Correcting Low $\Delta T$ in Buildings with District Cooling
District Cooling and $\Delta T$ Correction

Agenda

- What is Low $\Delta T$ Syndrome?
- Coil Design & Performance
- Why maintain $\Delta T$ at the point of water to air heat transfer?
- Common District Cooling Building Connections
  - Directly connected buildings
  - Decoupled buildings
- Causes of Low $\Delta T$ Syndrome
- Low $\Delta T$ and Pump Affinity
- Low $\Delta T$ and The Belimo Energy Valve™
- $\Delta T$ Correction in a High Rise Office Building with District Cooling
District Cooling and ΔT Correction
What is Low ΔT Syndrome?

Q(Btu/h) = 500xGPMxΔT

Low ΔT syndrome is the result of the inefficient use of chilled water at the point of consumption
## District Cooling and $\Delta T$ Correction
### Coil Design & Performance

<table>
<thead>
<tr>
<th>Chilled Water Coil</th>
<th>Component: 5</th>
<th>Length: 32 in</th>
<th>Shipping Section: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coil Model</strong></td>
<td><strong>Total Capacity</strong></td>
<td><strong>Sensible Capacity</strong></td>
<td><strong>Number of Coils</strong></td>
</tr>
<tr>
<td>5WM1008B</td>
<td>1257424 Btu/hr</td>
<td>859478 Btu/hr</td>
<td>2</td>
</tr>
<tr>
<td><strong>Air Volume</strong></td>
<td><strong>Air Temperature</strong></td>
<td><strong>Coil Air Pressure Drop</strong></td>
<td><strong>Finned Height</strong></td>
</tr>
<tr>
<td>Entering</td>
<td>Dry Bulb: 25000 cfm</td>
<td>Wet Bulb: 79.4 °F</td>
<td>Wet Bulb: 65.4 °F</td>
</tr>
<tr>
<td>Leaving</td>
<td>Dry Bulb: 42.0 °F</td>
<td>Wet Bulb: 56.0 °F</td>
<td><strong>Flow Rate</strong></td>
</tr>
</tbody>
</table>

### Water Connection

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
<th>Size</th>
<th>Location</th>
<th>Material</th>
<th>Min. Fin Surface Temp.</th>
<th>Min. Tube Wall Surface Temp.</th>
<th>Fouling Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded</td>
<td>2</td>
<td>2.50 in</td>
<td>Opp drive side</td>
<td>Carbon steel</td>
<td>42.0 °F</td>
<td>42.0 °F</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Drain Pan</th>
<th>Drain Side</th>
<th>Turbospiral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum .0075 in</td>
<td>Copper .035 in</td>
<td>Copper</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>Drive side</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
District Cooling and $\Delta T$ Correction
Why maintain $\Delta T$ at the point of water to air heat transfer?

- **Utilities rates change based on $\Delta T$**
  - The lower the $\Delta T$ the higher the rate
  - Rates can increase during demand hours
- **Reducing the flow transfers problems from the plant to the buildings**
- **Cooling coils should not operate below their design $\Delta T$**
- **Supply water temperature shouldn’t be increased to a point that compromises coil performance**
District Cooling and $\Delta T$ Correction
Direct Connected Buildings

- **Directly connected building with a booster pump**
  - Adds head pressure to guarantee flow but could compromise flow to other buildings on the loop
District Cooling and $\Delta T$ Correction
Direct Connected Buildings

- Directly connected building with a pressure regulating valve
  - Valve reduces the supply side pressure to coils & valves

![Diagram of district cooling system with pressure regulating valve.](image-url)
District Cooling and $\Delta T$ Correction
Direct Connected Buildings

- **Directly connected building**
  - Reliant on the pressure provided by the distribution system
District Cooling and \( \Delta T \) Correction

Direct Connected Buildings

- Directly connected building with booster pump & bypass
  - Increases pressure as needed at higher loads
District Cooling and $\Delta T$ Correction
Decoupled Buildings

- Decoupled building with entering water and crossover control valves
  - Inlet valve regulates water flow on the supply side and the valve in the crossover is used to regulate water temperature
District Cooling and $\Delta$T Correction
Decoupled Buildings

- Decoupled building with return water temperature control valve
  - Circulates water until it is at the design return water temperature
District Cooling and $\Delta T$ Correction
Decoupled Buildings

- **Decoupled building with a heat exchanger**
  - Fully separates the building from the distribution loop, there is a potential for heat transfer loss at the heat exchanger
District Cooling and $\Delta T$ Correction
Pump Affinity $10^\circ\Delta T$ vs $12^\circ\Delta T$ @ 100 Tons

\[ GPM = \frac{100 \times 24}{10^\circ\Delta T} \]

\[ GPM = 240 \]

\[ (240/200)^3 = 1.728 \]

73% more horsepower

\[ GPM = \frac{100 \times 24}{12^\circ\Delta T} \]

\[ GPM = 200 \]

$2^\circ F$ decrease in $\Delta T$
District Cooling and $\Delta T$ Correction

Causes of Low $\Delta T$

- Equipment designed for different $\Delta T$’s
- Three way valves allow chilled water to bypass coils at part load
- Resetting the supply air temperature set point above design can lead to unstable control and low return water temperature
- Coils that are not piped with water flow counter flow to air flow reduce the heat transfer efficiency of the coil compromising return water temperature
- Mixing flow from chilled water supply to chilled water return through the de-coupler or bypass adversely effects the return chilled water temperature
District Cooling and $\Delta T$ Correction

Causes of Low $\Delta T$

- Oversized chillers, pumps, coils, control valves and piping
- Controlling the chilled water valve using only the air sensor
- Manual balancing only addresses one flow condition
- Systems rarely run at full load causing overflow at part load
- Hydronic systems are changed but not rebalanced
District Cooling and $\Delta T$ Correction

Causes of Low $\Delta T$

- Laminar coil flow reduces overall heat transfer capacity of the coil
  - Laminar flow occurs when water flows in parallel layers and doesn't mix.
  - When water travels through a coil too slow it causes laminar flow.
  - The heat transfer efficiency of hydronic coils is based on turbulent flow.
The Belimo Energy Valve™ can measure flow, temperature and calculate $\Delta T$. With this information adjustments can be made to maximize the efficiency of hydronic coils.

Actuator & Controller

Flow Meter

Control Valve

Temperature Sensors
District Cooling and $\Delta$T Correction
Original Basis of Design. June of 1984

- 15 Story High Rise Office Building
- 15 Air Handlers
  - GPM Ranges from 71.2 – 86.5
  - 15°F Design $\Delta$T
- Average Building $\Delta$T Between 8°F - 11°F
- Average Monthly Low $\Delta$T Penalty of $1,090.00
- Maximum Average Flow in Excess of 550 GPM
# District Cooling and $\Delta T$ Correction

## Project Metrics

<table>
<thead>
<tr>
<th>Project Scope</th>
<th>Install 15 Energy Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost to Implement</td>
<td>$53,474.00</td>
</tr>
<tr>
<td>Annual Cost Avoidance</td>
<td>$22,821.00</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>2.4 Years</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>40%</td>
</tr>
<tr>
<td>Min/Max Average GPM Reduction</td>
<td>&gt;200 GPM</td>
</tr>
</tbody>
</table>
THANK YOU