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Investigating Issues in Large Hydronic Heating and Cooling Systems

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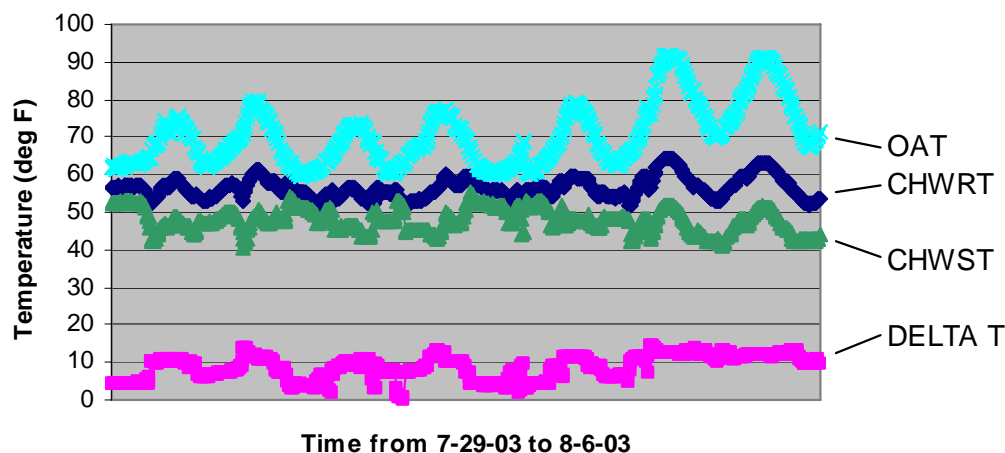
The information provided here is intended as a guide to explore hot and chilled water system performance issues that have been readily addressed with proper selection, application, and control of high quality pressure independent modulating control valves (DeltaPValves[®]). Treated as projects to improve available capacity, energy efficiency, and performance, there are many opportunities for outstanding investments in most large facilities with central heating and cooling. More details about the technology and specific applications may be found by contacting Flow Control Industries or reviewing the website at <http://www.flowcontrol.com>.

Issues to Investigate in Existing Facilities

Poor distribution delta T relative to design is the first and best indicator of serious issues with hot and chilled water system performance. In Figure 1 below, notice that chilled water delta T at the central plant falls short of design (14°F) at all outside air temperature conditions shown. This means excess flow is required per ton cooling. In addition, high distribution supply water temperature relative to coil design is another key indicator of problems.

In this case shown below, chilled water supply temperature (CHWST) varies wildly due to return water blending with supply due to low delta T through non-operating chillers. Both low delta T and high CHWST represent an excellent opportunity to increase available capacity, reduce energy consumption, and improve thermal stability. A similar chart provides excellent detail about overall hot water system performance.

Figure 1: University Central Plant Chilled Water System Data





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The data above is useful for analysis whether it captures the performance of an entire system or individual loops, buildings, or coils. ***To truly understand system performance, make sure that this data is monitored and collected in each of the pumping loops. If possible, it is also very beneficial to measure flow.*** Be aware that techniques used to control return water temperature back to the central plant only shifts the problem from the plant. Secondary and tertiary pump horsepower as well as air handler fan energy may rise. Humidity and temperature control may become issues.

Limited Capacity Chillers at Part Load

In most systems, delta T degrades significantly at part load. With low delta T relative to design, a single chiller in a multiple chiller system may reach its evaporator flow limit before delivering the full rated tons. In humid climates in particular, an additional chiller and its accessories are commonly run to sustain distribution chilled water supply temperature at design. ***To investigate this issue, explore how many tons cooling are delivered just before the next chiller is run.*** It is very common to walk through a central plant on a part load day and see too much equipment running. Individual chillers should be able to deliver the full installed tonnage. This won't happen with low delta T.

Limited Capacity Condensing Boilers

Condensing boilers require low return water temperature to operate in condensing mode. In systems with low hot water delta T, condenser mode operation may rarely occur, unless supply water temperature is reduced. This limits the utility of the coils and the boiler. With low supply water temperature, coil capacity is limited and fan energy may rise. ***Check to see what supply water temperature is reaching the hot water coils relative to coil design. See if the return water temperature is low enough to support condensing mode for the bulk of operating conditions.***

Unexpected Choke Points in Piping Systems

There are many large facilities across the country that proceed with hot or chilled water distribution system analysis and find, upon measuring actual performance, that higher than expected pressure drop exists at certain points in the system. Expensive projects are subsequently funded to increase pipe size or pump horsepower to address the issue. ***Consider the possibility that low delta T problems have generated this excess flow and pressure drop.*** As an example, consider a 12°F design delta T system operating at 9°F delta T at peak load. If delta T is raised to 15°F, flow is reduced by 40% and pressure drop is reduced by 64%. Fixing the low delta T issues is typically far less disruptive and expensive than purchasing additional horsepower or increasing pipe size to address the issue.

Flow Limited Central Plant

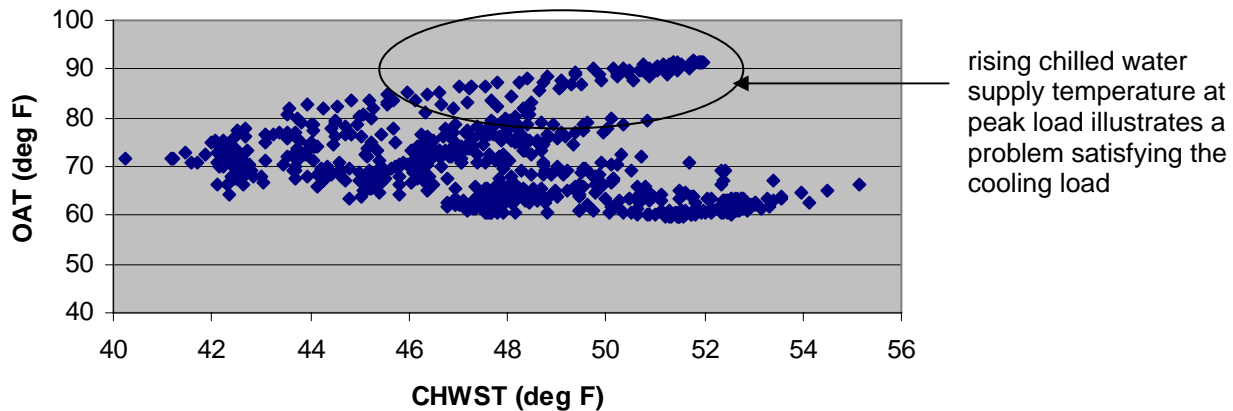
When delta T is less than design at peak load, a system can't deliver its full rated capacity. In a chilled water system, this may lead to hot calls on peak days. Too much chilled water provided to coils in one location may starve another. The best evidence of this is rising chilled water supply temperature on hot days. Poorly performing facilities have more installed tonnage than can be delivered. See Figure 2. ***In addition to low peak load delta T, the key things to look for are hot***



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calls on high load days, chilled water supply temperature increasing with rising cooling load, and an inability to deliver the installed tonnage of the plant.

Figure 2: Illustration of a Flow Limited Central Plant



Flow Limited Coils

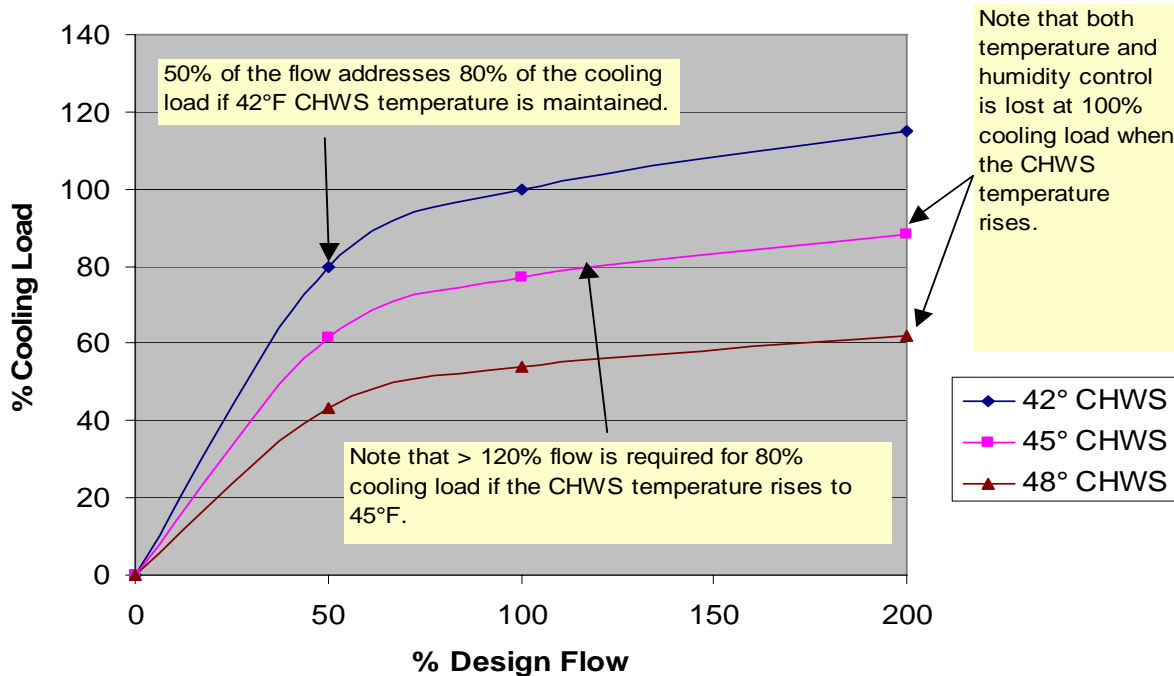
If water supply temperature to a cooling coil is above design, more water flow is required to achieve the same cooling for a given air flow. Likewise, if water supply temperature to a heating coil is below design, more water flow is required to achieve the same heating for a given air flow. At higher loads, balancing valves may limit the available flow. Hot and chilled water demand exceeds available supply and the discharge air temperature setpoint is not achieved. To maintain comfort conditions, additional air flow (if available), is required.

In a chilled water system, limited coil capacity occurs when return water blends with supply and raises the temperature. In a primary/secondary system, return water blending is likely to occur through the common leg or building bridge. In a variable primary flow system (with or without booster pumps), it typically occurs through one of the non-operating chillers. In a hot water system, limited coil capacity is prevalent in systems where the hot water supply temperature is adjusted downward to enable better condensing mode boiler operation. Poor quality control valves may also lead to this downward reset as operators attempt to minimize overheating.

To explore these issues, look for cases where supply water temperature to cooling coils is higher than coil design, hot water supply temperatures have been reduced, or more control valves than expected are operating full open at part load. In many cases it is common to find that the operators have either lowered the cooling coil leaving air temperature setpoint below design in an attempt to achieve more cooling or they have raised the setpoint above design because the system was unable to meet the mark in the first place. If variable speed fans are used on these coils, it is not unusual to find that they are running at higher frequency than desired for the majority of the time.



Figure 3: The Effect of Rising Chilled Water Supply Temperature on Coil Capacity



Limited Thermal Energy Storage

Low delta T in a system with thermal energy storage results in less tank capacity than anticipated and a reduction in the time during the peak hours that it is effective. Increasing the delta T to reduce the flow per ton cooling extends the operating hours of the tank. This is especially important in regions where utilities have peak load ratchet rates. **Check to see if the tank is providing chilled water for the total hours intended during the day.**

VFD's Running at Near Full Speed

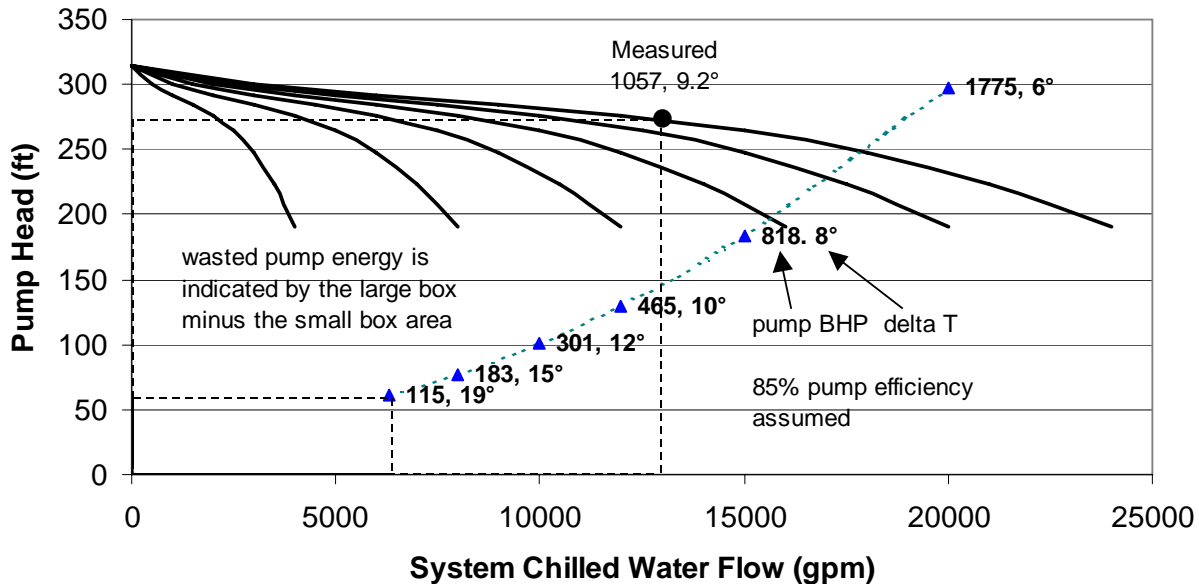
The sole purpose of a variable frequency or adjustable speed drives is to permit less air and water flow during part load operating conditions to save energy. In most applications, fan and pump horsepower can be estimated to vary as the cube of the flow. Reducing flow by 10% reduces power consumption by 27%. Reducing flow by 25% reduces power consumption by 42%. Reducing flow by 50% reduces power consumption by 88%. If demand for flow is not reduced during operation off peak, the installed VFD is not able to save energy as intended.

In a hydronics system, if delta T is 50% of design at 50% load, the VFD is running the pump 100%. The pump may as well be operating at constant speed. The demand for flow has not decreased at part load. In investigating a trace of pump speed vs. time, it is common to find very little turndown. Figure 4 illustrates the wasted pump energy with low delta T performance in a actual chilled water system.



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Figure 4: Pump Energy at 5,000 Tons Cooling and 6 to 19° Delta T



There has been a lot of emphasis in the HVAC industry about minimizing pressure drop across control valves to save pump energy. Pump energy is a function of BOTH pressure drop AND flow. Ignoring the flow element is short sighted. In Figure 4 above, note that low delta T places the system operation high and right on the chart. Conversely, low delta T minimizes the energy consumption by dramatically reducing the flow. The effect of control valve pressure drop alone is negligible. The example in Table 2 below illustrates the pump energy required to deliver chilled water through a single coil at various delta T's. In the bulk of the system, the differences in flow and pressure drop to serve the load are shown with no change, however, pressure drop through the circuit and conventional control valves vary with the square of the flow. The conventional control valve shown was selected for 4 psid (9.2 ft) and the pressure independent valve 5 psid (11.6 ft).

Valve type	Expected Performance		Design Conditions	
	Conventional	Press. Indep.	Conventional	Press. Indep.
Delta T at 100 tons	8°F	18°F	12°F	12°F
Flow at 100 tons	300 gpm	133 gpm	200 gpm	200 gpm
Pressure drop				
Pump fittings	8 ft	8 ft	8 ft	8 ft
Chiller and fittings	17 ft	17 ft	17 ft	17 ft
Distribution piping	80 ft	80 ft	80 ft	80 ft
Circuit piping	11.3 ft	2.2 ft	5 ft	5 ft
Cooling coil	22.5 ft	4.4 ft	10 ft	10 ft
Control valve	<u>15.6 ft</u>	<u>11.6 ft</u>	<u>9.2 ft</u>	<u>11.6 ft</u>
	154.4 ft	123.2 ft	129.2 ft	131.6 ft
Pump BHP at 85% eff	13.8	4.9	7.7	7.8



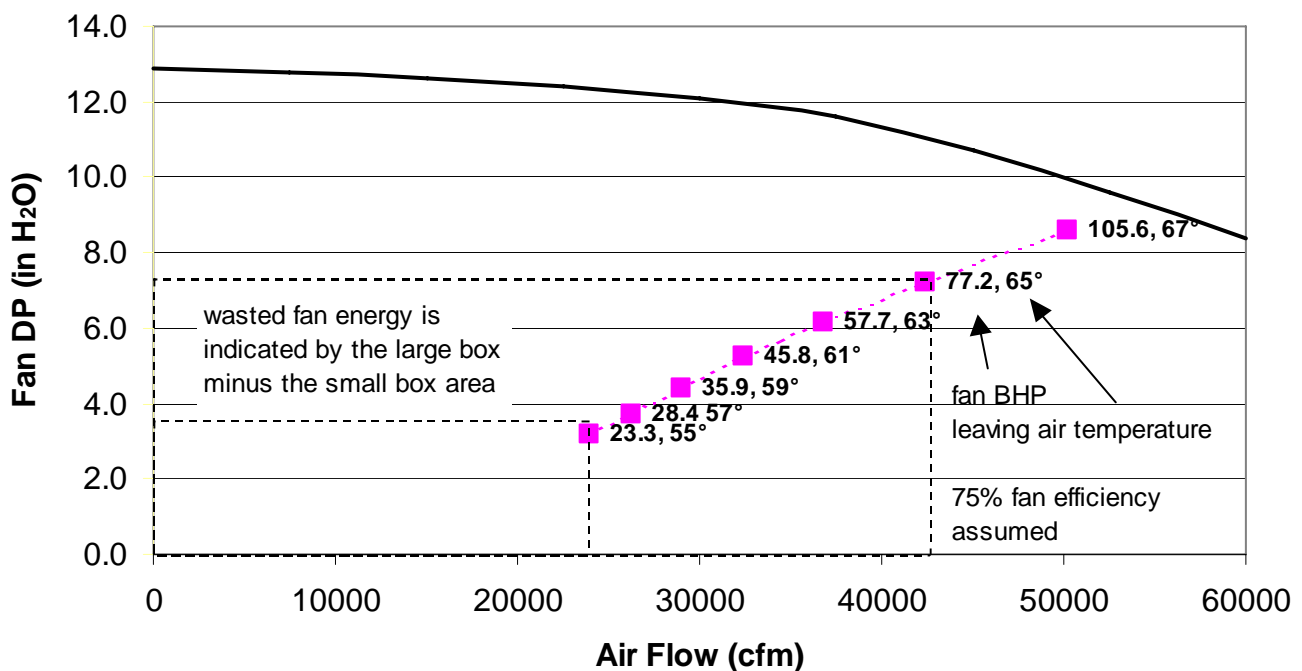
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Table 1: Pump BHP Consumed (actual vs. design) at Single AHU Coil

Delta T rises above design for pressure independent valves but typically falls short for conventional control valves, especially at part load. This example illustrates that the pump energy required to serve the coil is reduced by 64% from 13.8 to 4.9 brake horsepower. **Be sure to recognize that delta T and flow typically have a much greater influence on pump energy than pressure drop across control valves alone.**

As the chilled water supply temperature rises, more air flow is required for an air handler to sustain the leaving air temperature at certain load conditions. Figure 5 illustrates the impact on fan energy when the leaving air temperature setpoint is raised or can't be achieved at a single 45,000 cfm air handler at a constant 50 ton sensible cooling load.

Figure 5: Fan Energy at 50 Tons Sensible Cooling and 55 to 65°F Leaving Air Temperature



If a fan or pump VFD operates near full speed for most of the time, there is clearly a problem. The benefit of investments made for variable flow are not fully realized. **Check to see that the leaving air temperature has not been raised to deal with high chilled water supply temperature and that the fan actually runs at well less than 100% as intended.**

Undercooling / Subcooling / Reheat

Any change in differential pressure across a conventional pressure dependent control valve results in a change in flow through the coil, with or without a change in load. Pressures upstream and downstream of control valves change constantly as pumps start, stop, and change speed, and as valves elsewhere in the system open and close. Once the thermostat picks up the change in air

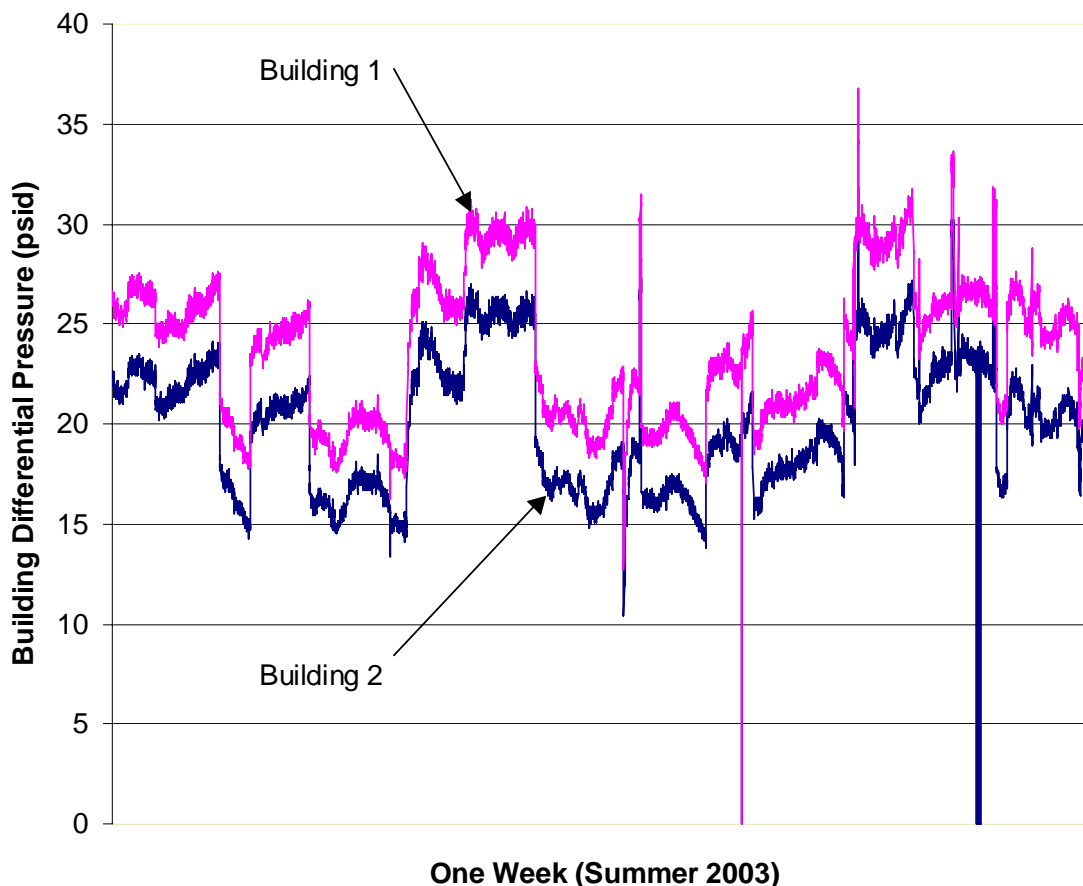


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temperature, the actuator is commanded to stroke the valve to return to the right flow for the load. This takes time with conventional valves, especially since actuators are designed to stroke very slowly.

Figures 6 and 7 illustrate how pressure fluctuates in a variable speed chilled water system. Figure 6 shows the differential pressure across a university building during a summer day. Figure 7 illustrates how flow through a coil will change at constant cooling load in the presence of a 5-15 psi differential pressure variation across the control valve.

Figure 6: Differential Pressure Across a Typical University Building



The pressure profile will be different at different locations in a hydronic system. **Investigate the differential pressure across coil control valves in buildings at a high sample rate (frequency 1/minute or greater) at multiple locations on campus. You may also see and even hear valves hunting in many systems or see frequent changes in control valve signals.** Hydronics systems (water) are incompressible. You may be surprised to see how widely and quickly differential pressures in a conventional control system vary. Consider what effect these pressure variations have on the flow through heating and cooling coils and delta T performance. As shown in the following conventional control valve equation, note the smaller the differential pressure across a control valve,

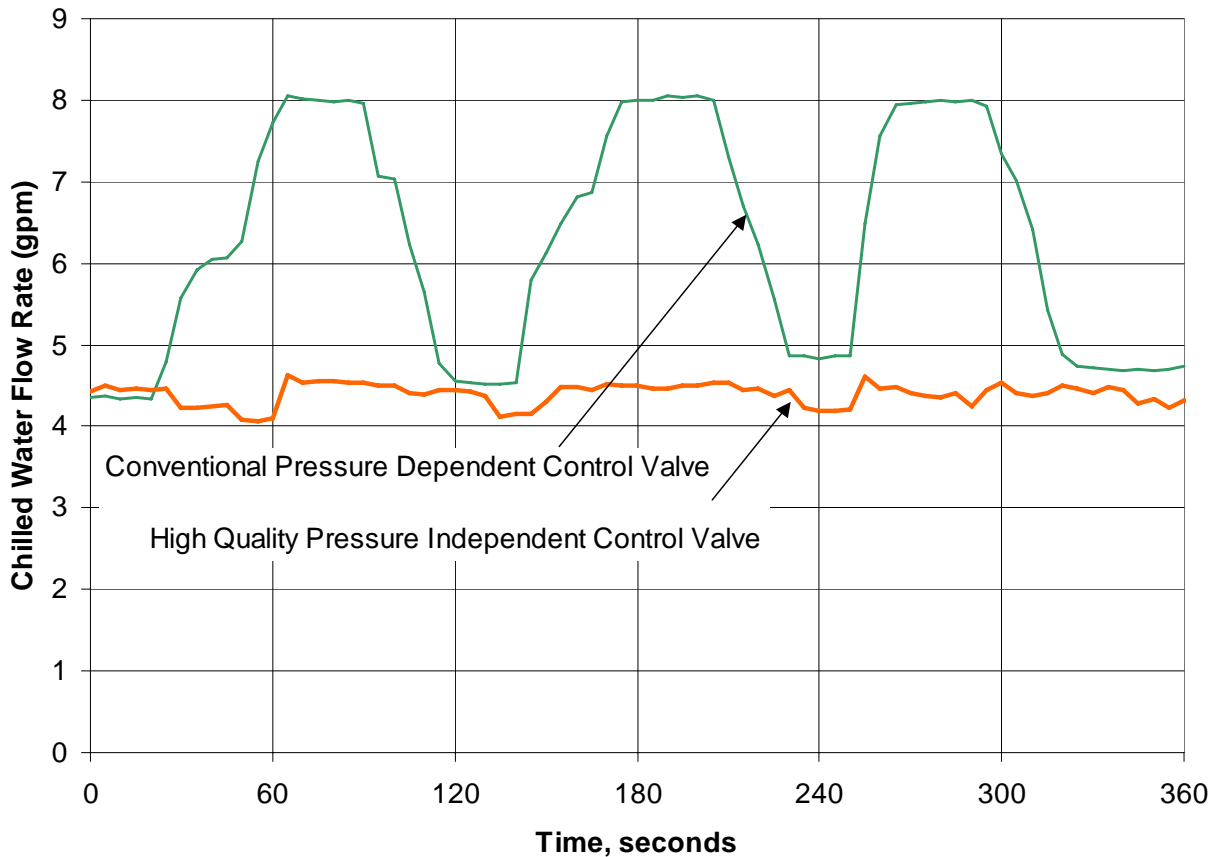


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the greater the variation in flow with a small system pressure change for a given Cv. For example, at Cv of 100 with 4 psid, flow is 200 gpm. If the differential pressure fluctuates to 9 psid, flow becomes 300 gpm. This reduces delta T to one third the original value at a given cooling load until the actuator has time to stroke the valve.

$$GPM = Cv \cdot \sqrt{\Delta P / Sg} \quad \text{where specific gravity (Sg) = 1 for water}$$

Figure 7: Flow Change at Constant Load with 5-15 psi Differential Pressure Fluctuations



When a large AHU coil is over-flowing, the reheat coil downstream typically opens to warm up any sub-cooled air. When it is under-flowing, air flow eventually increases to compensate for air in the space that is warmer than intended. This instability increases cooling requirements. Hot water flow in reheat coils during cooling season delivers added heat to the building. Greater fan horsepower puts more waste heat into the duct. It is very common to find leaving air temperature varying from 48 to 56°F with a 55°F setpoint. In addition, as shown in Figure 8 below, it is worth investigating the degree of simultaneous heating and cooling. Figure 8 shows the measured sensible cooling (positive tons) and heating (negative tons) at the air handler cooling coil and reheat coils at the same period of time. Every effort should be made to minimize this effect. **See how much the leaving air temperature varies using a high sample rate trace of the discharge air temperature from the air handler**



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upstream of the reheat coil. Calculate the heating and cooling occurring over the same time period at a single air handler and it's respective coils.

Figure 8: Simultaneous Heating and Cooling

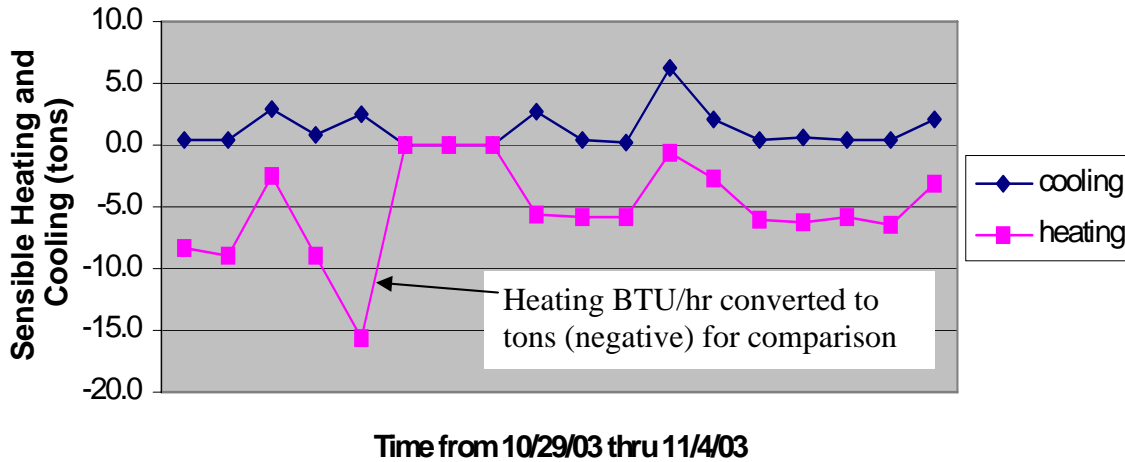


Table 2 below illustrates the change in ton-hours per cooling degree day measured after the application of high quality pressure independent modulating control valves in a single building on a large university campus. The controls in this application are pneumatic.

Before (2002) and After (2003) DeltaP Valve Retrofit							
Year		June	July	August	Sept.	October	Overall
2002	Cooling Degree Days Base 55°F	490	1,176	814	595	155	3,230
2003	Cooling Degree Days Base 55°F	414	1,035	854	407	234	2,944
2002	Ton-hrs	16,303	32,266	20,431	13,776	5,245	88,021
2003	Ton-hrs	8,059	23,834	16,964	7,089	6,081	62,027
2002	Ton-hrs/CDD55	33.3	27.4	25.1	23.2	33.8	27.3
2003	Ton-hrs/CDD55	19.5	23.0	19.9	17.4	26.0	21.1
	% Ton-hr/CDD Reduction	41.5%	16.1%	20.9%	24.8%	23.2%	22.7%

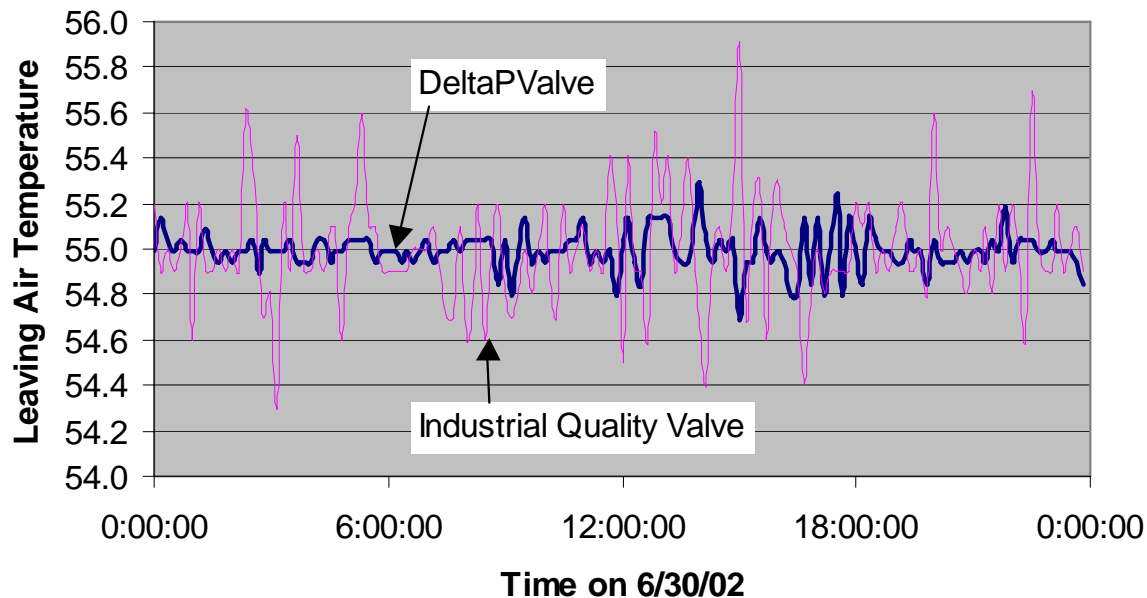
Table 2: Reduction in Cooling Load by Minimizing Sub-Cooling and Reheat
CDD55 = cooling degree days at a base 55°F



Thermal Instability

Figure 9 below illustrates how high quality pressure independent control valves (DeltaPValves) improve the stability of the leaving air temperature from the coil. This side by side comparison illustrates performance relative to an industrial quality globe valve with a 55°F setpoint.

Figure 9: Leaving Air Temperature Variation Reduction



Fume Hood Containment in Laboratories

Nothing is more important in most laboratories than the safety of scientists. Problems with fume hood containment in laboratories may arise when air flow and cross flow in the room is higher than expected. While there are a number of items that may contribute to this problem, it is worth noting the hot or chilled water system issues that may cause air flow to increase.

As discussed in “limited coil capacity” and “VFD’s running at near full speed” above, when the chilled water supply temperature rises above coil design, airflow must increase to sustain comfort conditions in the space. Chilled water supply temperature rises due to low delta T, return water blending, and chiller reset. Balancing valves (circuit setters) compound the excess airflow problem at high loads by limiting the available chilled water flow.

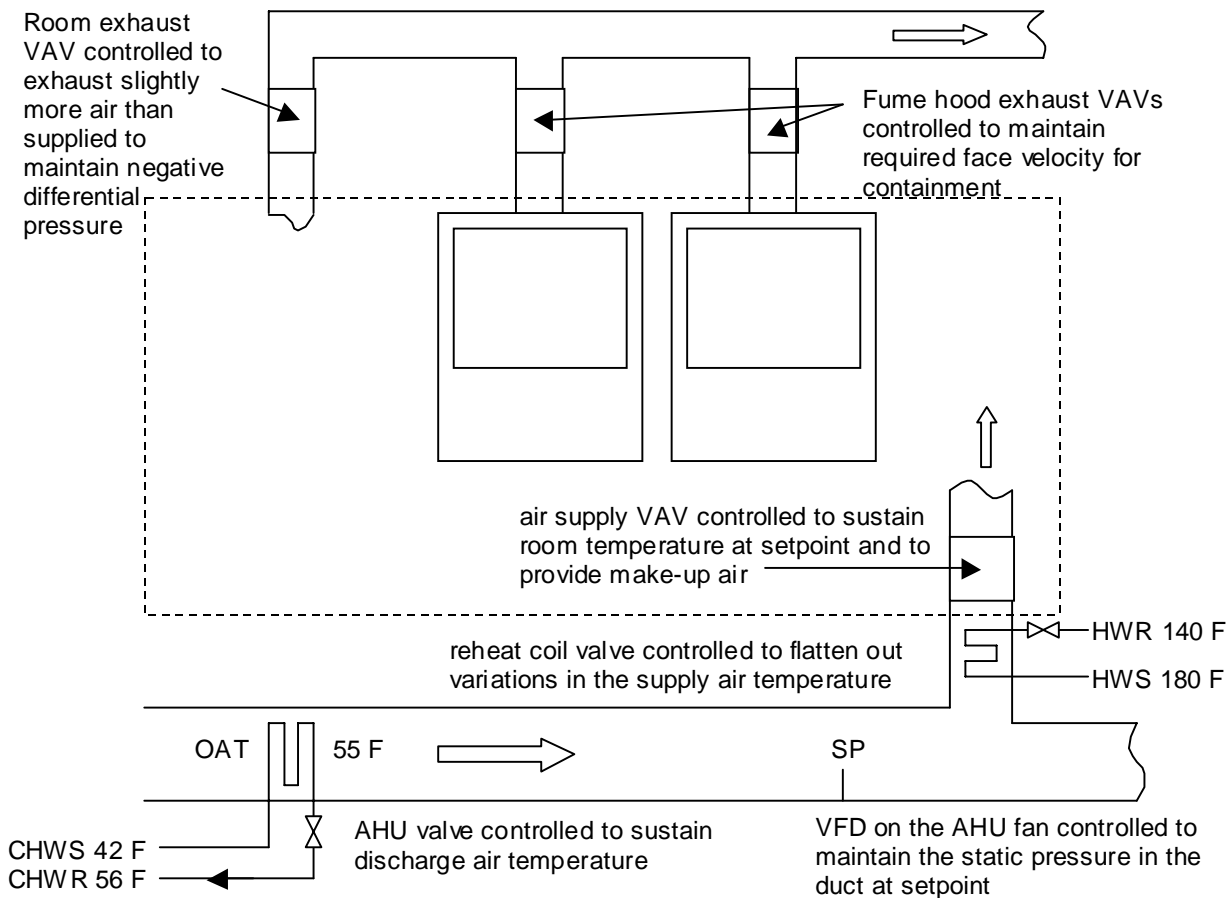
In some cases, due to poor control valve performance, operators will set the air handler discharge air temperature setpoint (in cooling mode) higher or lower than the original design. Increasing the setpoint causes the fan to work harder in all cooling load conditions. Decreasing the setpoint aggravates the low delta T problem causing more return water blending or an additional reduction in chiller capacity at the plant.



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If there are issues with fume hood containment, it makes sense to measure the air changes per hour at different cooling loads and compare it to requirements. If it is higher than expected, check to see if the chilled water supply temperature has risen above coil design. Figure 10 is an illustration of typical VAV laboratory controls.

Figure 10: Typical VAV Laboratory Controls



Humidity

It has been simply stated that the overwhelming majority of humidity control (latent heat removal) occurs in the last 5°F of leaving air temperature drop. If an air handler can't maintain leaving air temperature due to low delta T and/or high chilled water supply temperature, humidity issues may arise. Systems that use building valves and return water temperature controls are especially prone to these problems. Return water is simply held back while the water through the building is re-circulated. Return water blending reduces the capacity of the coil. ***Measure the humidity levels in various load conditions and compare to design requirements. Also see if there are any reports of sick building syndrome or mold growth. Investigate whether or not chilled water is supplied to the coils at design. Use a coil rating program to see if the air flow and measured coil conditions will put moisture into the air.***



Balancing / Rebalancing

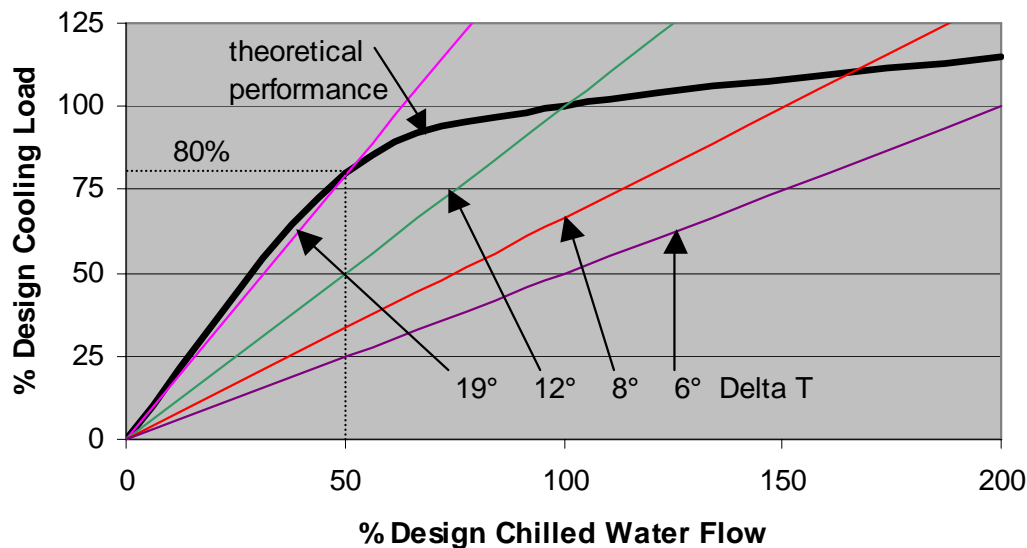
Balancing a hot or chilled water system can be a never ending struggle, especially in a growing or evolving facility as the load and hydraulic profiles change. The problem gets even more challenging when system capacity is limited. Hot and/or cold calls emerge from occupants in different buildings and the problems shift around. In many cases this represents a significant budget item that can be eliminated completely. **Simply review the operational expenses to see how much money is being spent balancing and rebalancing.** Keep in mind that a balancer is often employed to address problems when customers call to complain about thermal comfort issues. Pressure independent modulating control valves are installed without balancing valves and dynamically balance the system at ALL load conditions.

Energy Consumption and Peak Power Demand

Circulating extra water and air per unit cooling or heating clearly wastes energy in pumps and fans. Low delta T also wastes chiller, boiler, condenser pump, and tower fan energy when additional equipment must be run to satisfy a specific supply water temperature requirement. In addition to resolving capacity, safety and other issues noted above, engineering analysis of field data indicates that most large systems have an opportunity to reduce the energy consumed for heating or cooling by 20% to 40% or more. Raising delta T reduces the flow required. This is the key to outstanding results.

Figures 11 and 12 illustrate the reduction in flow made possible with the proper application and control of high quality pressure independent control valves. Figure 11 illustrates the theoretical performance of a 12°F cooling coil while showing the flow vs. the load at different delta T conditions. In many retrofit applications, performance can improve further when low delta T mitigation efforts reduce return water blending and deliver chilled water at supply temperatures less than design for the coil.

Figure 11: Theoretical Cooling Coil Performance for 12°F Delta T Coil

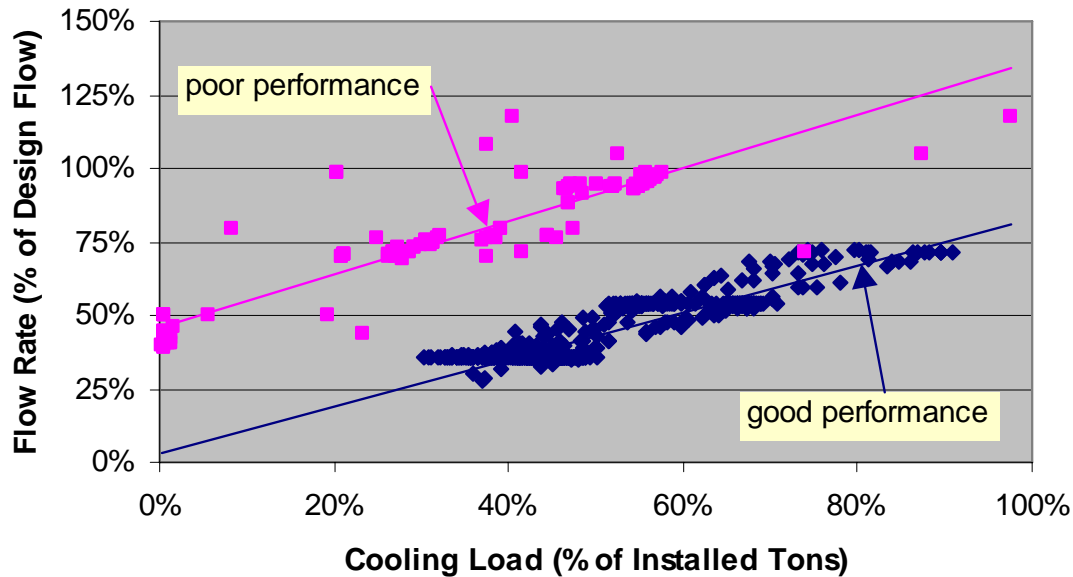




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Figure 12 shows how the flow rate at various cooling loads is stabilized and reduced by applying control valves that precisely meter flow in the presence of unavoidable system pressure fluctuations.

Figure 12: Improved Performance w/ High Quality Pressure Independent Valve Retrofit



Inadequate Control Valve Structural Strength

The location of coils and control valves in a system may have an effect on the performance in operation. Delta T performance is again the first and best indicator of how a system is running and can be measured at individual buildings or coils. Figure 7 above illustrates the severity of flow variations at more hydraulically remote locations where the available pressure drop across the control valves is very low. Figure 13 below illustrates the differential pressure in a typical system that must be managed at locations closer to pumps.

The control valves close to the pumps must be able to handle the high head requirements no matter what the current load condition is on the coil. Many conventional control valves will lift off their seats at higher flows or bang shut at low flow in these locations. Full shutoff can become a problem due to wire cutting at the seat within the valve. Control valve hunting elsewhere in the distribution system only aggravates this situation.

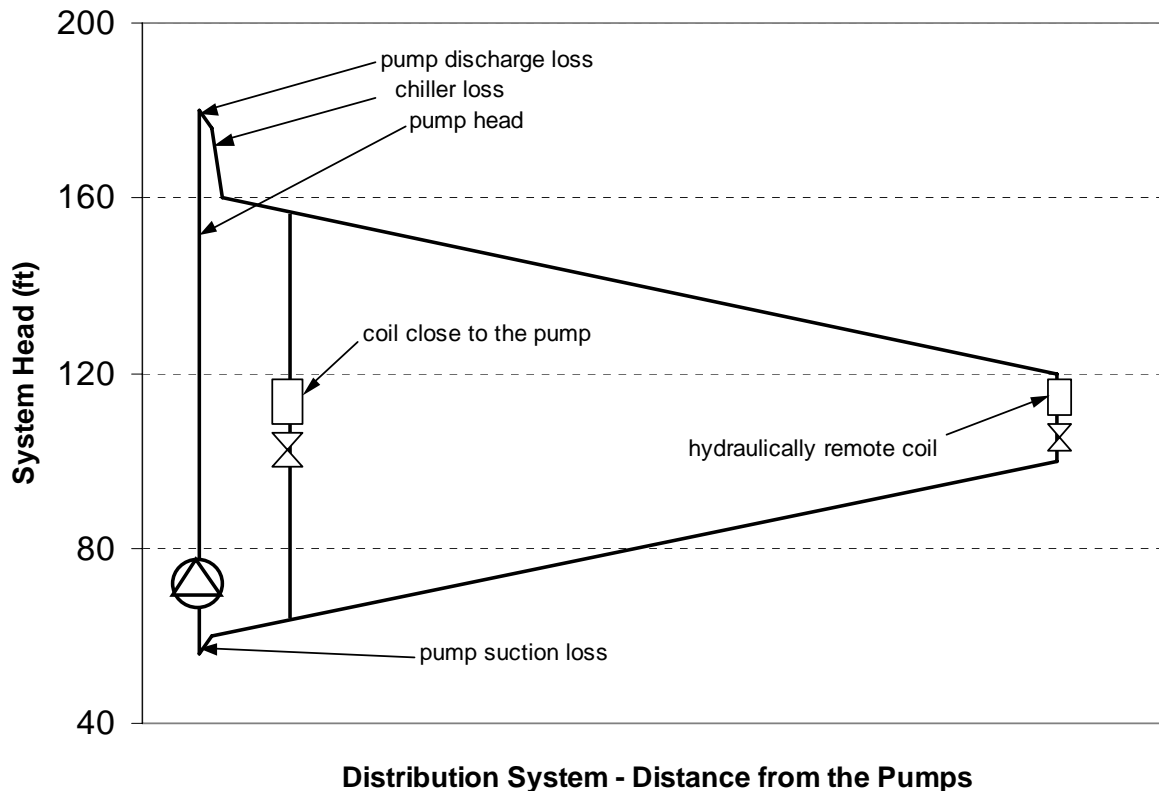
To even minimally function in a system, the control valve selected and its actuator must have high rangeability and possess sufficient structural strength to handle the differential pressures (static and dynamic) that it experiences in service. Raising delta T (minimizing flow per ton) at the more hydraulically remote location reduces the head across control valves close to the pumps.

Investigate differential pressures across control valves in conjunction with delta T performance at different locations in a system. It is common to find control valves acting more like



on-off valves in the presence of high differential pressure at high and low flow or hunting excessively in any location.

Figure 13: Hydraulic Profile of a Typical Chilled Water System



Raising Delta T without Pressure Independent Control Valves

There are a number of approaches that have been employed to address low delta T issues in both hot and chilled water systems. Some will incrementally improve performance. Others tend to shift the problems around. Some work every time. Eliminating 3-way valves is a widely accepted practice.

The most common other approaches were discussed above or are described below. Return water temperature control, repositioning valves with differential pressure, running cooling coils in series, pumping every coil, and converting to variable primary flow are a few. Many of the most recent publications acknowledge the importance of good control valve selection.

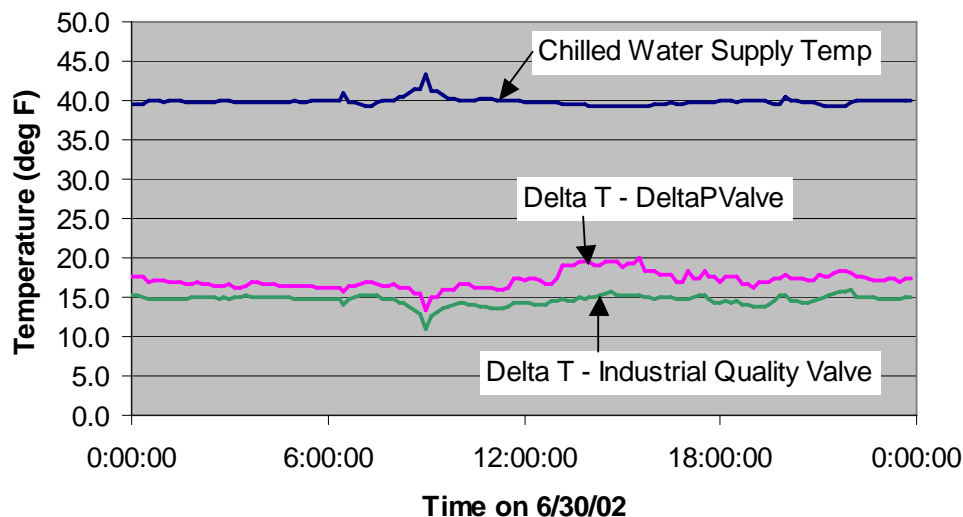
Ignore It, The Customer May Not Find Out – This is far and above the most common approach to dealing with low delta T. If occupants are provided with adequate comfort, little attention is paid to the lost capacity, wasted energy or other issues. Inattention to the system first cost or the life cycle cost related to delta T performance will drive this approach.



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Use Higher Quality Conventional Control Valves – This will improve delta T performance if the existing control valves and their actuators have poor rangeability and inadequate strength to handle high differential pressures. On the other hand, none of these valves will provide steady flow through coils in the presence of unavoidable system pressure fluctuations. Pressure independent, steady flow is the key to optimizing delta T. Below, the performance of a high quality pressure independent control valve is compared to an industrial quality pressure dependent control valve (the best alternative) in a side by side trial. Note that high quality pressure independent control valves (DeltaPValves) always outperform.

Figure 14: Comparison of Delta T Performance with Industrial Quality Valves



Apply Return Water Temperature Control – As discussed earlier, this approach is a band-aid that can lead to return water blending with supply, lost coil capacity, and humidity issues. This is covered in detail in James B. Rishel's "HVAC Pump Handbook."

Reposition Conventional Valves Using Differential Pressure – Software will not fix hardware problems. Actuators are designed to stroke control valves slowly. Using this method will put conventional control valves in constant motion trying to establish the right flow for the load. This will not optimize delta T and puts more wear and tear on both the actuators and the valves.

Clean the Heating and Cooling Coils – It makes sense to keep coils clean to improve heat transfer performance; however, this is seldom the root cause of low part load delta T. It is far more common to find poorly performing control valves leading to unsteady flow and an increased demand for water to serve the load.

Buy Additional Capacity – By far the most expensive (yet one of the most common) approaches used to deal with low delta T is to purchase and install additional capacity. This may come in the form of larger pumps, fans, pipes, chillers, coils, thermal energy storage and is often the first recommendation of many equipment salesmen and engineers. Don't be fooled. Explore low delta T issues first.



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Install a Check Valve in the Primary Secondary Bypass Line – This is a technique designed to minimize the return water blending with supply in chilled water systems so that low chilled water supply temperature can be maintained. While it is a good objective to minimize blending, if the system is demanding more flow and the coils produce low delta T, the excess flow must be processed back at the plant. With a check valve installed, the excess flow may simply travel through a non-operating chiller and have the same adverse blending effect.

Use Variable Speed Drives with Pumps – This is a good idea and we recommend it in most systems; however, by itself it will not solve low delta T issues. Demand for flow comes from the air temperature thermostat either at the coil or in the space. If the coil needs more flow to sustain comfort conditions, the control valves will open or close as required and the pumps will react accordingly. Low delta T systems simply demand more water causing the variable speed drive to run at or near 100% most of the time.

Install DDC Controls – Again, software will not solve hardware problems. Like variable speed drives, we believe that DDC control provide a number of excellent benefits in large HVAC system. DDC controls in conjunction with carefully engineered hydronics systems and high quality pressure independent control valves will deliver optimum delta T performance.

Variable Primary Flow – Converting to variable primary flow is a good idea that we recommend; however, be advised that with poor delta T performance at the coils, the system is likely to act like a “virtual” primary/secondary system if return water must be blended with supply through a non-operating chiller to deal with the excess flow.

Reverse Return Piping – Reverse return piping represents a significant first cost increase and is intended to minimize the differential pressure differences from building to building and from coil to coil. Pump head must be increased to handle the additional friction loss. There is no guarantee of high delta T if the control valve performance is poor. This approach is certainly not well suited for most retrofit applications. Pressure independent control valves with a wide operating pressure range make this approach obsolete. There is no need to circulate all the water through an additional pipe the full length of the piping system (very expensive).

Install Balancing Valves – Balancing valves (circuit setters) are designed to prevent flow from exceeding the maximum at a coil but will do nothing to ensure the optimum flow is not exceeded at part load. Balancing valves do not improve part load performance. If supply water temperature rises when balancing valves are used, this can limit the available capacity of coils. Pressure independent modulating control valves are installed without balancing valves and dynamically balance the system at **ALL** load conditions.

Retro-commissioning / Test and Balance – Retro-commissioning, if skillfully performed, can identify significant issues in a system. Balancing, on the other hand, is a single load condition event that will never optimize the flow rate at every coil for every load condition and, with low delta T, may lead to inadequate flow at certain coils and additional air flow. Systems with pressure independent control valves installed may be commissioned but do not require balancing at startup or upon system expansion. The system is dynamically balanced at all loads.

Pump Every Coil – There are manufacturers and consultants in the industry that have proposed pumping every coil in systems and removing control valves entirely. If you are willing to drive in rush hour on the freeway without brakes in your car, this is the approach for you. Be sure to consider the



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loss of pump redundancy and rangeability in your system as it tries to operate at low loads and flows. Don't forget the lost efficiency with smaller impellers and added first cost and maintenance expense with all the extra pumps. This is recommended for small red schoolhouses but little else.

Raise the Leaving Air Temperature Setpoint – This will raise the chilled water delta T. It will also increase the fan energy consumption. $CFM = 12,000 * TONS_{sensible} / (1.085 * (EAT-LAT))$. If the leaving air temperature goes up, so does the air flow required to sustain the comfort conditions at the sensible cooling load. Fan power consumption varies as the cube of the air flow. In certain conditions, too much air flow will put moisture into the air stream leading to humidity issues.

Employ Cooling Coils in Series - Some authors have recommended that facilities install cooling coils in series to raise delta T. However, they fail to mention that this comes at the expense of both pump and fan energy. In this approach the first coil is designed to manage the latent cooling load and the second coil functions to manage the sensible load. Using this method, the pump must circulate water through an additional restriction and the fan experiences an additional pressure drop across the second coil. The installed cost rises with the application of larger air handlers, multiple coils and greater horsepower pumps and fans. ***If isolated buildings on a large campus achieve high delta T, it is worth investigating if cooling coils were run in series and this performance came at the expense of additional pump and fan energy.***

Building Valves for Differential Pressure Control – Many large campuses have pressure reducing valves installed in the line serving the whole building to maintain a specific differential pressure across the coils and control valves within. This approach is intended to limit overpressure to the coils and valves in the building. Pressure independent control valves eliminate the overpressure concern throughout the system. No pressure reducing valves are required.

Summary

Billions of dollars are spent in the HVAC industry trying to solve or prevent many of the issues noted above in both new construction and retrofit projects. The cost of control valves is a small fraction of the total system first cost. Designing for high delta T and counting on this performance in operation can significantly reduce system first costs. Bear in mind that control valve selection has a huge impact on operating and maintenance expenses for the life of the facility.

Without high quality pressure independent control valves, performance risk exists in new construction projects when facilities are designed for high delta T and maximum diversity. Seldom do these facilities achieve the optimum performance in operation. As a result, the components in many systems are significantly oversized. Furthermore, the engineering effort required to accurately model a conventional system and its hydraulic profile in various load conditions and carefully match these characteristics to control valve selection has proven to be a daunting or low priority task for many engineering firms. The evidence is low delta T in the vast majority of large chilled water systems.

It is very common to find a facility with capital budget allotted for additional mechanical system capacity - new chillers, thermal energy storage, larger pumps and pipes, and other equipment, simply to address problems related to low delta T. If possible, delaying or shifting this budget to fund control valve retrofits is a very prudent investment move. Not only will the approach lead to considerably



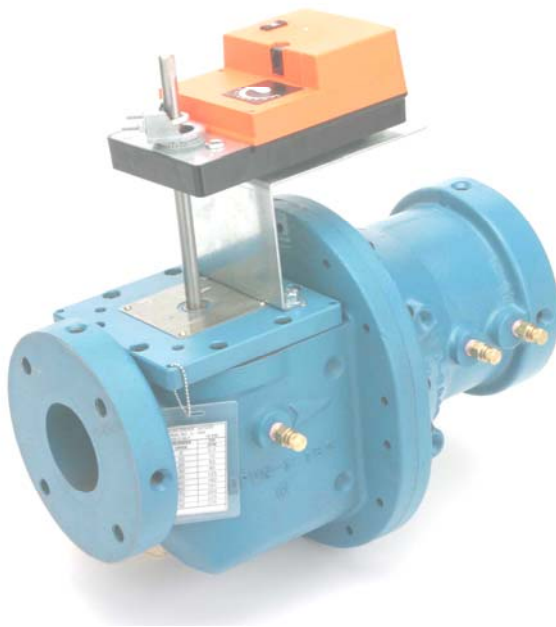
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more available system capacity while utilizing current equipment, it is far less expensive, and will lead to long term energy savings.

The bulk of energy savings is generated at part load conditions in chillers, boilers, pumps, condenser pumps, tower fans, and air handling fans; however, peak load savings cannot be ignored. Most systems will not see all coils operating at maximum block load. Diversity applies. In addition, coils are typically oversized by 10-20% and 50% of the flow will address 80% of a cooling or heating load. Therefore, most systems should flow well less than design flow in almost every load condition. Systems with VFDs installed but operating with low delta T finally have a chance to deliver the anticipated energy savings.

There is also excess operating and maintenance budget consumed every year with undue energy consumption, balancing and rebalancing, and equipment maintenance. Stabilizing control and reducing water and air flow minimizes the wear and tear on equipment and extends useful life.

Designing for and counting on high delta T in new construction projects can save considerable first cost and life cycle costs at many facilities. It simply takes the effort and vision to employ the right technology available in the market.



To consider any of the issues described herein or to assess an investment in DeltaP Valves, please contact Eric Moe, Greg Doland, or Paul Skoglund at Flow Control Industries 425-483-1297 www.flowcontrol.com or any one of our local representatives.