# The DeltaPValve® System – Standard Control Gets Substandard Performance

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*Abstract: HVAC system designers and operators have a new system technology that increases efficiency and the effective system capacity, cures low delta T syndrome, improves comfort and simplifies operation. A DeltaPValve® System, using DeltaPValves as manufactured by Flow Control Industries, is revolutionary, changing the way HVAC systems are designed and operated. By establishing unprecedented system stability, the benefits of precision control extend throughout the HVAC system resulting in substantial energy savings as high as 40%. Precise control of an HVAC system provides efficient comfort for building occupants.*

## INTRODUCTION

The DeltaPValve® is the original pressure independent control valve for chilled and heating water systems, designed to perform significantly better than most industrial control devices. As a revolutionary control device the DeltaPValve® provides precise performance previously reserved for only the most demanding industrial processes. This newly harnessed performance capability is changing the way engineers and facility owners heat and cool buildings throughout the world.

Since the mid-20th century, the ability to create uniform year-round comfort in commercial and institutional buildings has enabled gains in worker productivity for American businesses similar to those seen with the introduction of computers, cell phones and the internet. However, while the goal for most designers and operators in the past has been to improve occupant comfort, it is typically at the cost of excessive energy usage. Minor improvements in efficiencies and control technologies have occurred over the years, but many of the system types, designs and, more importantly, *expectations* have remained unchanged.

*"Insanity: doing the same thing over and over again and expecting different results."*

*-Albert Einstein*

With increasing awareness around the negative environmental impacts the planet faces from generating heat and electricity, there is a growing need to treat energy as a precious resource. Squandering energy is not only bad for the planet – it's expensive. Facility owners are now focusing more on energy costs, and the days of inefficient comfort are fading into the past.

However, the designer tasked with crafting a more efficient system has the same mechanical devices and control components as offered by manufacturers in the past. To the detriment of the innovative manufacturer, design standards and regulations reinforce the status quo. There is no market for a better mousetrap if the old one is "good enough". Similar to Einstein's quote regarding insanity – ***Expecting high performance from a system built per the status quo is insanity***.

A DeltaPValve® System has the ability to upset this status quo with its progressive precision control and ability to deliver peak performance at all load conditions. DeltaPValve® Systems are more efficient, deliver full system capacity, improve comfort, and are easier to operate and maintain. This not only keeps operating costs at their lowest while providing efficient and effective comfort, it also minimizes the need for the additional capacity often required to accommodate poor performing systems. DeltaPValve® systems are a "win-win" in terms of energy and capital conservation, as well as comfort control.

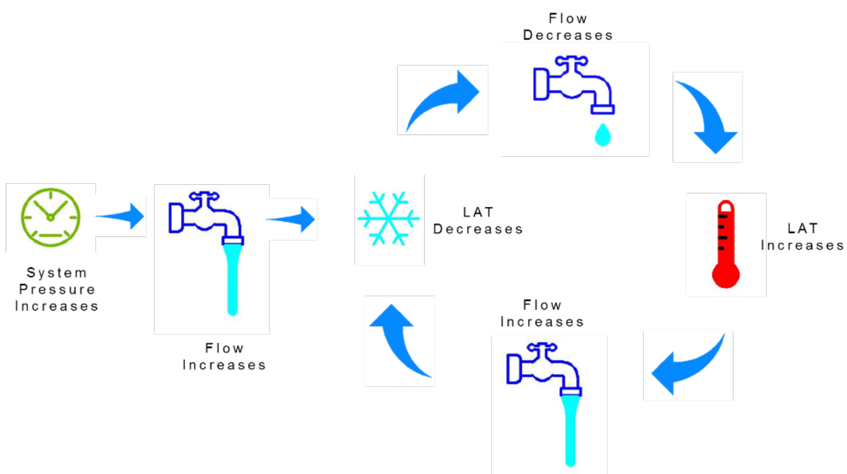
## STANDARD CONTROL AND SYSTEM INEFFICIENCY

In order to fully understand the benefits of the DeltaPValve® System, it is important to understand the reasons that a standard system lacks the ability to deliver efficient comfort. Standard system control initiates a cascade effect that results in inefficient equipment operation and wasted energy. These lapses in efficiency can all be traced back to a single phenomenon – *coil leaving air temperature (LAT) instability*.

Standard System

A hydronic system utilizing traditional pressure-dependent control valves and meeting ASHRAE Guideline 13-2000, 2007 for stability (±1.5° F for LAT)

The initial cause of LAT instability is the wide berth of LAT that is afforded per industry standard coupled with pressure dependent valves inability to instantaneously compensate for pressure fluctuations in the system. The chain reaction can be set in motion by a pressure change in the system:




There are many important items to note from this cycle of deficiency. Primarily is that, while this is bad enough for one coil, the ramifications extend throughout the system by the simple fact that one valves fluctuating flow rate causes system pressure fluctuations thereby exacerbating the instability. Secondly, the figures mentioned are predicated on the system "operating as it should". Throw in an out-of-calibration temp sensor or a poorly tuned PID (Proportional, Integral, Derivative) loop things get out of hand quick.

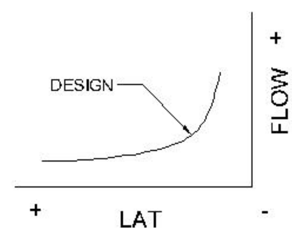
So, now we have coils that are supplying air above and below the setpoint. From a comfort standpoint, colder air is not a problem, it can be re-heated at the VAV (Variable Air Volume) boxes (note: *more energy*). However, air that is too warm is a problem as it leads to *latent cooling degradation* wherein the required latent cooling cannot be accomplished due to higher than design air temperatures and thus comfort suffers via excess humidity.

One of two results will inevitably occur – either the fan speed will increase to satisfy the VAV's demand for more air or the *setpoint will be reduced* to a point where the upper bound of air temperature keeps the boxes satisfied. Typically, the first scenario will ultimately lead to the second on a design day when the air handler cannot satisfy the VAV's demand and the system goes flat meaning that the demand can no longer be met and occupant comfort suffers. The setpoint is decreased for good because the problem has been 'solved'.

On the airside, our system is now making colder than design supply air and sending it out to the VAV's. As previously stated, this air will need to be reheated at the boxes in order to meet the setpoint. We've now removed energy (cooled the air) only to add it back in (reheat). Worse yet, we've added *additional load* to the space that will need to be removed again – the reheat energy will be extracted by the cooling coil as soon as it is returned to the air handler!

Since there is a 'need' for reheat, we now must keep a boiler and heating water pump (or steam system) online – compounding our energy expenditure. While the skeptical reader may baulk at this notion, I would challenge them to visit a typical campus in the heat of summer. More often than not, there will be a boiler or other energy source pumping out heat additional to whatever process requirements there are to satisfy the reheat 'requirement'.

Now that the airside has been investigated, let's turn our focus back to the water side. It's been established there are pressure fluctuations in the system that cannot be compensated for by standard valves. Remember also that the coil is now making below design air temperature. A quick look at a coil curve will reveal two resulting problem - *low ΔT and high flow*. The flow requirements of a coil increase dramatically as the LAT drops below design. Additionally, the chilled water return temperature is pushed below coil design because the coil cannot transfer enough energy fast enough to warm up the water. The net result is more system flow at lower ΔT which requires more *pumping energy*.



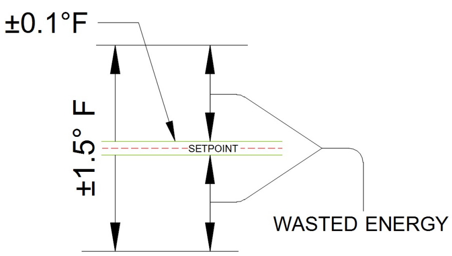

Often the flow requirements are so great that additional chillers must be brought online at part load simply to accommodate the additional flow. With more chillers comes more cooling towers and condenser water pumps. More equipment running equates to greater expenditure assuming that more equipment is available.

All of these inefficiencies culminate into what is known as a *flow limited plant* where the campus load cannot be fully met because the flow requirements are so great. Another way to put it is the system exhibits a high degree of *stranded capacity* that can only be recovered by stabilizing the system and increasing ΔT.

## DEFINING STABILITY AND PRECISION CONTROL

Now that the performance ramifications of a standard system using pressure dependent valves and 'standard' temperature sensors has been explained, let us examine how a system should operate and what it takes to make it happen. The key is, of course, to maximize the energy transferred from the air to the water while maintaining comfort. This optimal energy transfer cannot occur without stability and precision control.

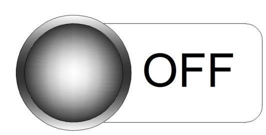
The DeltaPValve® System delivers both stability and precision control by eliminating the LAT fluctuations responsible for inefficient system operation. Whereas the ASHRAE guideline for stability is ±1.5° F of LAT, the DeltaPValve® System is capable of ±0.1° F, or *15x* better control than a 'properly operating' standard system. This level of operational precision necessitates the use of a temperature sensor whose accuracy is equal to or better than the desired temperature range.




The reason that the DeltaPValve® System is capable of this unprecedented level of precision is its inherent ability to instantly respond to pressure fluctuations in the system. Should the system pressure change, the regulator portion of the valve responds *instantly* to assure that the flow rate remains rock solid and thus eliminates any corresponding effect on the LAT.

Since LAT has been stabilized through precision control, the setpoint can be set back to design and the detrimental effects of poor control listed previously will begin to disappear. Reheat will be minimized and boilers/pumps won't be needed. The additional cooling load from the reheat will be eliminated. ΔT will increase while the system flows will decrease. Lower flows equates to less pumping and fewer chillers running. Those that remain online can be fully loaded. The additional towers and condenser water pumps will no longer be required to support the additional chillers.

Not only will the equipment efficiencies increase (the most efficient piece of equipment is the one that isn't running), the system will now be able to utilize the stranded capacity that it previously could not. System pressure will increase and buildings that struggled under standard control will operate as they were designed to. Comfort complaints will be cut drastically and, perhaps most importantly, expenditure of capital for more equipment will be deferred.



## CONCLUSION

When a system is designed and operated using DeltaPValves at the air handling unit coils, system stability and comfort control is achieved. With HVAC systems taking up as much as 40% of total building energy consumption (U.S. Department of Energy, 2010), accepting instability and low system ΔT is accepting a failed system and a failed building. Responsibility dictates and science proves that actual system performance should be much better than most HVAC designers and system operators believe. The DeltaPValve® System provides high-performance precision control to achieve simple system operation for efficient comfort with minimal capital and operating costs.