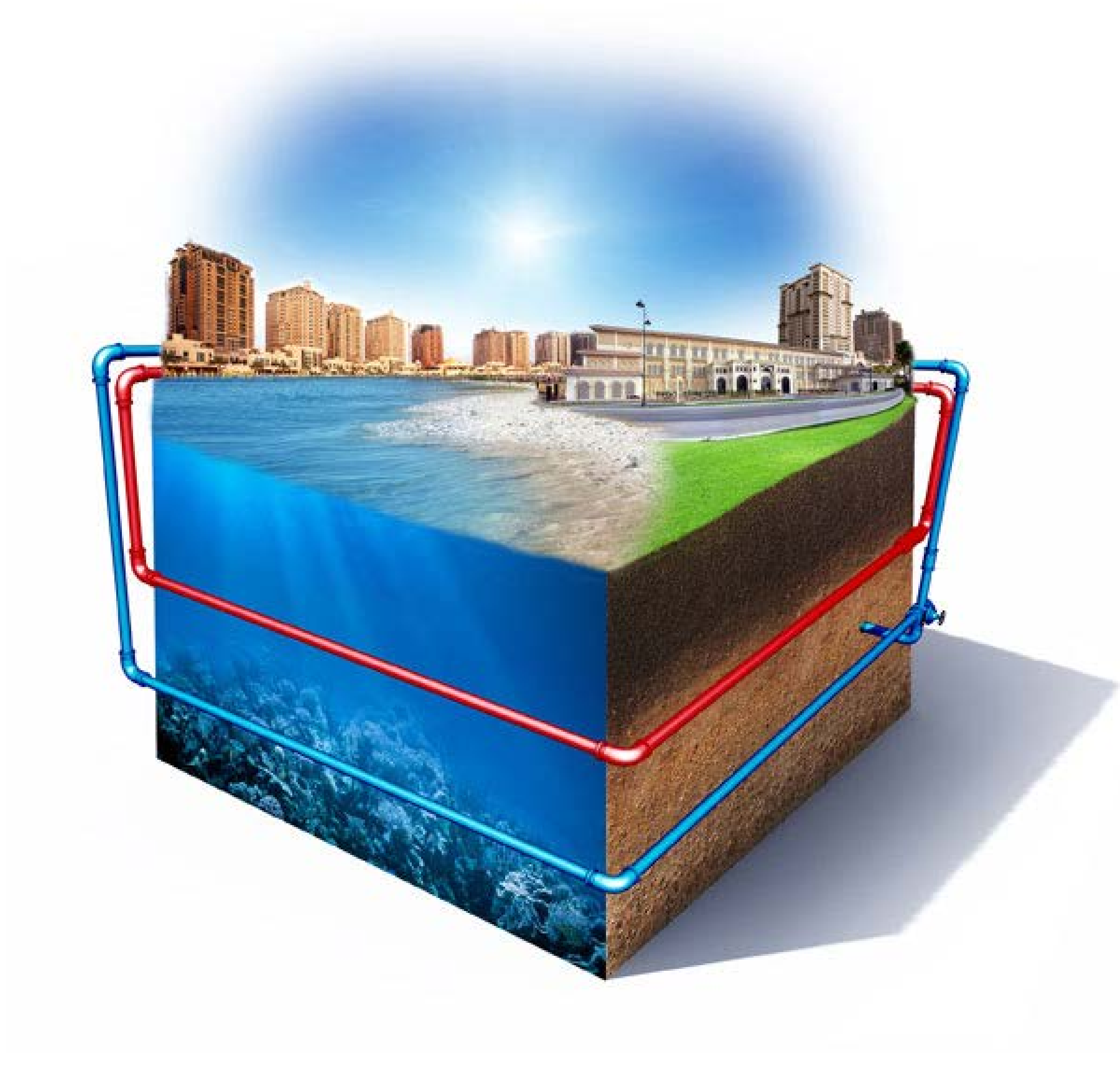
Correcting Low ΔT in Buildings with District Cooling



District Cooling and ΔT Correction
Agenda

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

District Cooling and ΔT Correction

What is Low ΔT Syndrome?

$$Q(\text{Btu/h}) = 500xGPMx\Delta T$$

Low ΔT syndrome is the result of the inefficient use of chilled water at the point of consumption

District Cooling and ΔT Correction

Coil Design & Performance

Chilled Water Coil		Component: 5		Length: 32 in		Shipping Section: 4	
Coil Model	Total Capacity	Sensible Capacity	Number of Coils	Number of Rows	Fins per Inch	Tube Diameter	Tube Spacing (Face x Row)
5WM1008B	1257424 Btu/hr	859478 Btu/hr	2	8	10	0.625 in	1.50 in x 1.299 in

Air Volume	Air Temperature				Coil Air Pressure Drop	Finned Height	Finned Length	Face Area	Face Velocity
	Entering		Leaving						
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb					
25000 cfm	79.4 °F	65.4 °F	48.0 °F	47.8 °F	0.64 inWc	39 in	123 in	66.63 ft²	375 ft/min

Water		Flow Rate	Pressure Drop	Velocity	Volume	Weight	Piping Vestibule
Entering	Leaving						
42.0 °F	56.0 °F	180.00 gpm	16.20 ftHd	2.80 ft/s	68.0 gal	570.00 lb	24 in

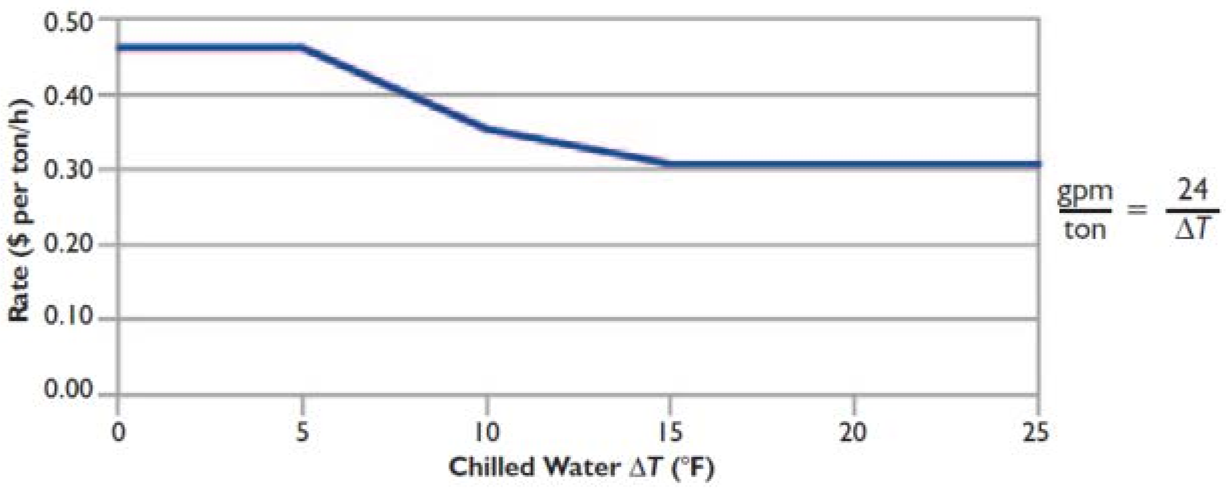
Connection					Min. Fin Surface Temp.	Min. Tube Wall Surface Temp.	Fouling Factor
Type	Quantity	Size	Location	Material			
Threaded	2	2.50 in	Opp drive side	Carbon steel	42.0 °F	42.0 °F	0.000

Material				Drain Pan	Drain Side	Turbospiral
Fin	Tube	Header	Case			
Aluminum .0075 in	Copper .035 in	Copper	Stainless steel	Stainless steel	Drive side	Yes

District Cooling and ΔT Correction

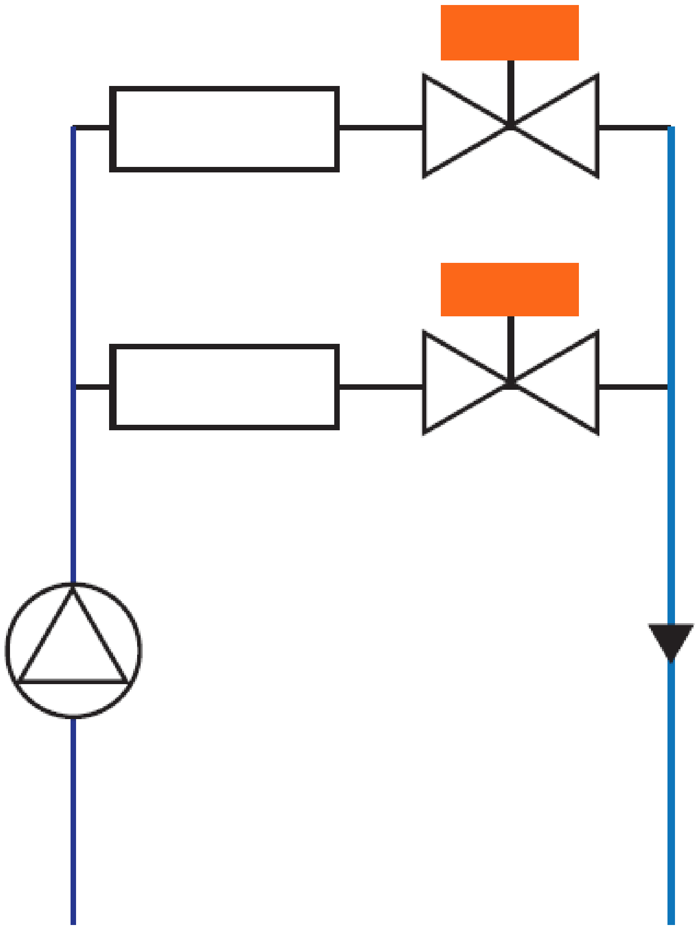
Why maintain ΔT at the point of water to air hear transfer?

- **Utilities rates change based on ΔT**
  - The lower the ΔT 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 ΔT**
- **Supply water temperature shouldn't be increased to a point that compromises coil performance**



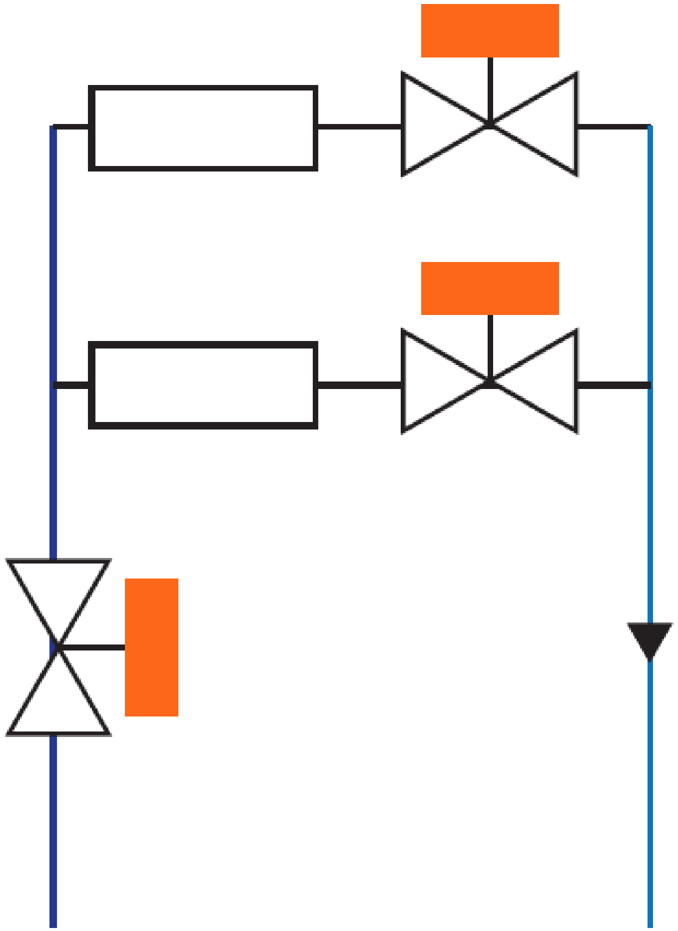
District Cooling and ΔT Correction
Direct Connected Buildings

- **Directly connected building with a booster pump**
  - Adds head pressure to guarantee flow but could compromise flow to other buildings on the loop



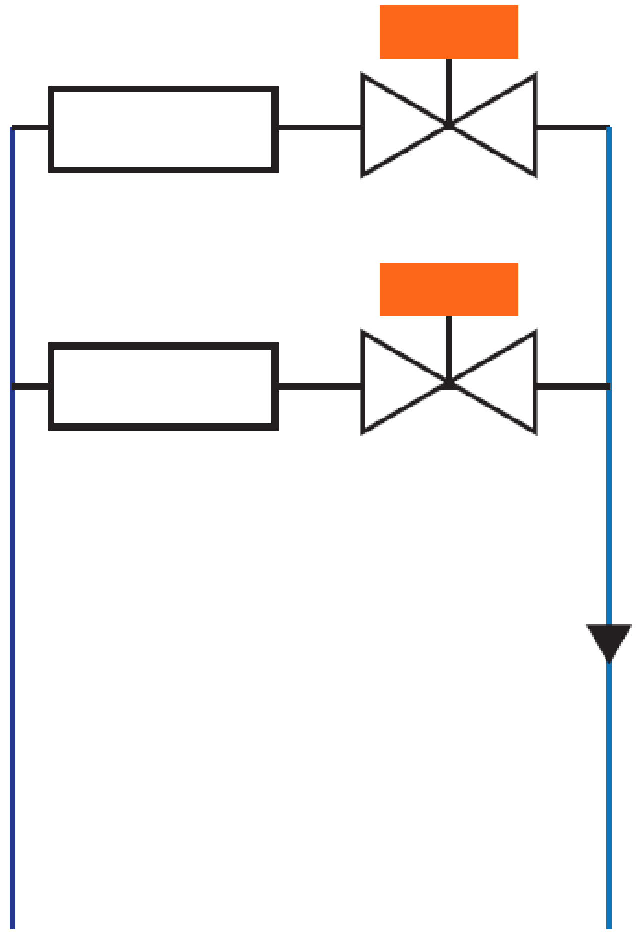
District Cooling and ΔT Correction
Direct Connected Buildings

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



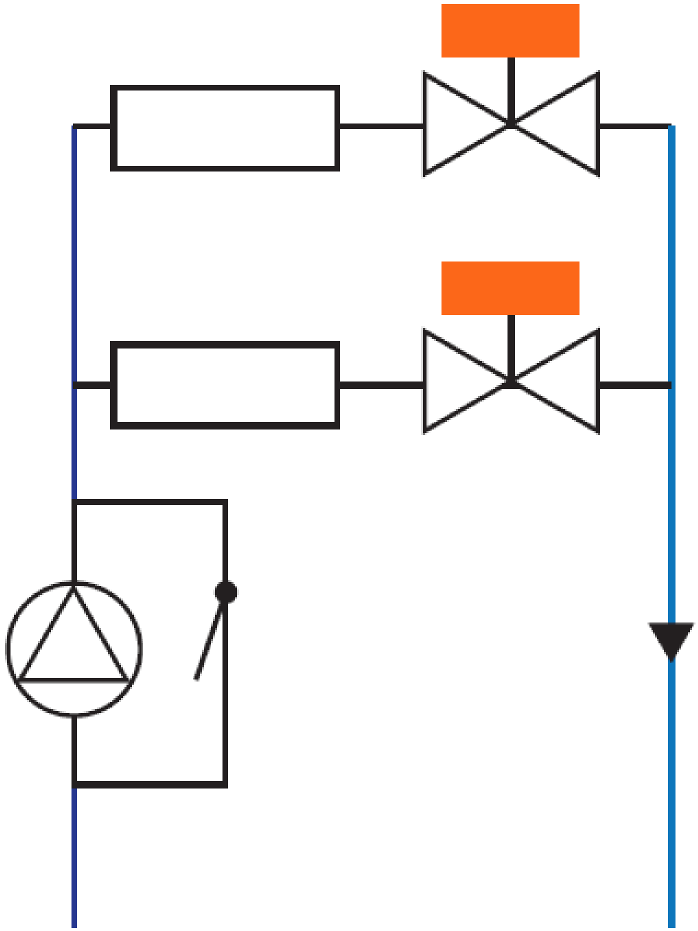
District Cooling and ΔT Correction
Direct Connected Buildings

- **Directly connected building**
  - Reliant on the pressure provided by the distribution system



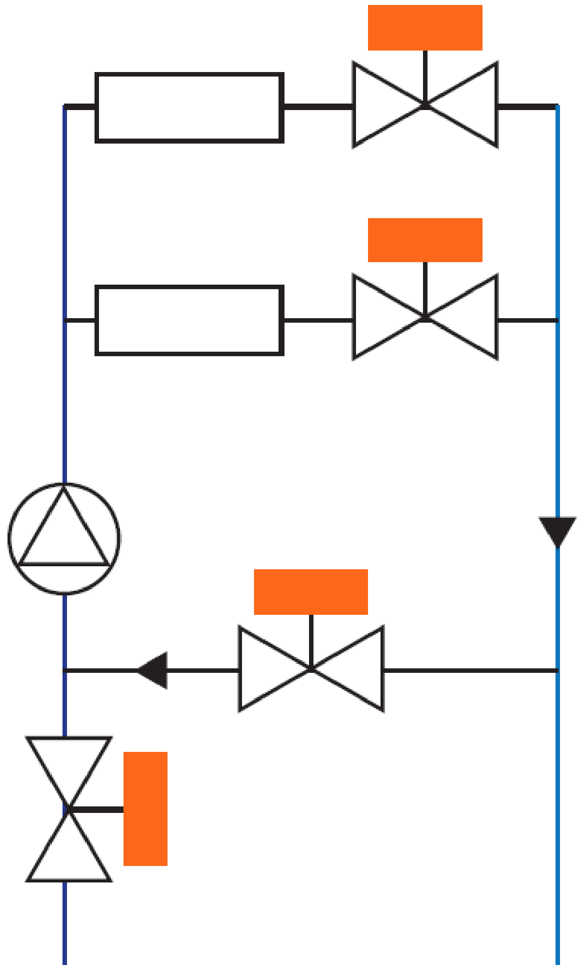
District Cooling and ΔT Correction
Direct Connected Buildings

- **Directly connected building with booster pump & bypass**
  - Increases pressure as needed at higher loads



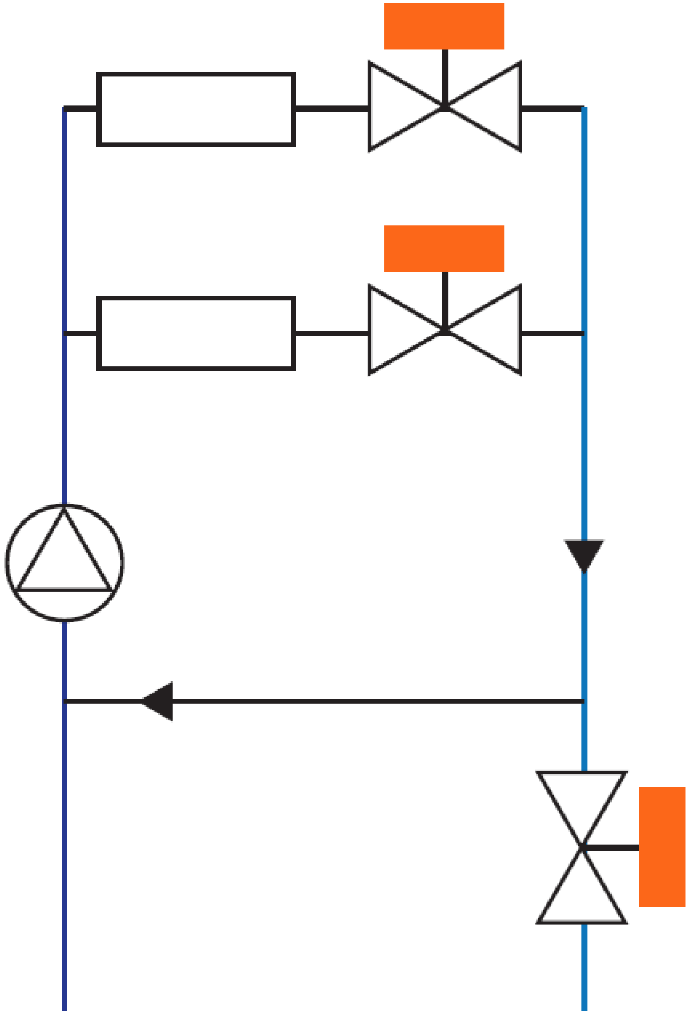
District Cooling and ΔT Correction
Decoupled Buildings

- **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



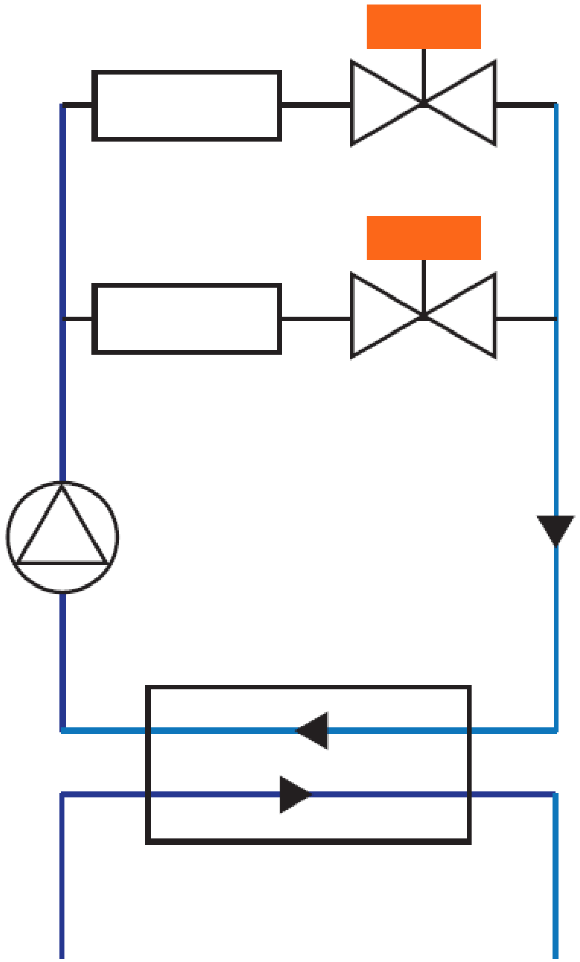
District Cooling and ΔT Correction
Decoupled Buildings

- **Decoupled building with return water temperature control valve**
  - Circulates water until it is at the design return water temperature



District Cooling and ∆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 ΔT Correction

Pump Affinity 10°ΔT vs 12°ΔT @ 100 Tons

$$GPM = \frac{100 \; x \; 24}{10°\Delta T}$$

$$GPM = 240$$

$$(240/200)^3 = 1.728$$

73% more horsepower

$$GPM = \frac{100 \; x \; 24}{12°\Delta T}$$

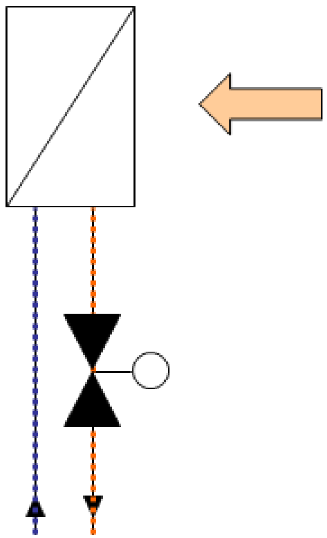
2°F decrease in ΔT

$$GPM = 200$$

District Cooling and ∆T Correction

Causes of Low ∆T

- **Equipment designed for different ΔT'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 ΔT Correction

Causes of Low ΔT

- **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**

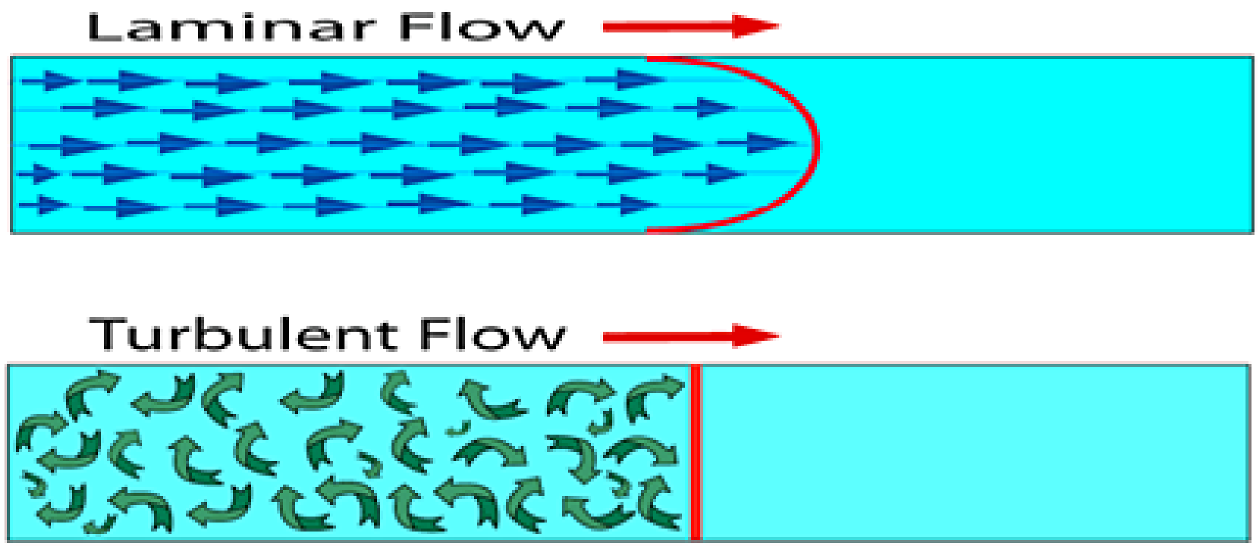





District Cooling and ΔT Correction

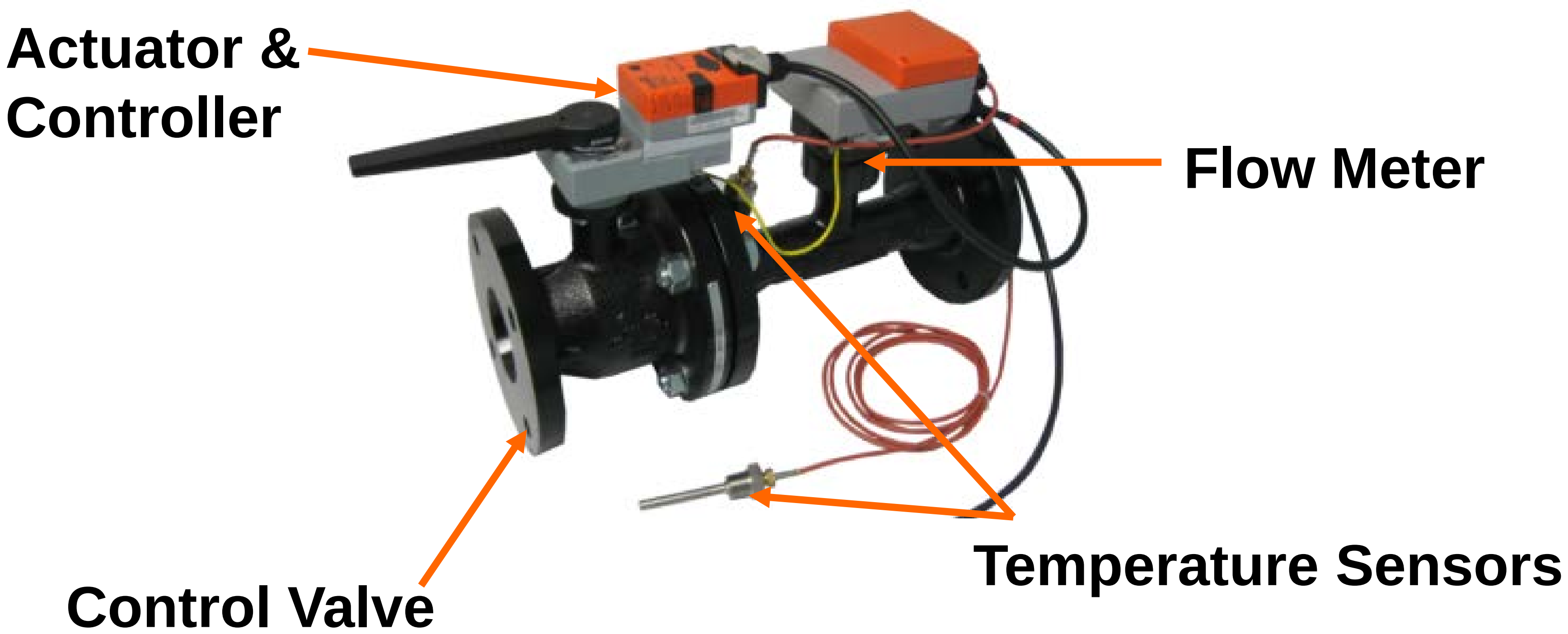
Causes of Low ΔT

- **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.



District Cooling and ΔT Correction

The Belimo Energy Valve™ can measure flow, temperature and calculate ΔT. With this information adjustments can be made to maximize the efficiency of hydronic coils.



District Cooling and ΔT 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 ΔT
- **Average Building ΔT Between 8°F - 11°F**
- **Average Monthly Low ΔT Penalty of $1,090.00**
- **Maximum Average Flow in Excess of 550 GPM**

A/C UNIT SCH

(A) = COMBINATION MAG-X-LINE.
(B) = AUTO. TRANSFORMER.
(C) = HAND-OFF-AUTO. SWITCH, 120 VOLT CONTROL TRANSFORMER, & PILOT LIGHT.
(D) = MANUAL MOTOR STARTER.
(1) = MOTORIZED INLET VANES.
(2) = G3TWPSC MOTOR, A-COIL, MED SPEED, BACK DUCT COLLAR, 1" TA FILTER

IDENT.	AREA SERVED	TYPE	LOW, MED, OR HIGH PRESSURE	MANUFACTURER MODEL NO.	FAN			OUTSIDE AIR		COOLING COIL										
					CFM	EXT. SP.(1)	TOT. SP.	MINIMUM	MAXIMUM	MAX. FV	ENTERING D.B./W.B.	LEAVING D.B./W.B.	SENS. BTU / HR.	GTH BTU / HR.	GPM CH. WTR.	CH. WTR. ENT./LVG.	ROWS & FINS/FT	MAX. AIR SP. LOSS	MAX. PD.
A/C#1	BANK LEVEL 1	VERTICAL DRAW-THRU	MED	TRANE 31	15,480	2.5	3.4	1500	1500	510	80/65.5	53.0/52.7	---	592,500	78.9	42/57	6/104	0.82	7
A/C#2	BANK LEVEL 2	VERTICAL DRAW-THRU	MED	TRANE 31	13,940	2.5	3.2	1500	1500	460	80/65.5	53.0/52.7	---	534,600	71.2	42/57	6/97	0.67	6
A/C#(3-14)	TYPICAL FLOOR	VERTICAL DRAW-THRU	MED	TRANE 31	15,920	2.5	3.1	1500	1500	520	80.2/65.5	53.0/52.6	---	613,200	81.7	42/57	6/125	0.61	8
A/C#15	LEVEL 15	VERTICAL DRAW-THRU	MED	TRANE 31	16,900	2.5	3.2	1500	1500	555	80.3/65.6	53.0/52.6	---	649,700	86.5	42/57	6/130	0.69	8
FCU-1	FIRE COMMAND RM	FAN COIL UNIT	LOW	TRANE UNITRANE SIZE 4 MODEL C	260	0.5	---	0	0	180	75/63	---	4,300	4,900	1.3	42/52	---	---	2
FCU-2	ELECTRICAL ROOM	FAN COIL UNIT	LOW	TRANE UNITRANE SIZE 10 MODEL D	1460	0.05	---	0	0	450	75/63	---	22,200	25,000	5.7	42/52	---	---	5

District Cooling and ΔT Correction
Project Metrics

Project Scope	Install 15 Energy Valves
Cost to Implement	$53,474.00
Annual Cost Avoidance	$22,821.00
Simple Payback	2.4 Years
Return on Investment	40%
Min/Max Average GPM Reduction	>200 GPM

THANK YOU