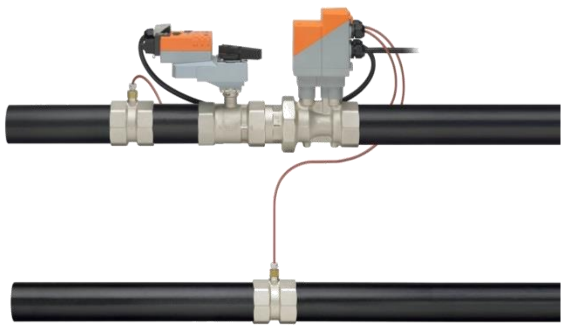
The Advancement of Pressure Independent Technology



This session will look at the new pressure independent technology and its energy savings potential.

Topics include:

- A brief review of the differences between Pressure Dependent/Pressure Independent Technology
- Airside Pressure Independent Technology in use for many years, now water side PI technology is making huge advances due to technology.
- Introduction to Intelligent Control Valves (a further advancement above PI technology alone).
- Using Intelligent Control Valves to:
    - View changes in water coil performance and degradation over time
    - Analyze a water coil's hydronic power curve
    - Introduction of the concepts of a water coil's "flow/power saturation point" and "waste zone"
    - Functionality of different Control Modes:
        - Dynamic Balancing (PI)
        - PI + ΔT Manager
        - PI + Power (BTU) Control

    - Using "constant commissioning" by providing the coil's performance data over time
    - Optimize water coil performance

Presenter:

<u>Garry Cole</u>
Belimo Americas
Regional Applications Consultant

Garry has been involved in the HVAC industry since 1972, holding many different positions in residential, commercial and industrial HVAC design, commissioning, service and controls.

His career with Belimo started in 2005 as a field Quality Engineer advising on product and mechanical systems trouble shooting. He is an expert on DDC systems applications and programming.

In his current role, he is the Regional Applications Consultant for Belimo where his primary responsibilities include applications support for HVAC consultants and facilities engineering for large end users.

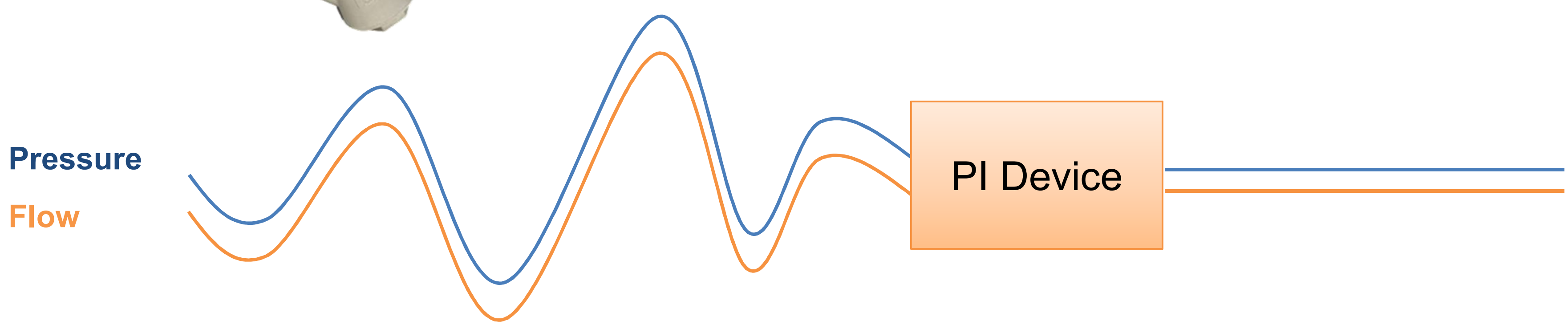
He is an active member of ASHRAE, has received CPMP certification and makes his home in Portland, Oregon.

Intelligent Control Valves

The Advancement of Pressure Independent Technology

Pressure Independent Technology

A pressure independent device supplies a specific flow for each value of the control signal regardless of pressure variations in the system.



Agenda

BELIMO

Airside

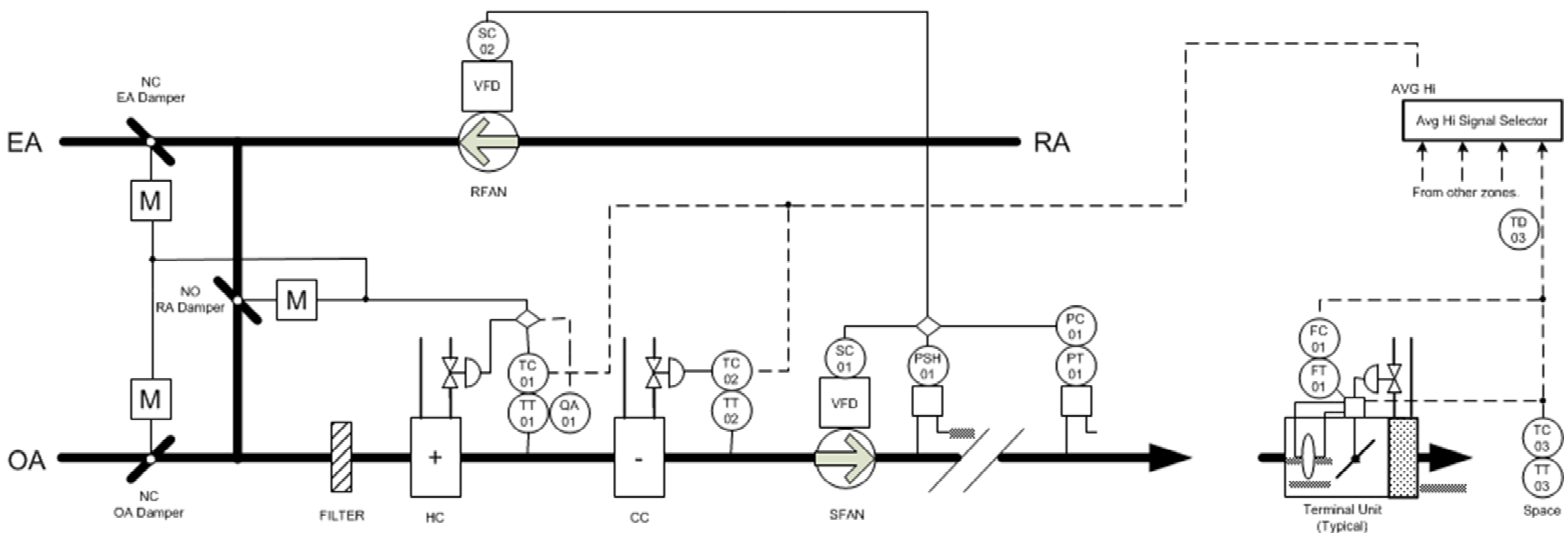
- **Variable Air Volume Systems**
  - Pressure Dependent Terminal Units
  - Pressure Independent Terminal Units

Wetside

- **Pressure Dependent Valves**
  - Understanding Low Delta T
  - More flow ≠ more heat transfer
  - Low Flow Instability
  - Coil Behavior
- **Pressure Independent Valves**
  - Mechanical PI Valve (ΔP Control)
  - Electronic PI Valve
    - Flow Control
- **Intelligent Control Valves**
    - Flow Control
    - Power Control
    - ΔT Control

AIRSIDE

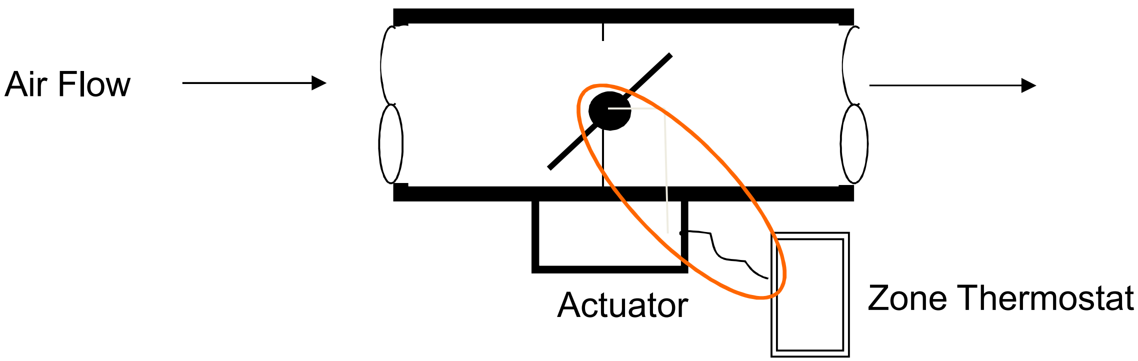
VAV AHU



- **A VAV system controls the space temperature by using terminal units to vary the volume of cool supply air from the air handler to match the actual cooling load for each zone.**

- ***The AHU is quite typically the <u>only</u> source for cooling for all the zones served.***

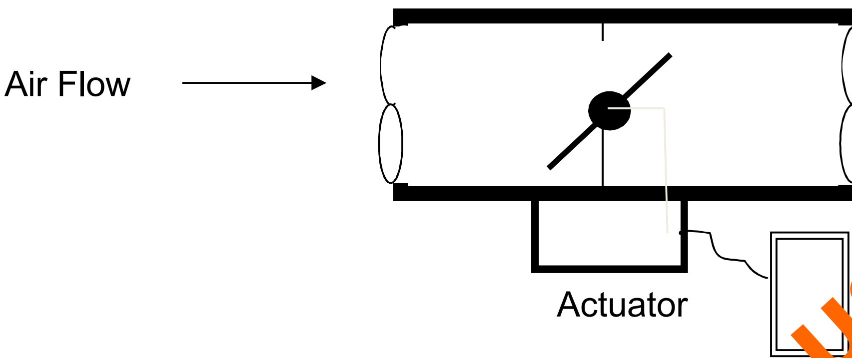
Airside - VAV Terminal Units
(Pressure Dependent)



Zone temperature deviation from setpoint controls air valve position directly.

Airflow rate not controlled (varies as the air handler supply duct pressure varies).

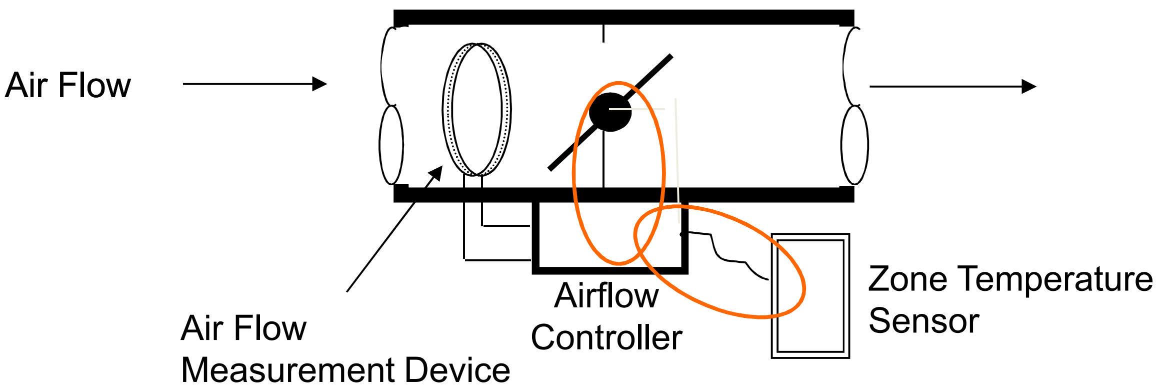
Airside - VAV Terminal Units
(Pressure Dependent)

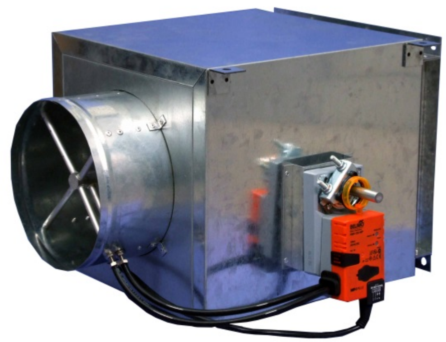


Mostly used on VVT, not on VAV anymore.

- **Manual stops required to ensure "min and max" flow limits maintained.**
- **Temperature control is more unstable due to airflow instability.**
- **Results in wider zone temperature variations.**

Airside - VAV Terminal Units
(Pressure Independent)



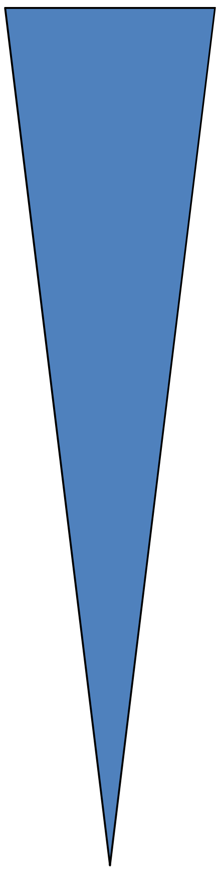


Room temperature deviation from setpoint resets airflow setpoint.

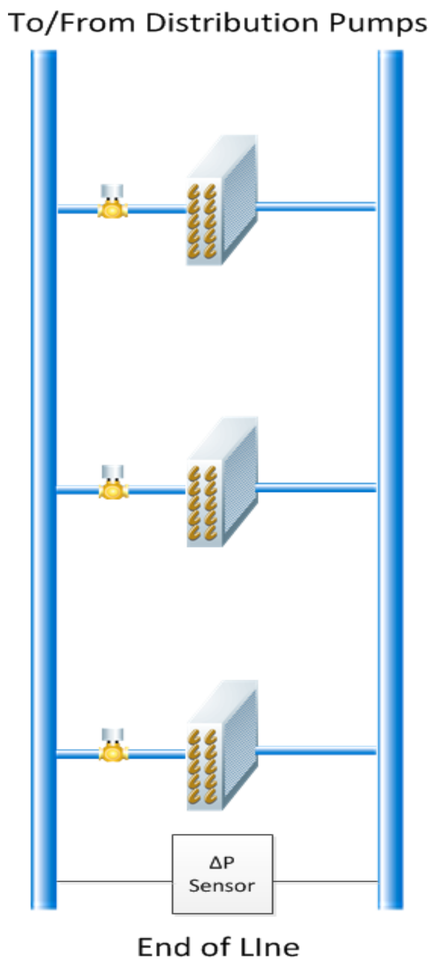
Airflow rate is directly controlled.

Results in more stable zone temperature control.

Wetside - Variable Flow Systems



Pressure
Gradient



- As systemic load moves around, pressure gradient changes.
- ΔP closer to pumps higher;
  ΔP further away lower.
- The longer the piping system, the larger the pressure gradient.
- ***No way to predict ΔPs at part load conditions. It is constantly changing.***

Reverse Return Piping helps this but can be difficult to install and very expensive.

Wetside – Sizing Pressure Dependent Control Valves

- **Control valve sizing is a trade off between minimizing pump head requirements and valve controllability.**
- **Modulating valves need at least ½ of the branch pressure drop when the valve is fully open. But…not less than 2 pipe sizes smaller than line size.**

Wetside – Sizing Pressure Dependent Control Valves

Application Cv:

$$Cv = \frac{GPM}{\sqrt{\Delta P}}$$

If valve with exact Cv is not available, then next larger valve is usually selected, causing valve to be oversized for the application.

Wetside - Issues with Pressure Dependent Valves

- **Low Delta T: Causes problems and inefficiencies with chiller plants**
- **At High Flow: More flow ≠ more heat transfer**
- **At Low Flow: Unstable Control (valve is essentially “oversized”)**

Wetside – Coil Output

BELIMO

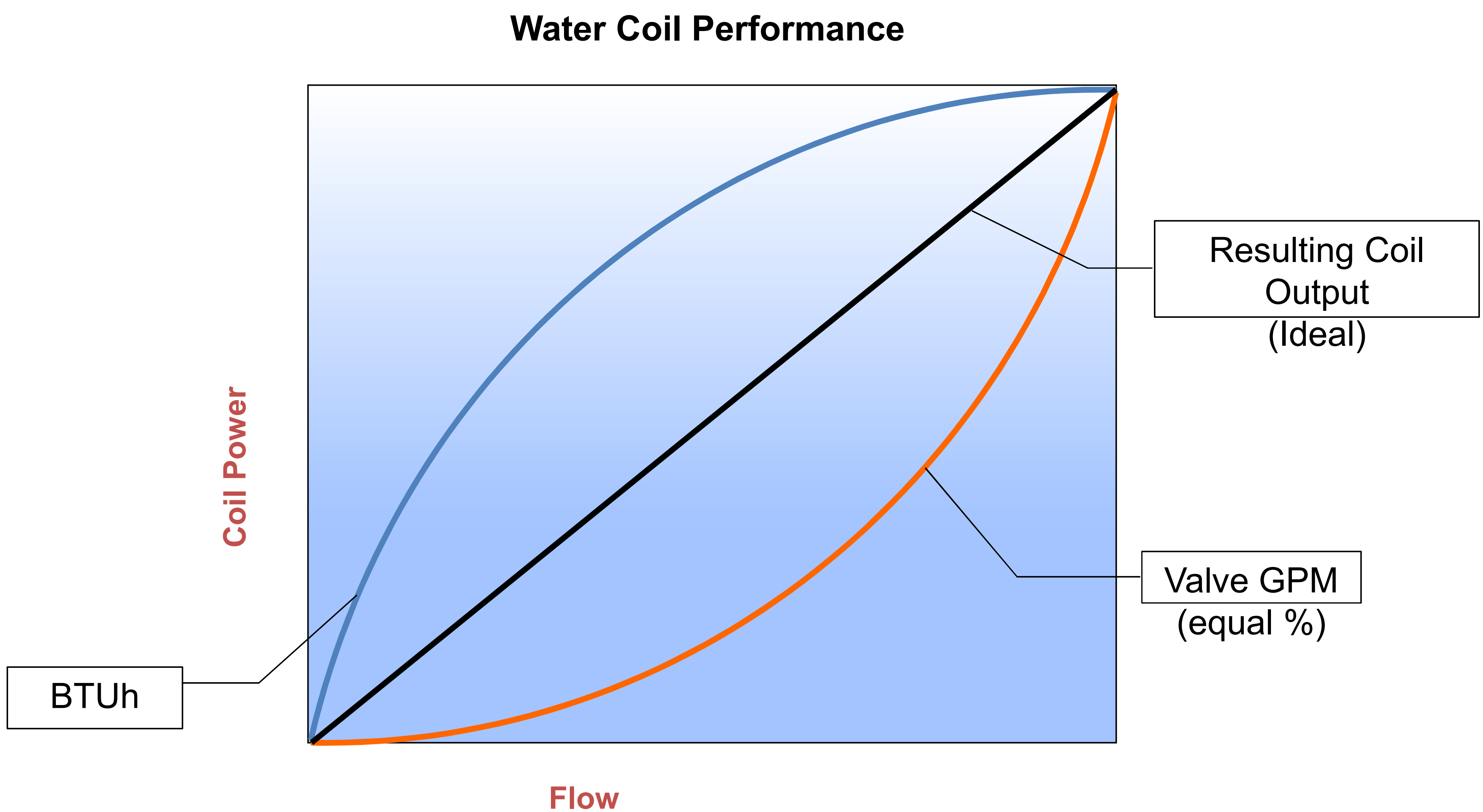
Actual Flow Rate: $GPM = C_v \times \sqrt{\Delta P}$

Changes in ΔP across a PD valve results in changes to flow

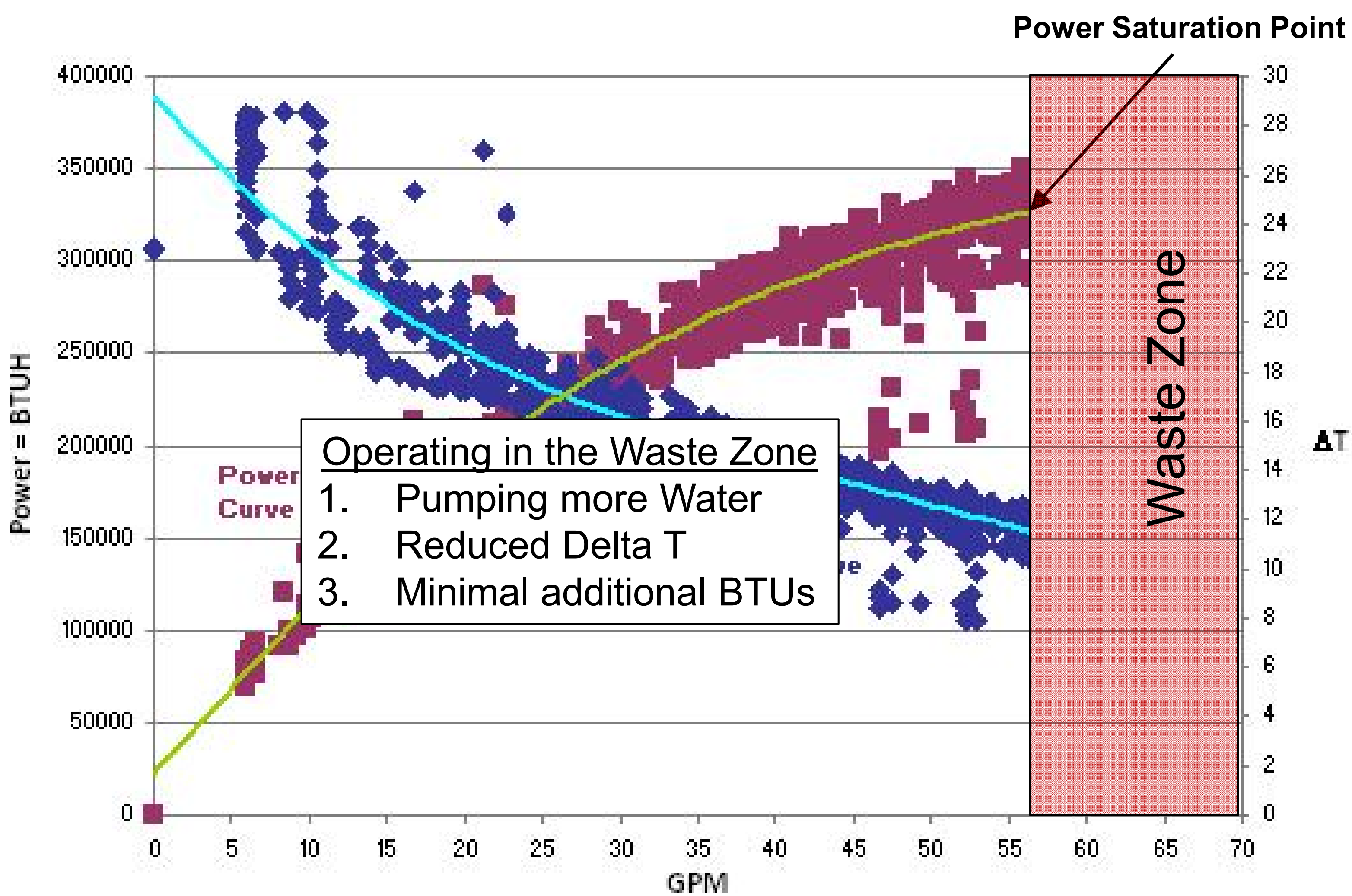
Coil Output: $Q(\text{Btu/h}) = 500 \times GPM \times \Delta T$

For a given load, Flow and ΔT are inversely proportional.
As Flow increases, ΔT drops and vice versa.

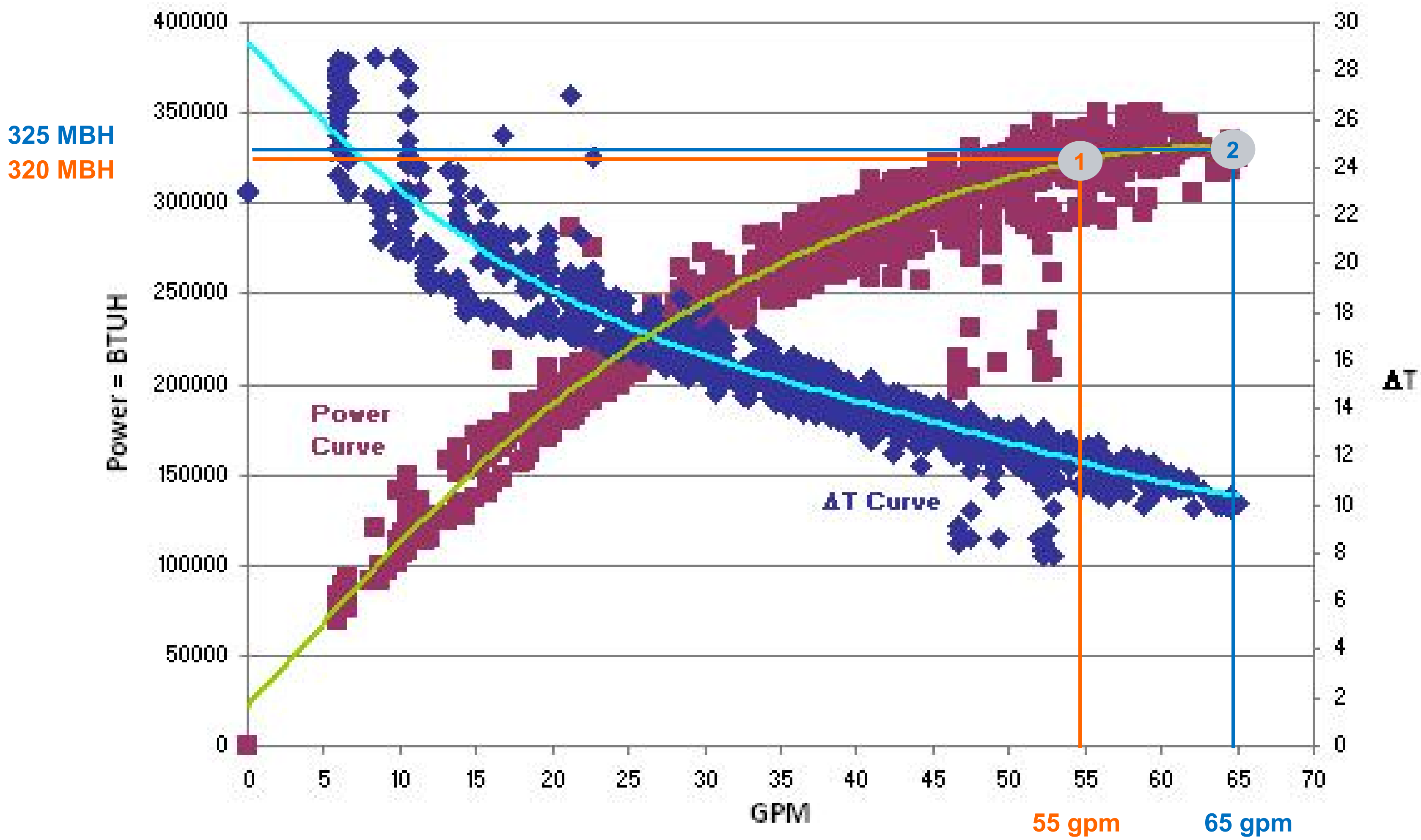
Wetside - Valve and Coil Performance



Wetside - Understanding Coil Behavior

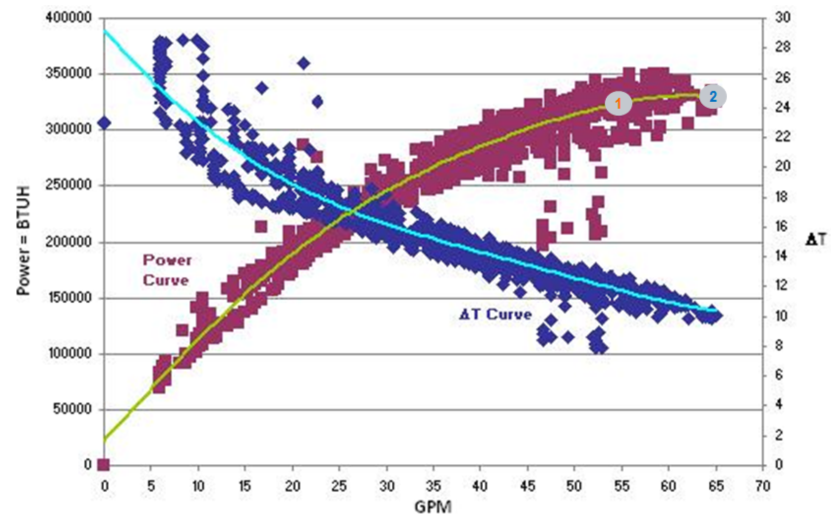


Wetside - Cost of “Overflowing” the Coil



Wetside - Cost of “Overflowing” the Coil

	1	2	Δ
BTUh	**320,000**	**325,000**	1.6%
GPM	**55 GPM**	**65 GPM**	18%
Pump hp	Hp increase = $(65/55)^3$		65%

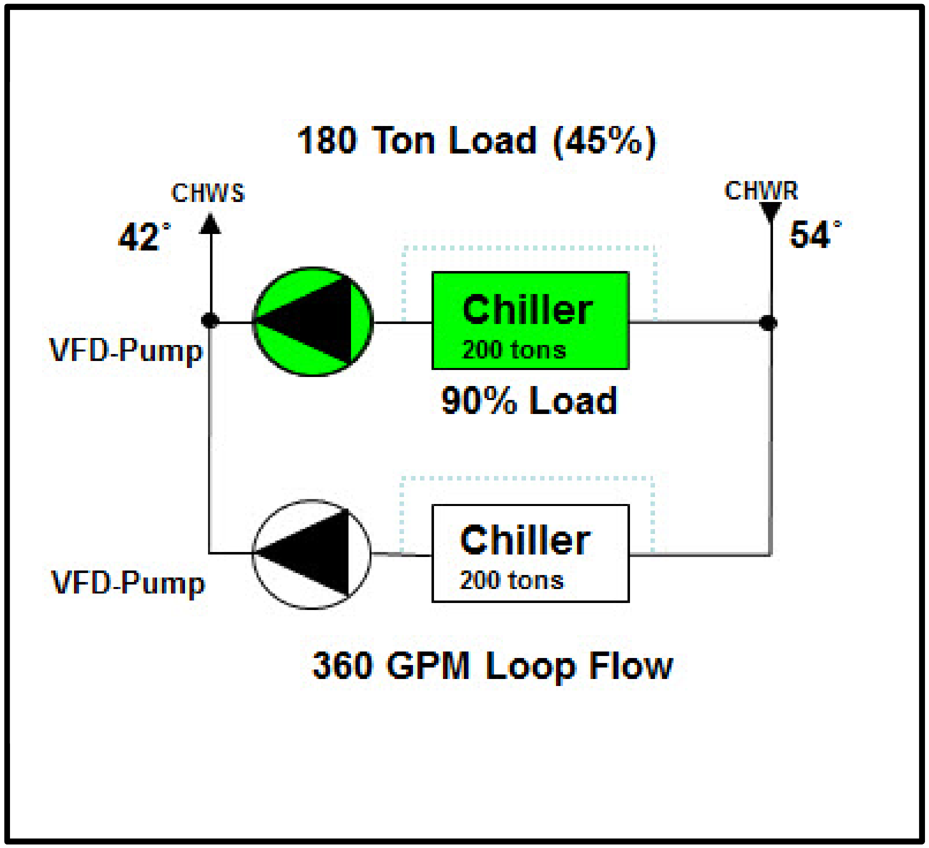


Pump Affinity Law

$$\frac{HP_2}{HP_1} \qquad \frac{GPM_2}{GPM_1}$$

Wetside - Impact of Low Delta T
At the Plant

Design: 400 tons; 12°ΔT; 800 GPM



Part Load (Ideal)

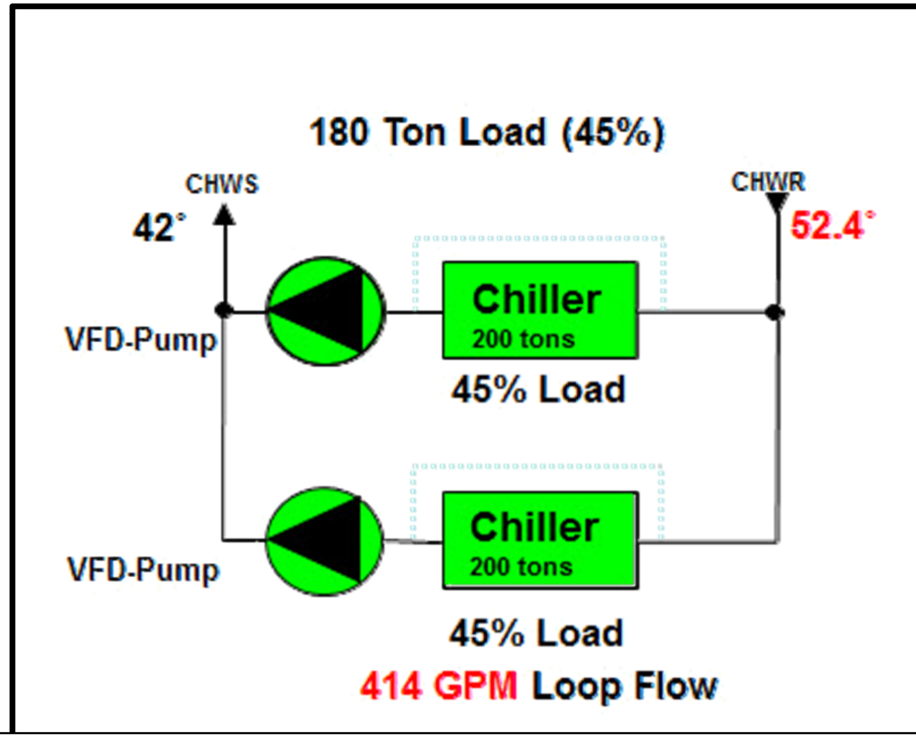
- $\Delta T = 12^{o}F$ ($54^{o}F - 42^{o}F$)
- 360 GPM
- 1 Chiller, 90% Loaded (180 Ton)

Wetside - Impact of Low Delta T
At the Plant

Chiller Plant Efficiency

Low ΔT

- ΔT=**10.4°F** (52.4°F - 42°F)
- **414 GPM** (15% overflow)
- **2 Chillers**, (45% Load 180 Ton)



An additional pump/chiller is brought online to satisfy pump DP (flow) demand, not necessarily cooling demand.

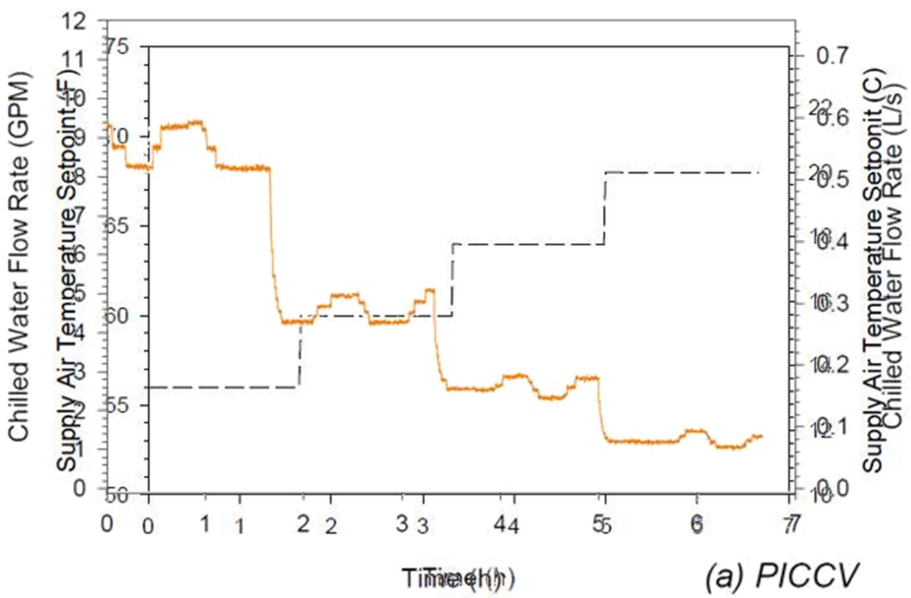
Wetside - Control Instability

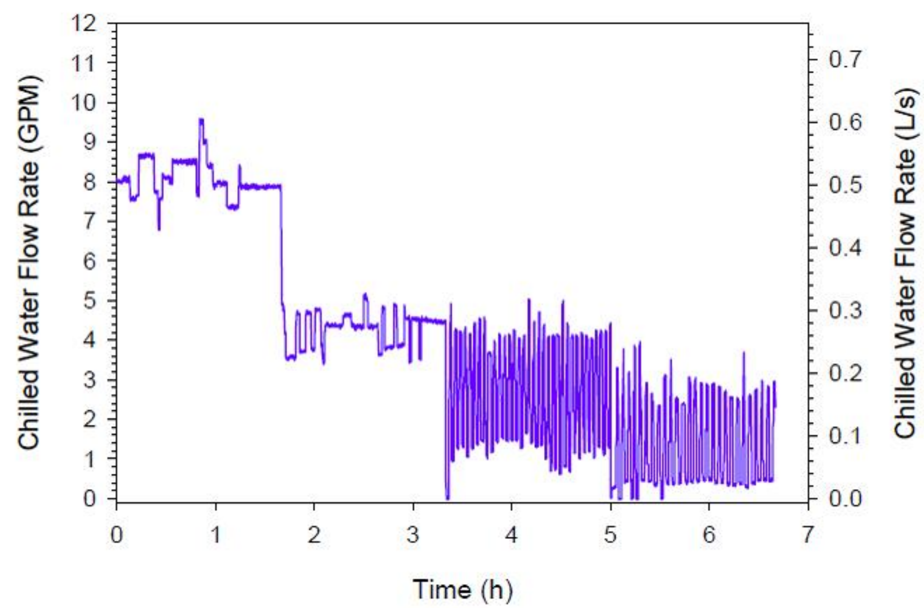
BELIMO

Iowa Energy Center Pressure Independent Valves Study

Chilled Water Closed Loop Test

Pressure Independent is more stable, especially at low flows.





Pressure Independent

Setpoint Step Change

Ball Valve Response

Pressure Dependent

Globe Valve Response

Pressure Independent Valve Technologies

BELIMO

- Sized based on the required design flow rate, not Cv.
- Cv is variable. Maintains a constant flow rate at any given load.

Pressure Independent Valve Technologies

Electronic

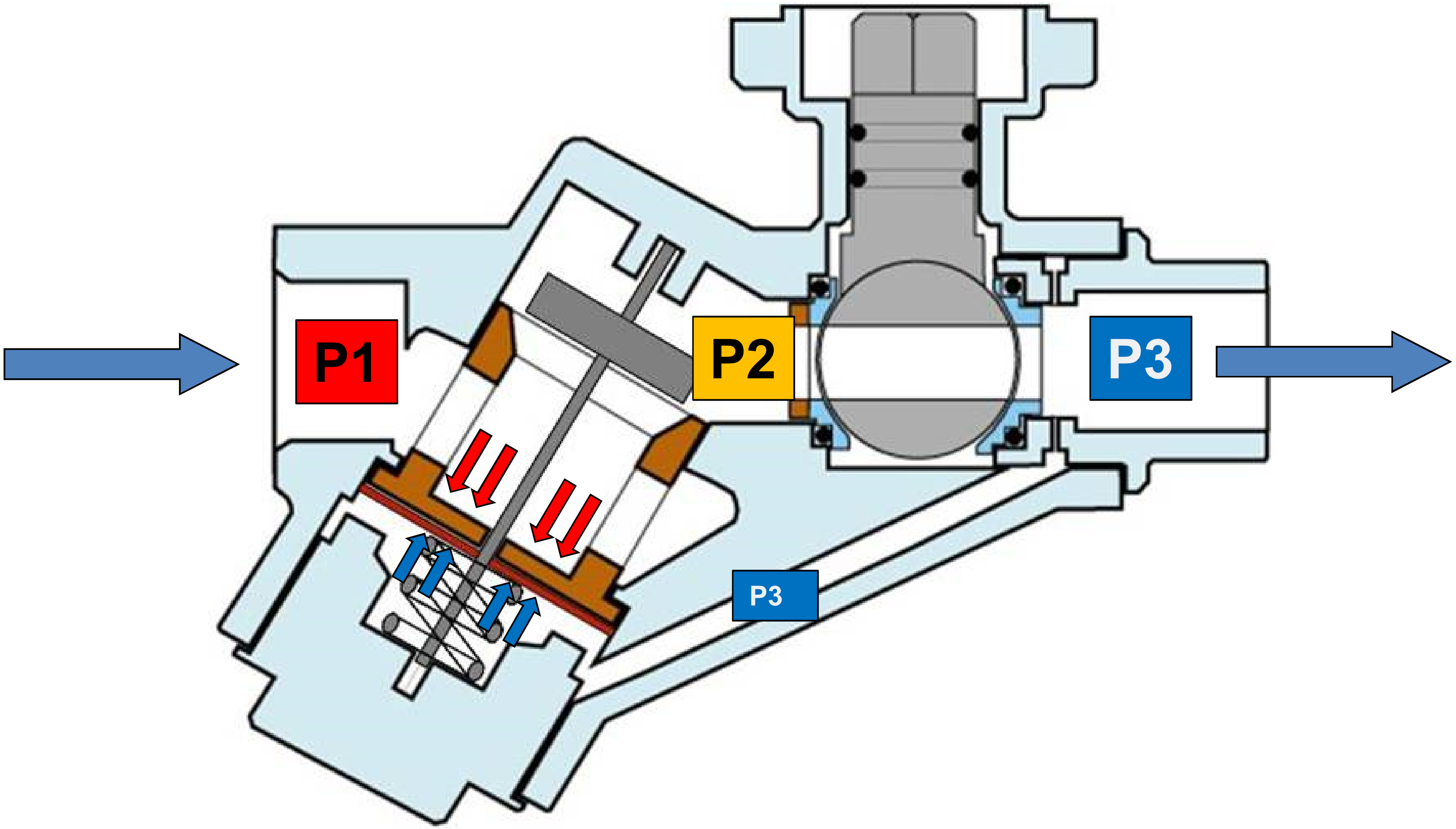
Mechanical

ΔP Control

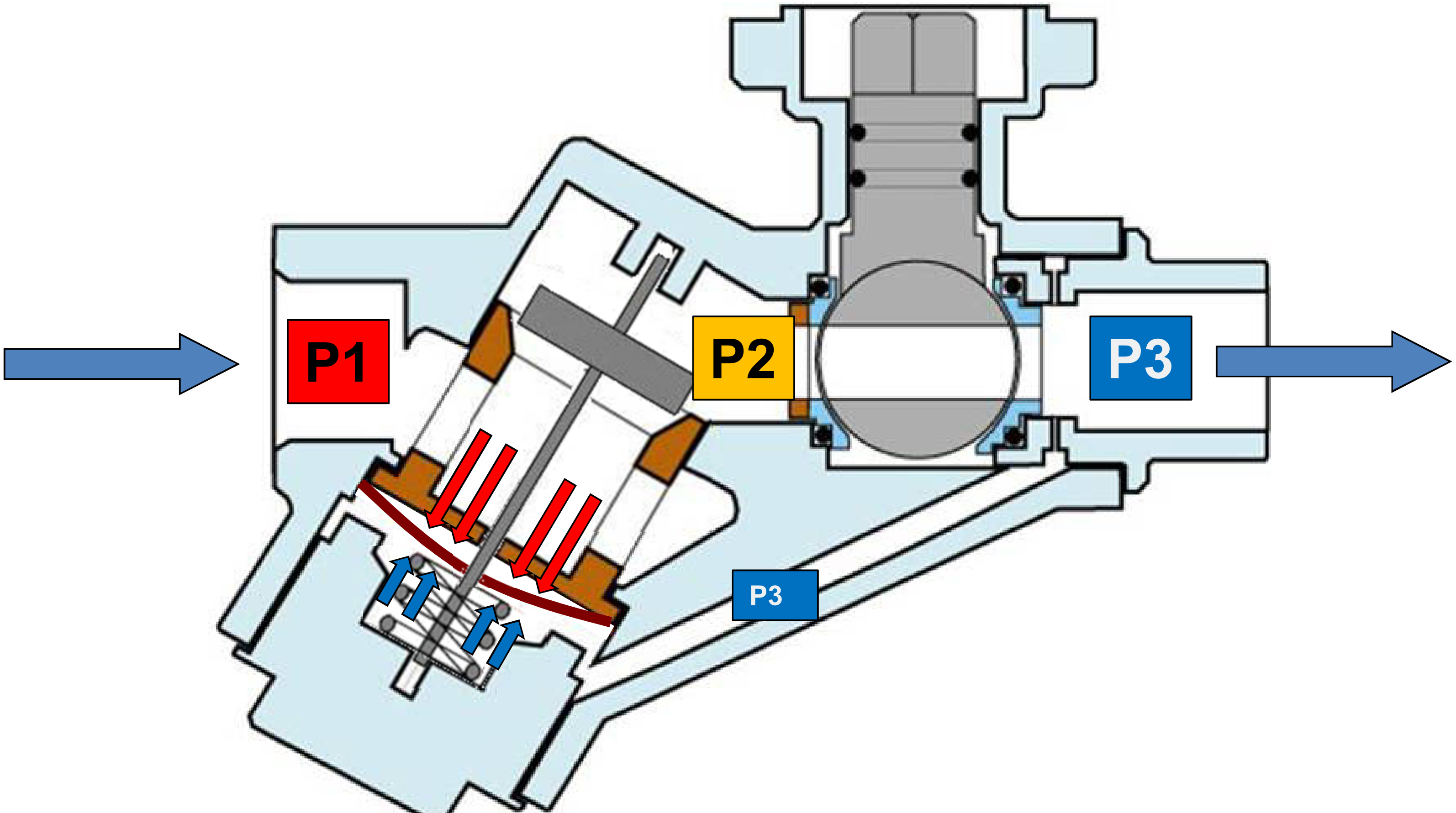
Flow, Power (BTU) and ΔT Control

Flow Control

Pressure Independent Technology
Mechanical

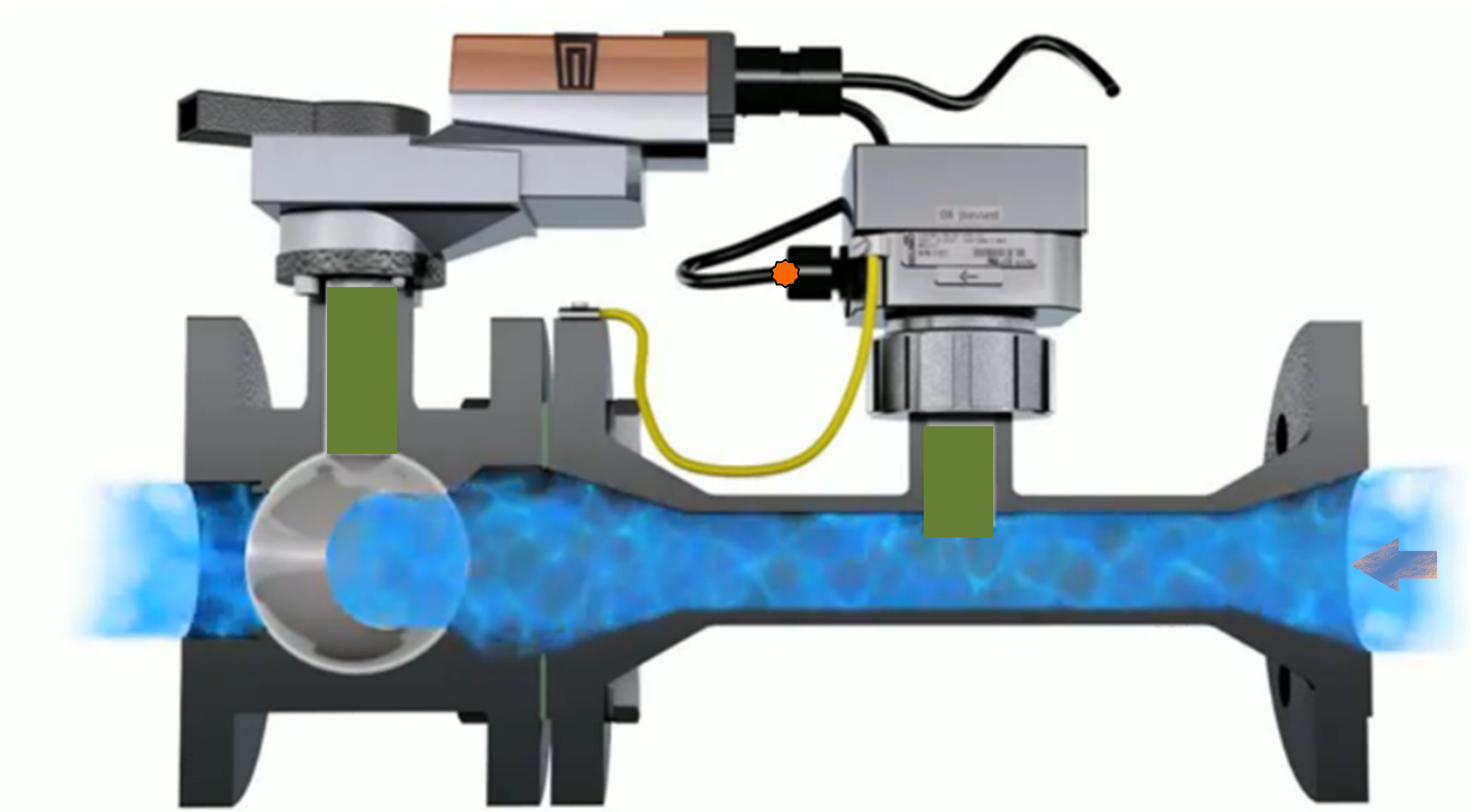


Pressure Independent Technology
Mechanical



Regulator controls ΔP across valve orifice to a fixed value. Valve stroke determines volumetric flow.

Pressure Independent Technology
Electronic

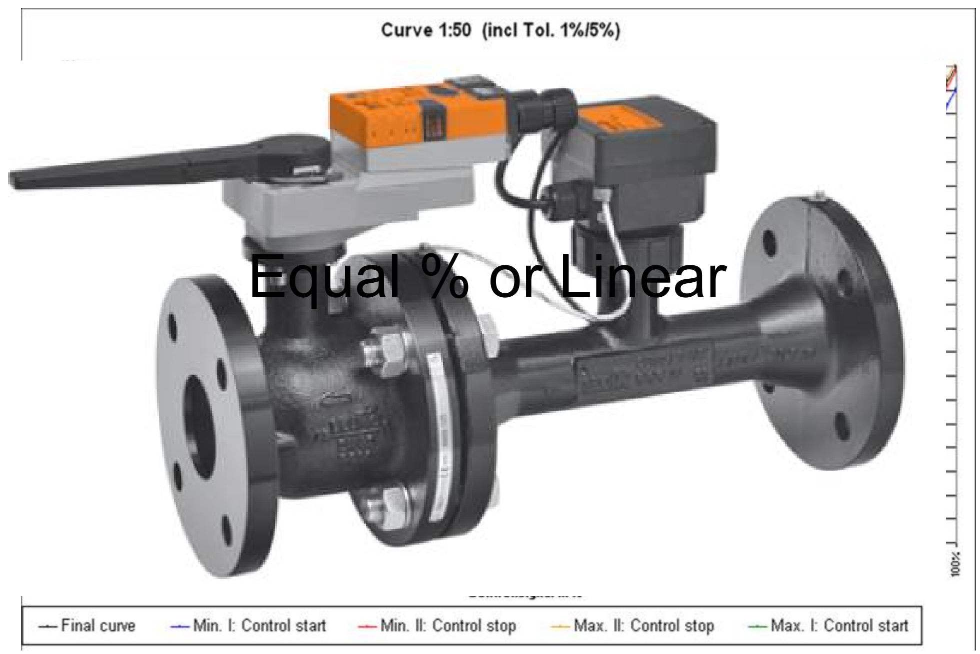


Uses integral flow measurement to achieve Pressure Independent Flow

Pressure Independent Technology
Electronic

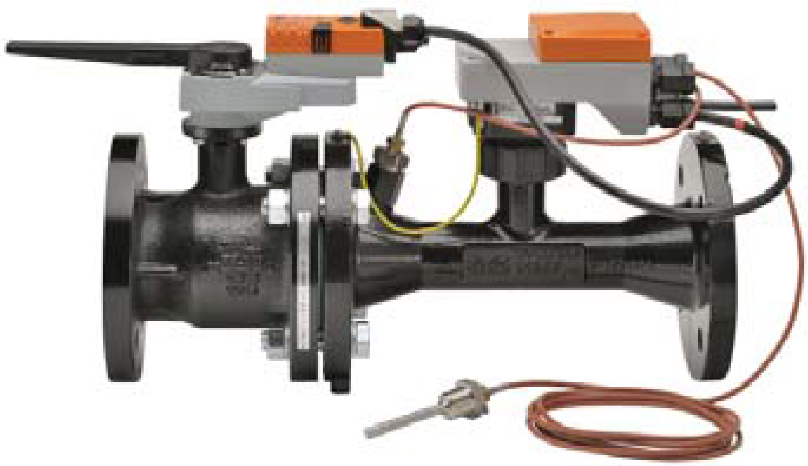
Advantages of <u>Electronic</u> Pressure Independence:

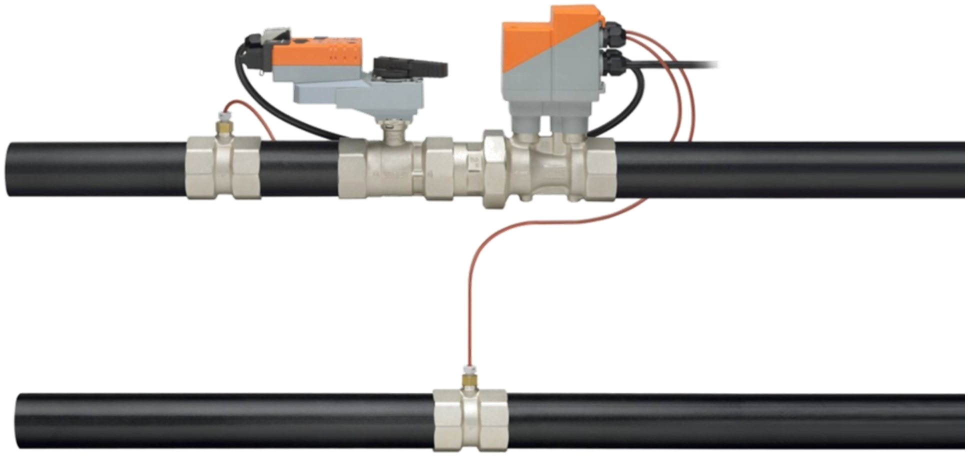
- **Dynamic Balancing**
- **Direct Flow Measurement**
- **Programmable to <u>exact</u> Flow Requirements**
- **Electronically Determined Flow Characteristics**
- **Lower Pressure Drop**



Intelligent Valve Technologies
Electronic

- **Flow (PI) Control**
- **Power (BTU) Control**
- **Delta T Control**
- **BACnet capable**





Intelligent Valve Technologies

Power (BTU) Control

- **Power Control allows DDC to deliver exact energy required to the space**
- **0 to 10 VDC = 0 to 100% BTU Capacity**

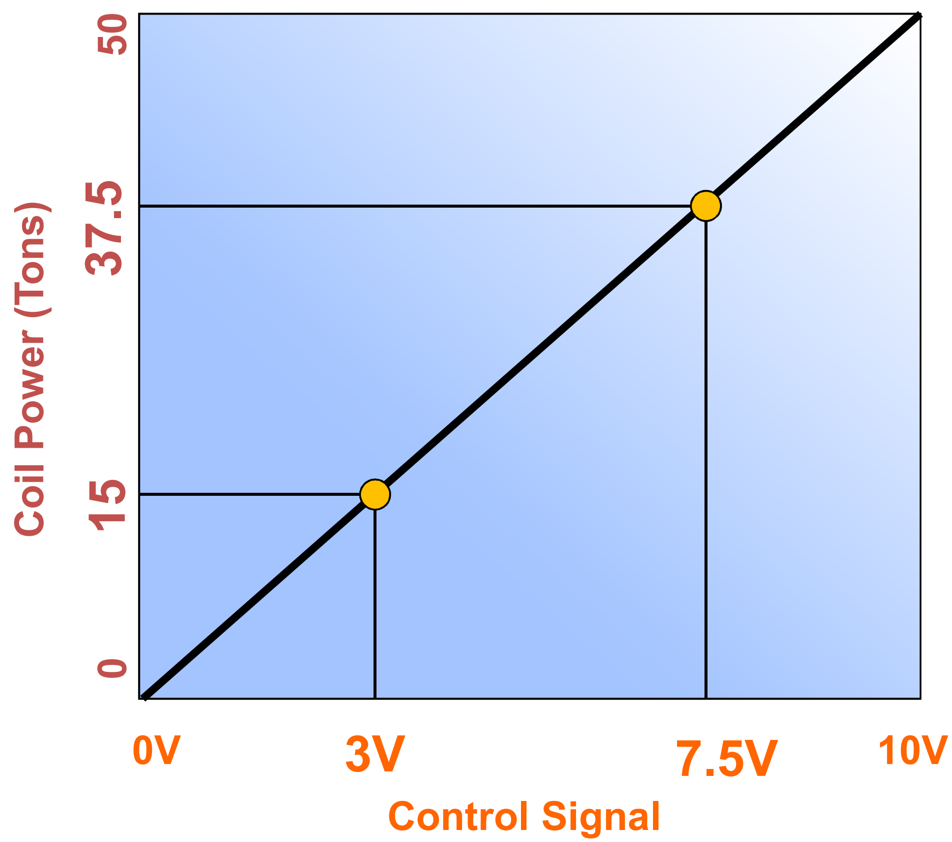
Example: 50 Ton Coil

0 VDC = 0 tons setpoint

3 VDC = 15 tons setpoint

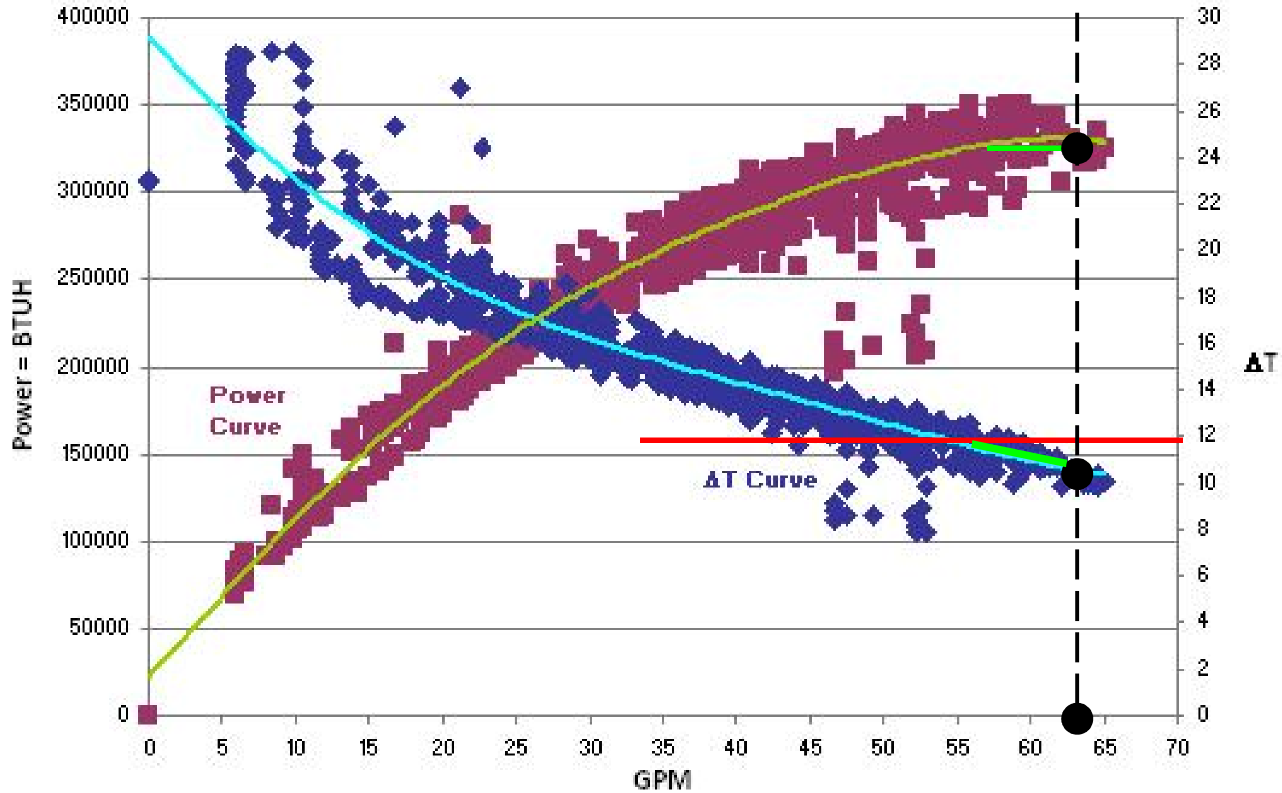
7.5 VDC = 37.5 tons setpoint

10 VDC = 50 tons setpoint



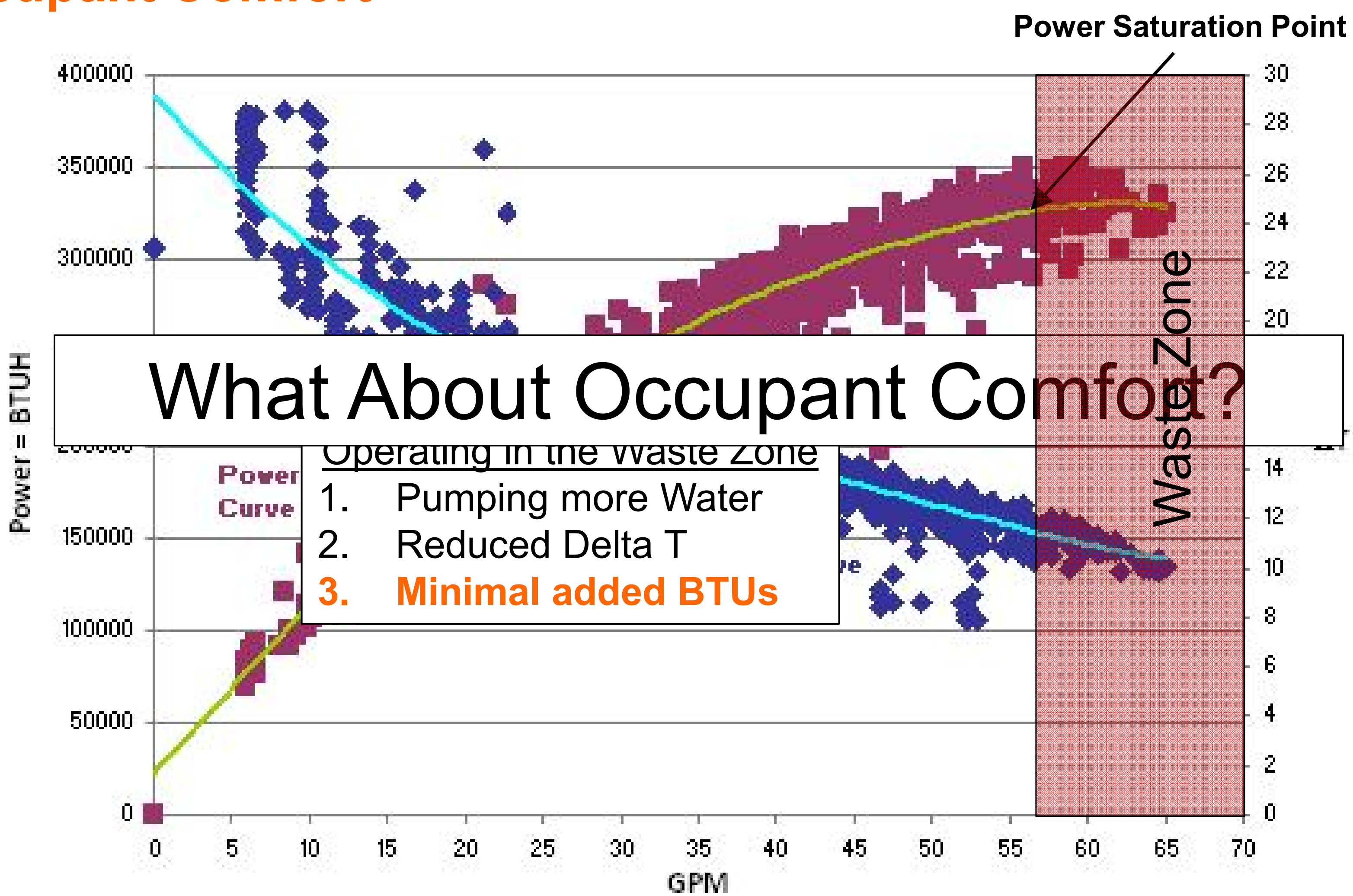
Intelligent Valve Technologies

∆T Control



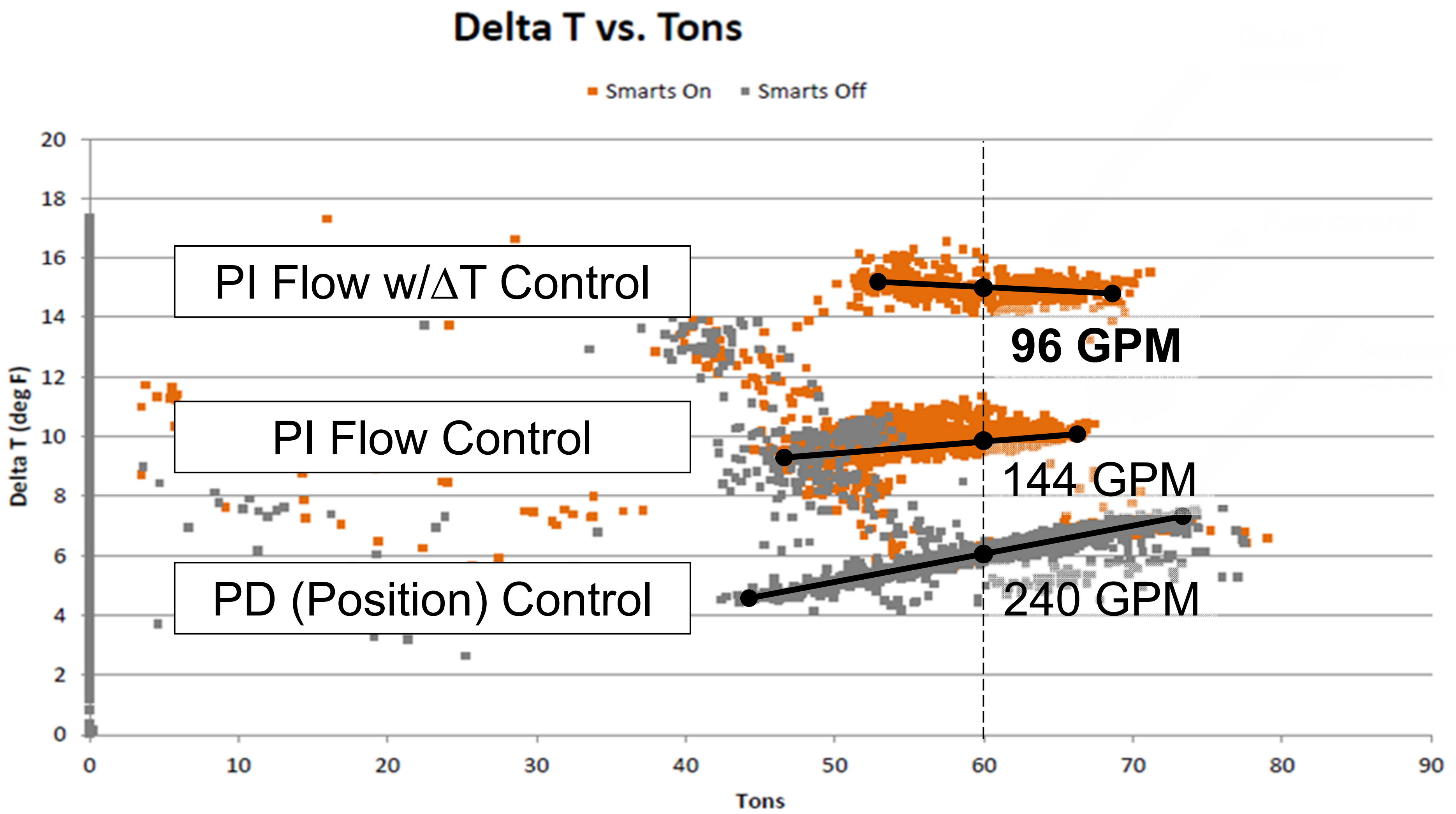
Intelligent Valve Technologies

Occupant Comfort



Intelligent Valves

Large Tech Company in North Carolina




Questions?