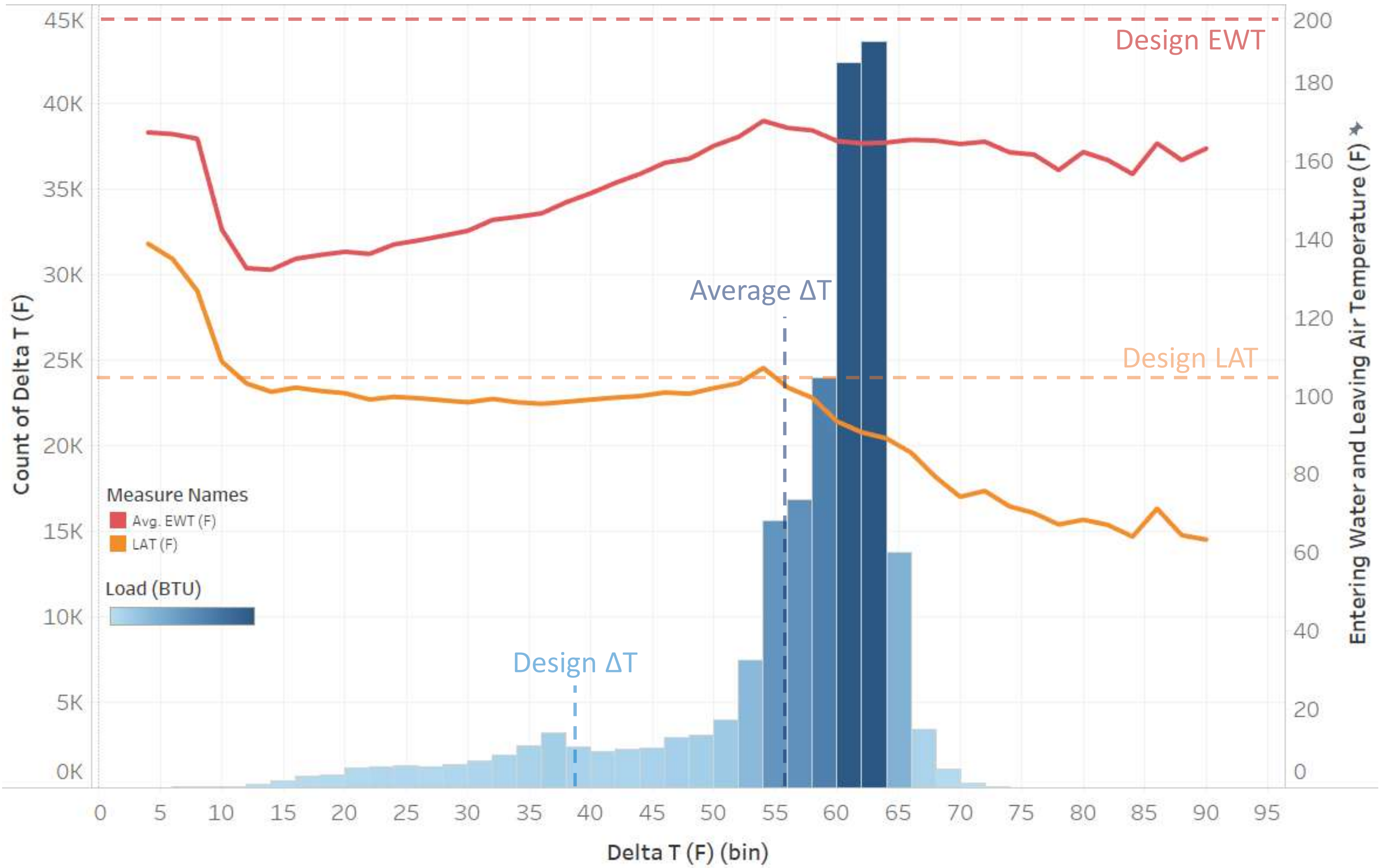




But Does it Really Work?

- Multiple existing HHW coils evaluated serving different spaces:
  - Undergraduate library
  - Classrooms
  - Biological science labs
- Project implemented in 2013
- 1 full year of operational data evaluated (2018)
- 1 minute interval data from individual SmartValves at AHU heating coils: air & water temperatures, flow, pressures, load

Coil ΔT Profile (Library)



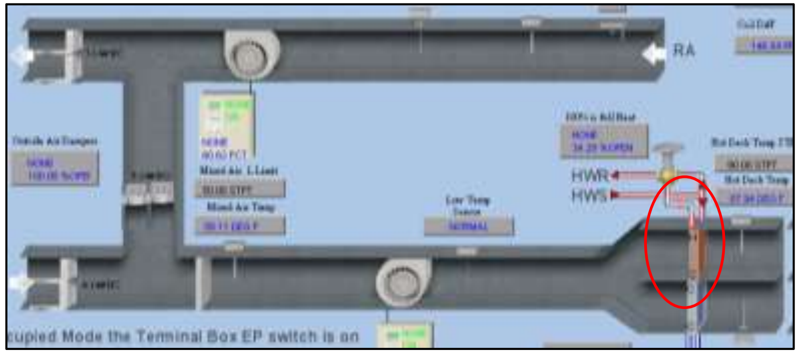
<u>Avg. Performance</u>

All conditions, heating active

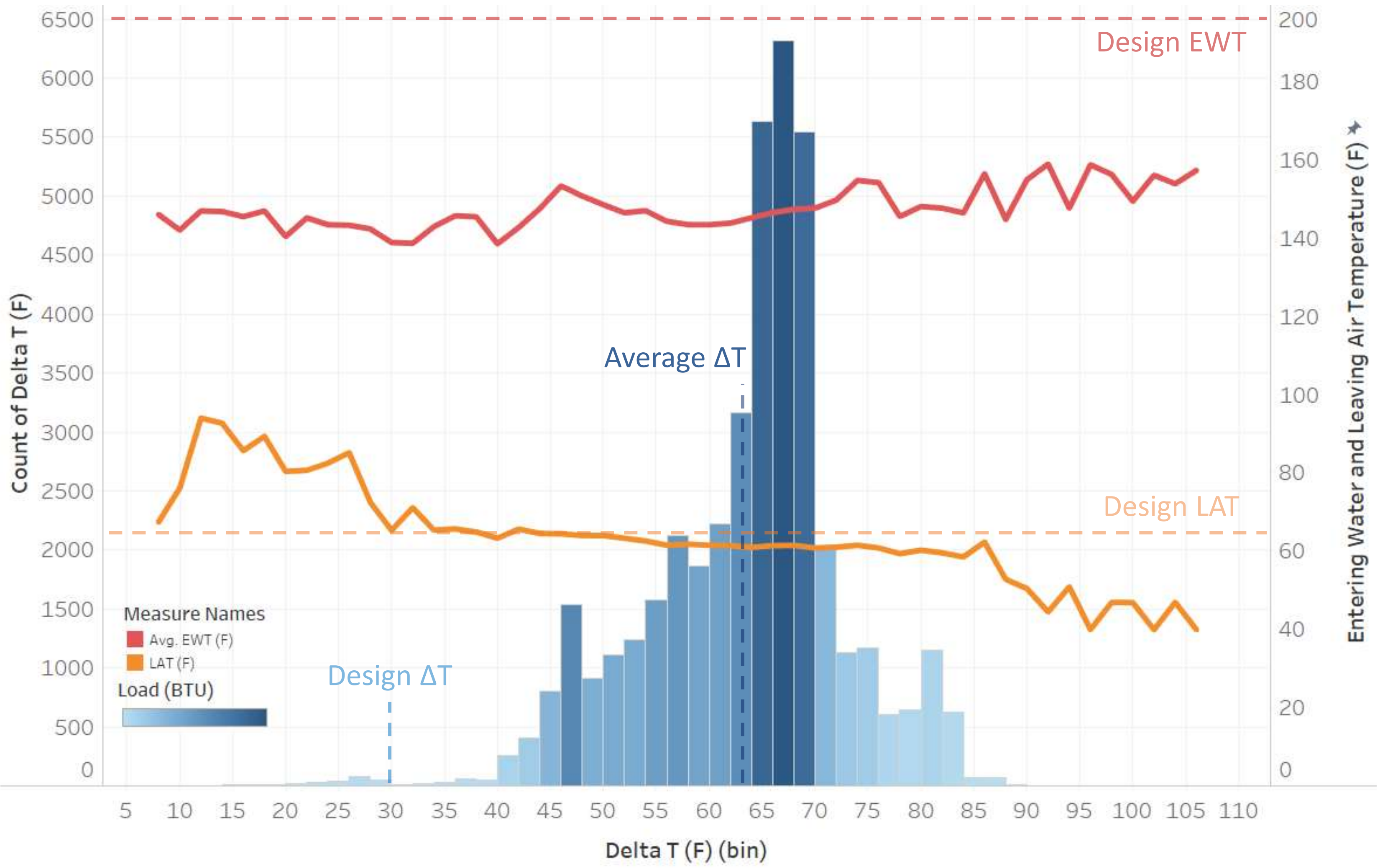
- 22.4% load
- 19.8 GPM
- **<u>56.4°F ΔT</u>** <u>(144%)</u>
- 163.2°F HWST
- 96.3°F Coil LAT

<u>Coil Design Details</u>

- Hot Deck
- 40,000 CFM
- 2,250 MBH
- 115 GPM
- 39.1°F ΔT
- 200/160.9°F HHW
- 106.8°F Coil LAT



Coil ΔT Profile (Classrooms)



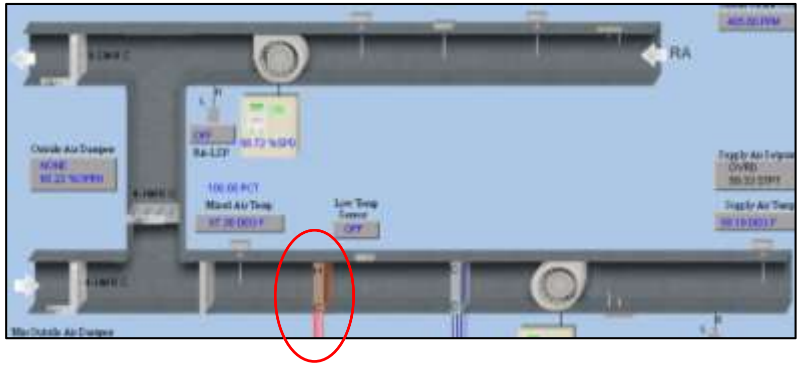
<u>Avg. Performance</u>

All conditions, heating active

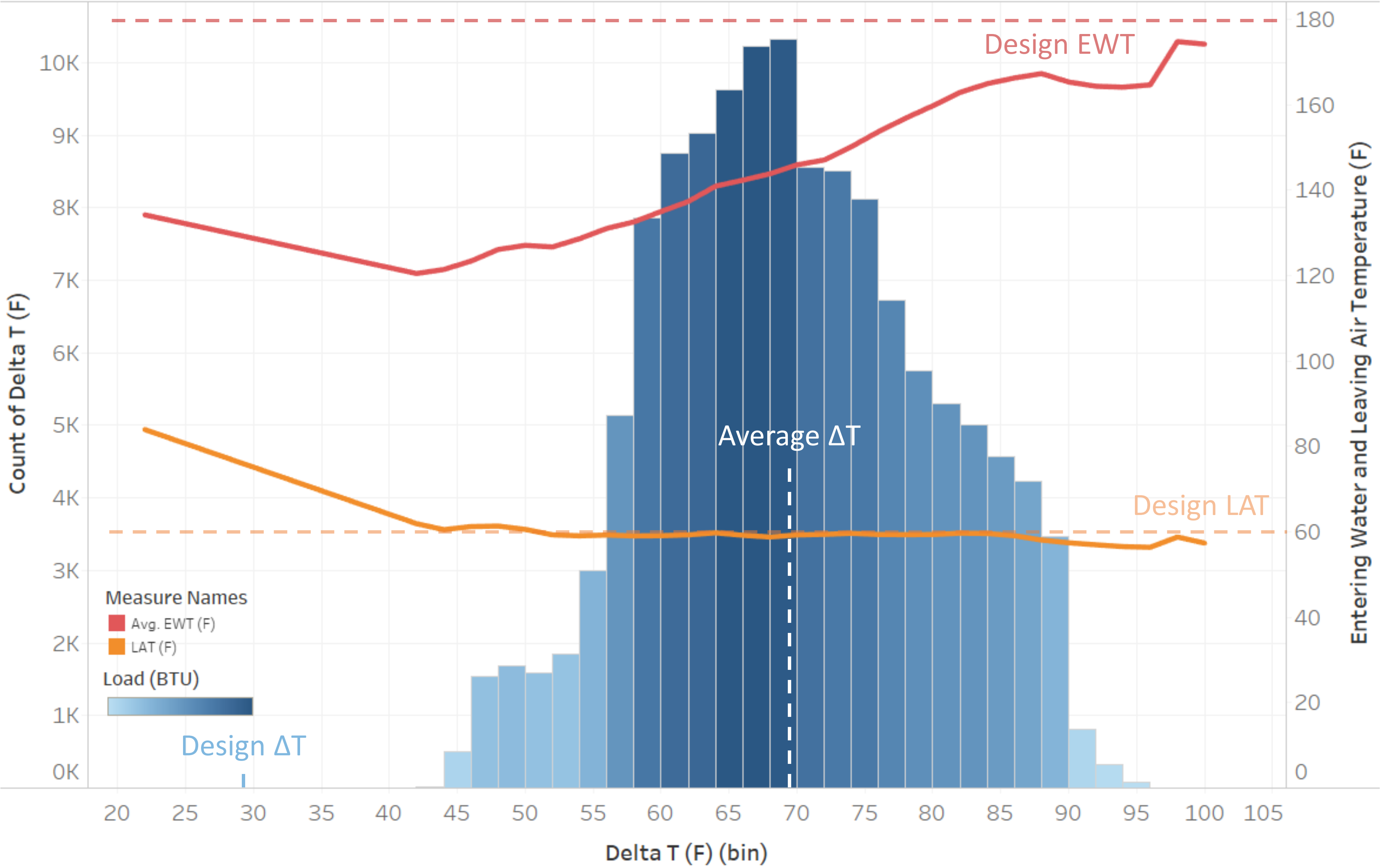
- 29.9% load
- 7.1 GPM
- **<u>63.6°F ΔT</u>** <u>(212%)</u>
- 146.7°F HWST
- 61.8°F Coil LAT

<u>Coil Design Details</u>

- Heating
- 18,500 CFM
- 693 MBH
- 45 GPM
- 30.0°F ΔT
- 200/170°F HHW
- 64.0°F Coil LAT



Coil ΔT Profile (Labs)



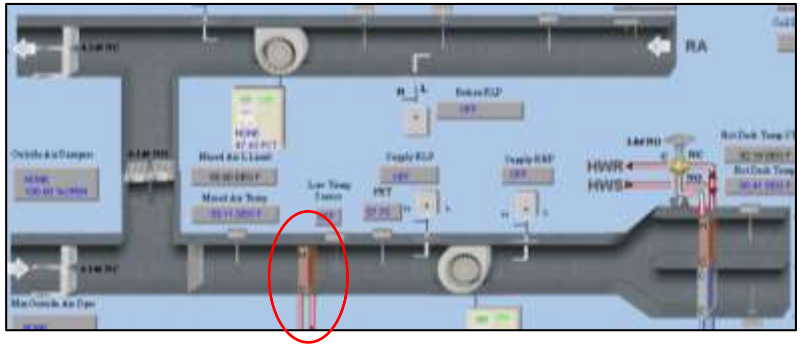
Avg. Performance

All conditions, Heating active

- 7.6% load
- 2.3 GPM
- **69.7°F ΔT** (238%)
- 145.4°F HWST
- 59.3°F Coil LAT

Coil Design Details

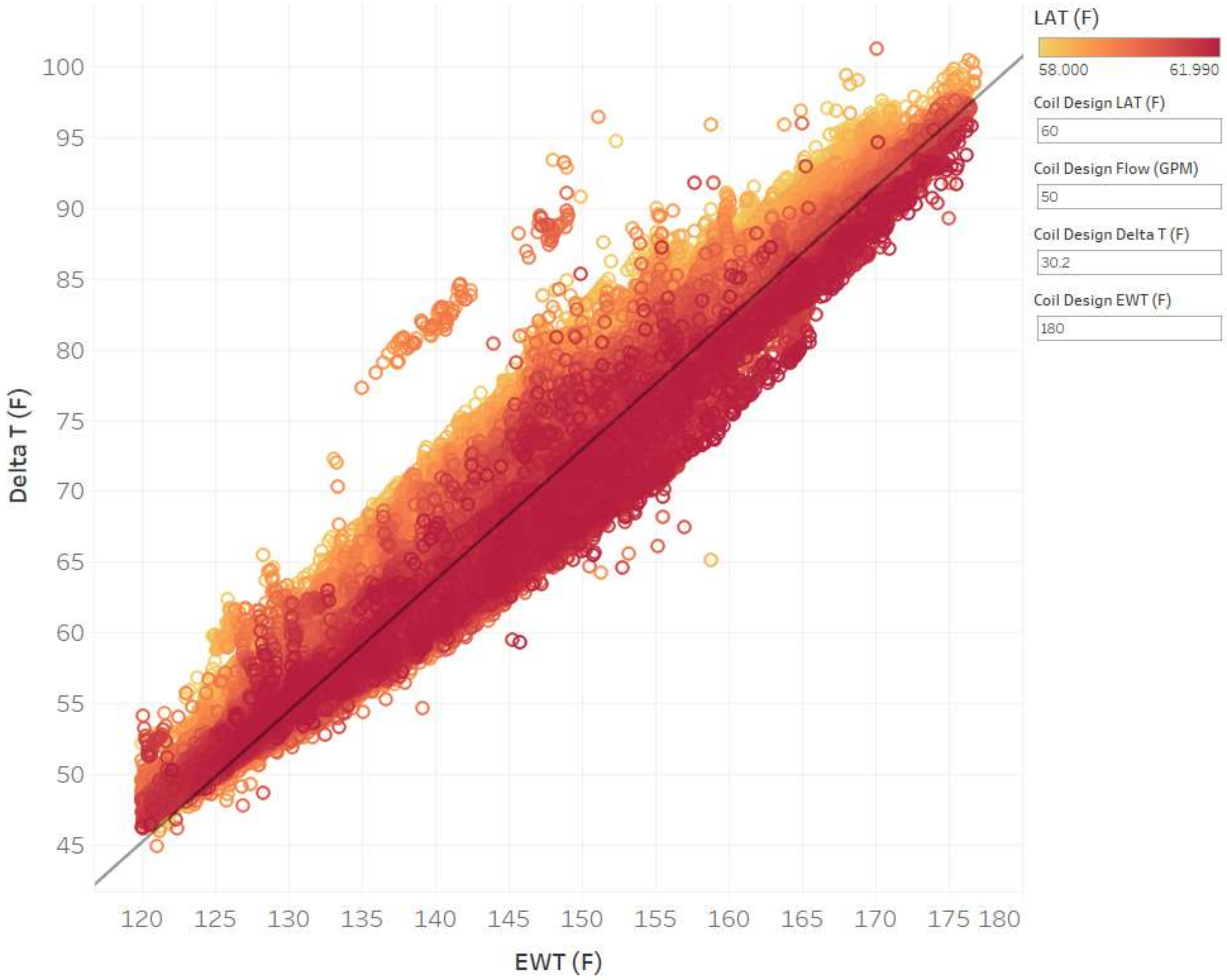
- Preheat
- 28,000 CFM
- 756 MBH
- 50 GPM
- 29.2°F ΔT
- 180/149.8°F HHW
- 60.0°F Coil LAT



Coil Performance Influencers - EWT

Entering Water Temperature

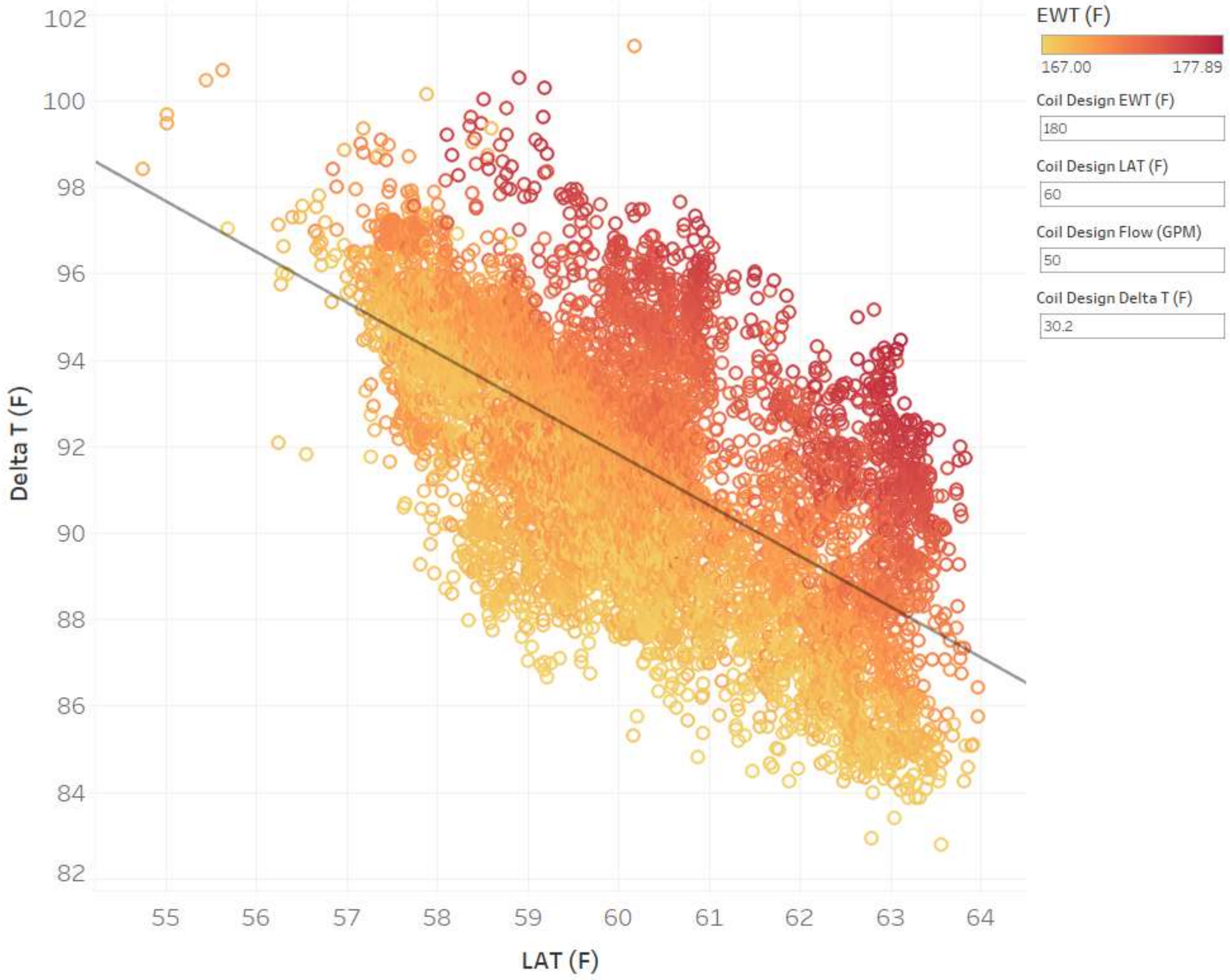
- 1°F increase in EWT increases delta T by ~0.9-1.0°F
- Higher delta T designs are more sensitive to changes
- Heat transfer improves when flow rate is stable
- Resets and boiler cycling can degrade coil performance



Coil Performance Influencers - LAT

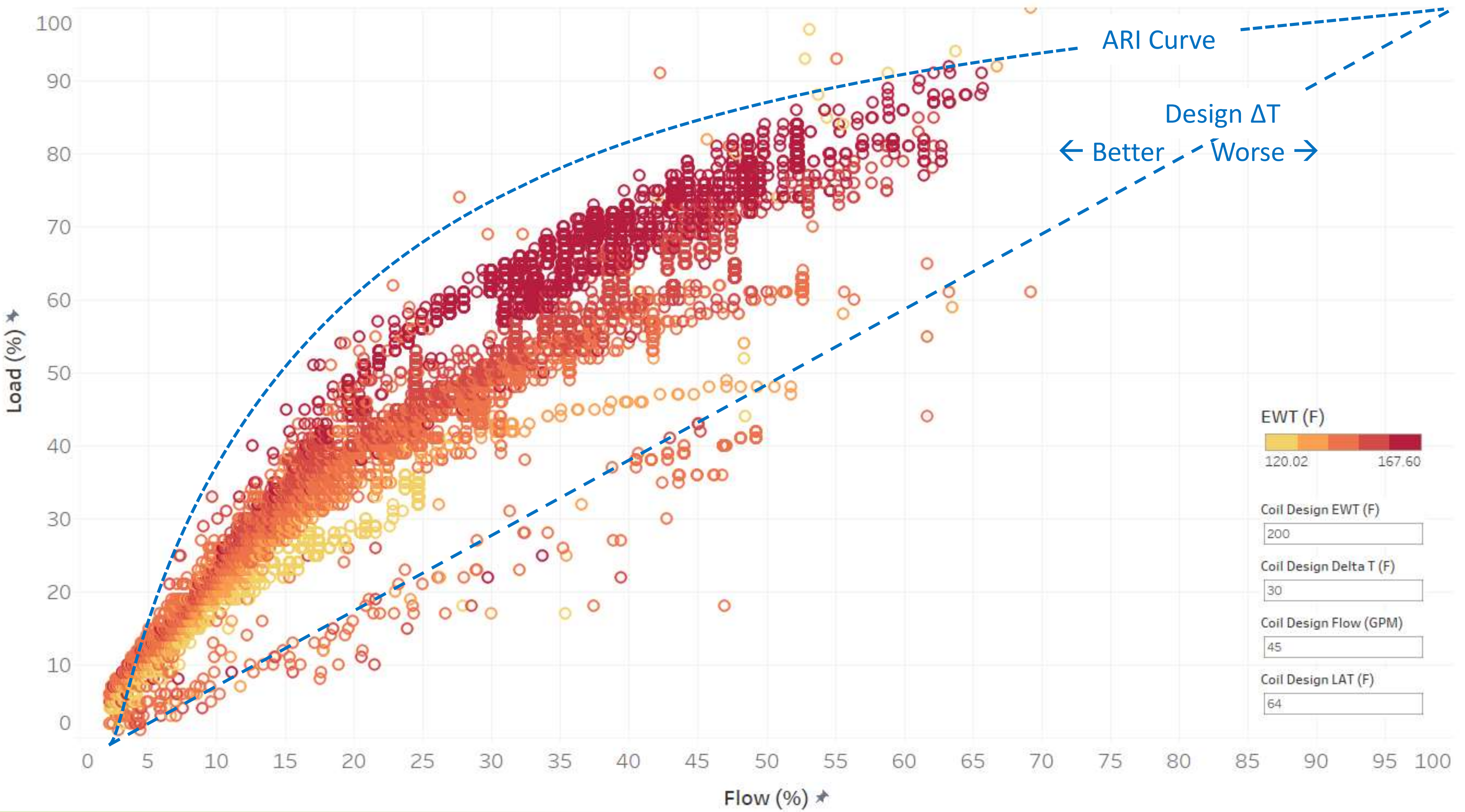
Leaving Air Temperature

- 1°F increase in LAT reduces delta T by ~0.9-1.0°F
- Higher delta T coil designs are more sensitive to changes

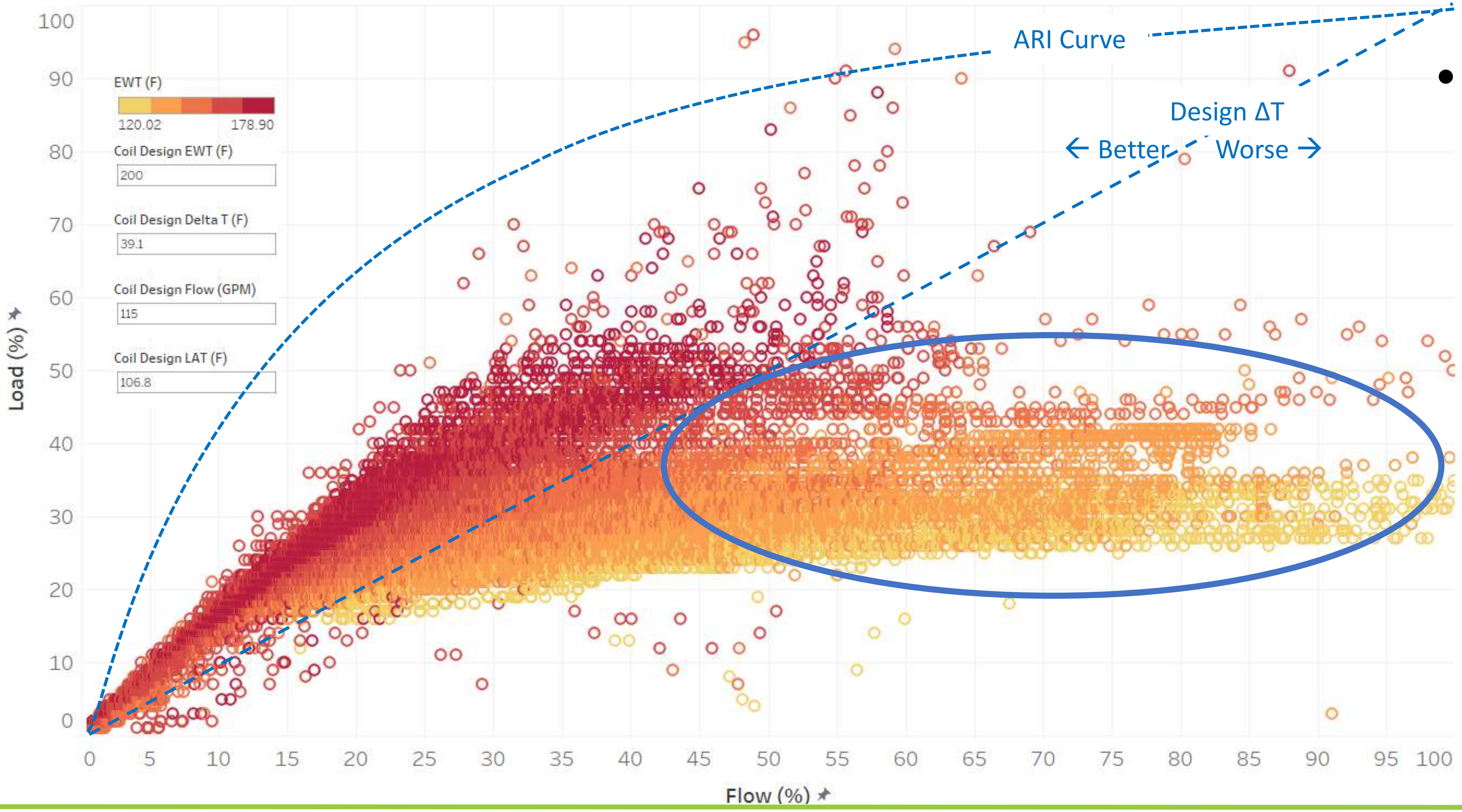


Coil Performance - Load vs. Flow

- Distinct curves associated with different EWT conditions
- Design heating is only reached with higher HWST
- Near design capacity may be served with EWT less than design



Coil Performance – Load vs. Flow



- Low EWT limits the coil heating capacity and drastically increases the required flow

Hospital Solutions & Results

- Pressure independent control conversions for CHW system
  - *Increased ΔT from ~6°F to 12-14°F*
- Variable primary conversion with improved CHW ΔT
  - *Reduction of 7,000 GPM, running 2 fewer chillers on a peak day*
- Full heating system ΔT increased from 10°F to 30°F
  - *HRC carried full winter CHW load with one 10 HP pump*
- With the new addition, the hospital ***dropped total electrical consumption by 10% and gas consumption by 20%***

Findings & Summary

- Most coils are oversized, allowing sufficient heating with lower temperature water
- Higher delta T coils are more sensitive to change in flow, and require stable control to deliver the expected performance
- Coils should exceed design ΔT, regardless of location or service
- Monitor individual loads to inform reset strategies, and utilize real-time performance metrics to proactively identify potential comfort or energy issues

Q&A // THANK YOU

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