



HAYS

ASHRAE Kansas City Chapter

11/3/2025

Agenda

- Why Do We Balance?
- Balancing Options
 - Reverse Return
 - Balancing Valves
 - Manual vs. Automatic (Different Technologies)
- System Costs
 - Initial vs. Long-term
 - Material Costs & T&B (Initial)
 - System Efficiencies (Long-term)
- Auto-Balancing & Modulation

Why Balance?

- Reduced water flow reduces heat transfer
- Terminals furthest from the pump in unbalanced systems receive less flow resulting in reduced heat transfer
- Excessive flow
 - Increases pressure drop and pump energy
 - Increases pump wear and noise
 - Increasing water flow to 200% of coil design
 - only increases heat transfer by 6% but, increases pressure drop by 400%

Balancing Options

Reverse Return Piping

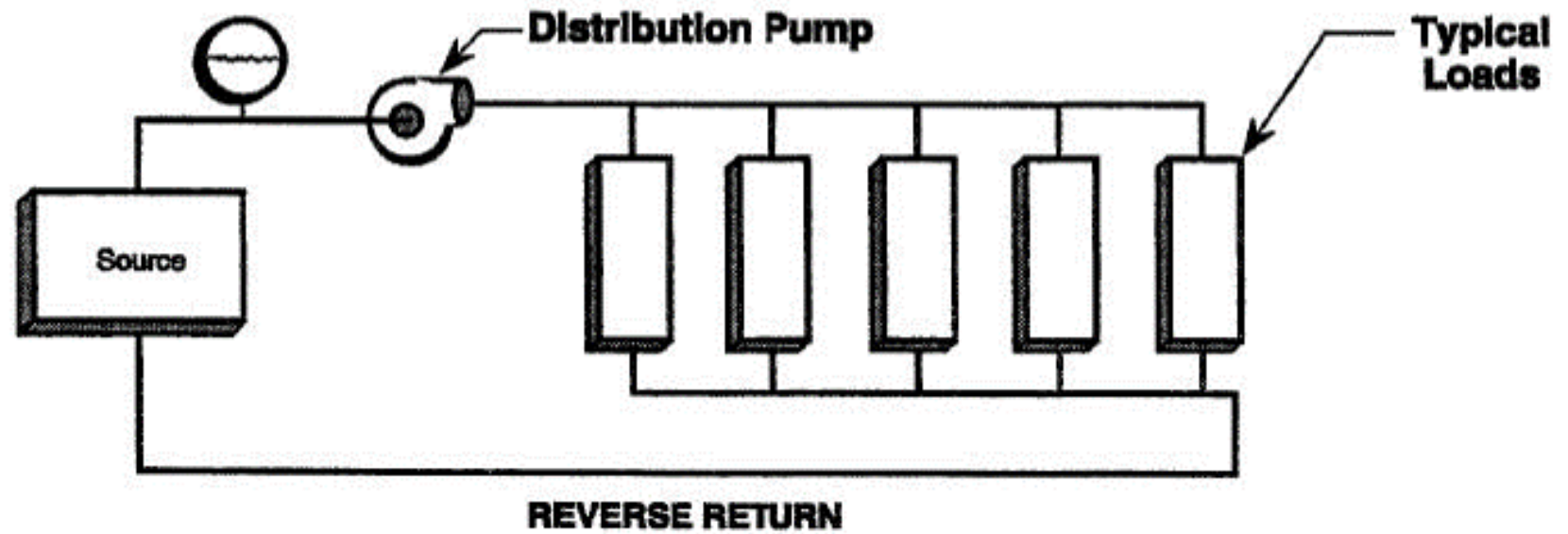
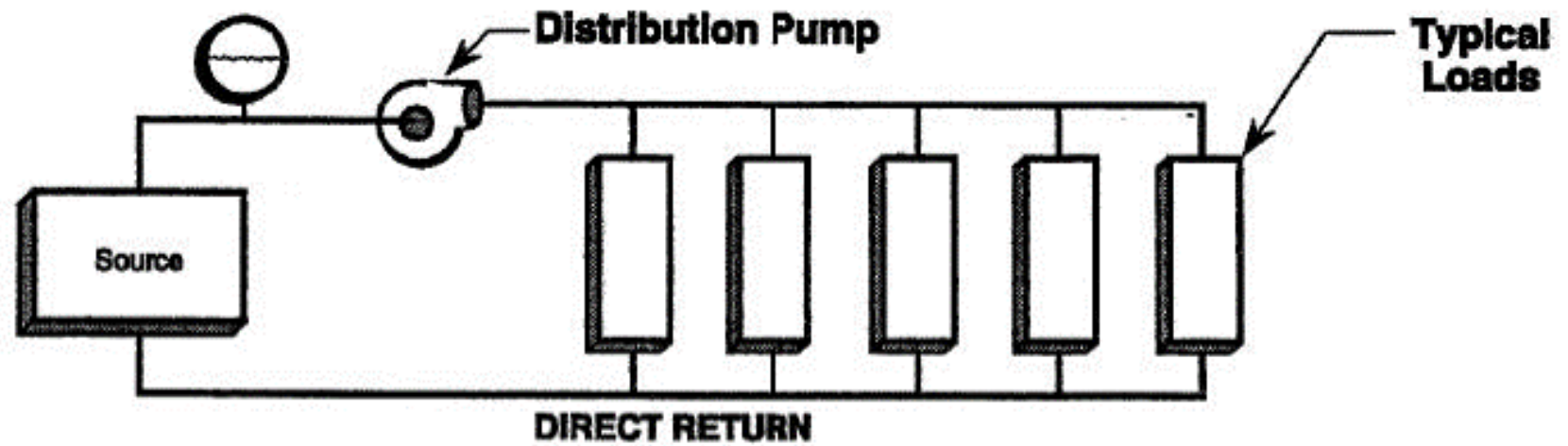
Manual Balancing

Automatic Flow Control Valves

Unconventional Methods

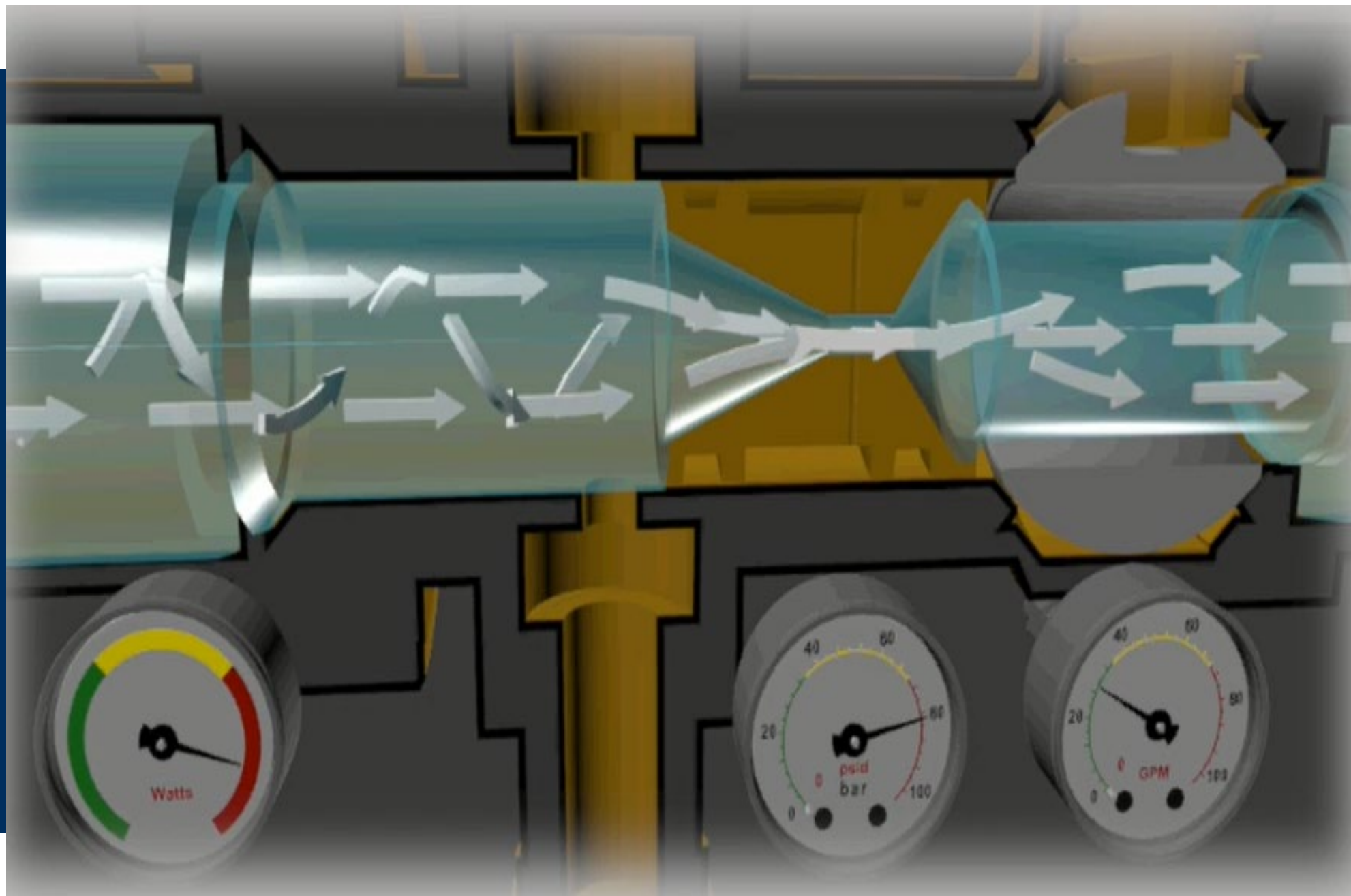
- Circulating Pumps at Each Unit

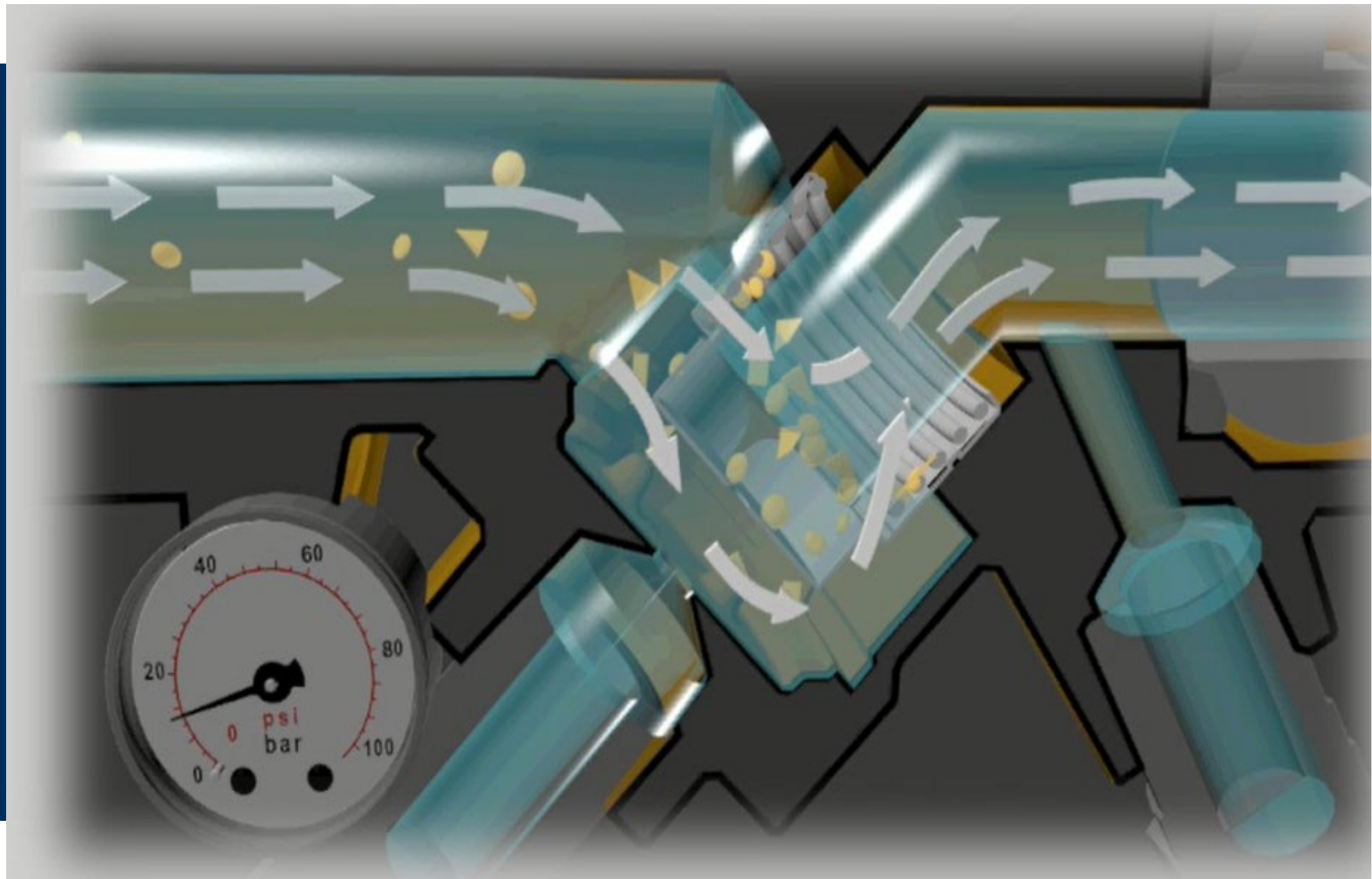
Reverse Return

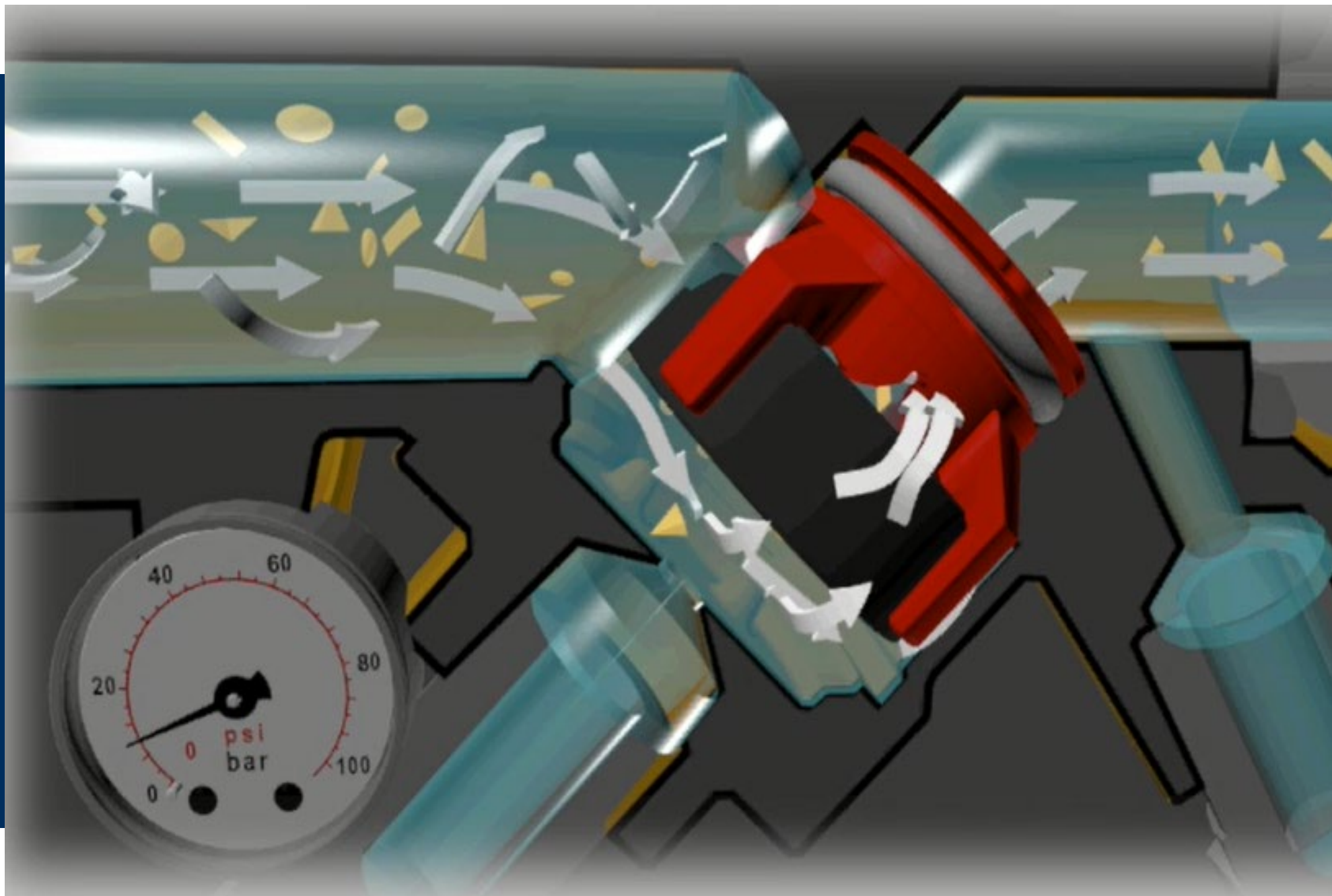


- Balancing Valves
 - provide proper distribution of water flow to terminal units in the system to ensure maximum comfort with minimal energy consumption.
- Improves performance of
 - HVAC Systems
 - Domestic Water Systems

What Is A
Balancing
Valve?

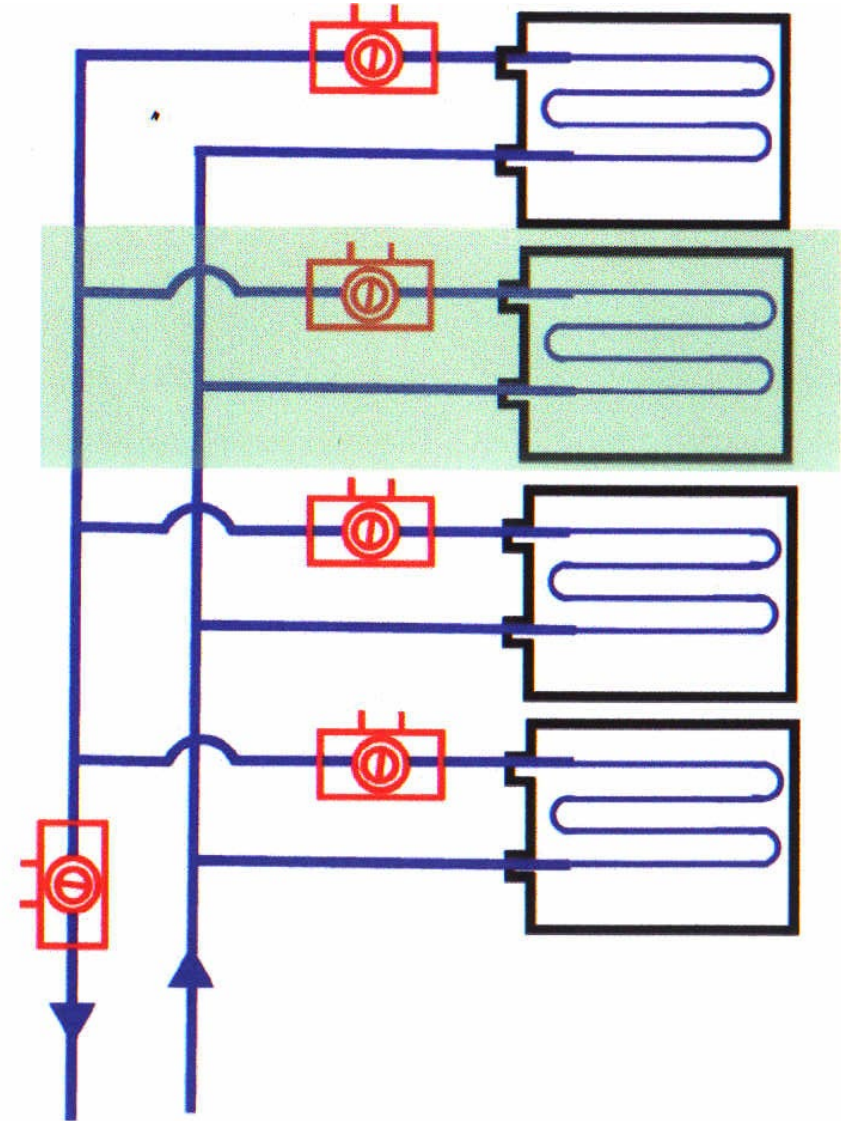


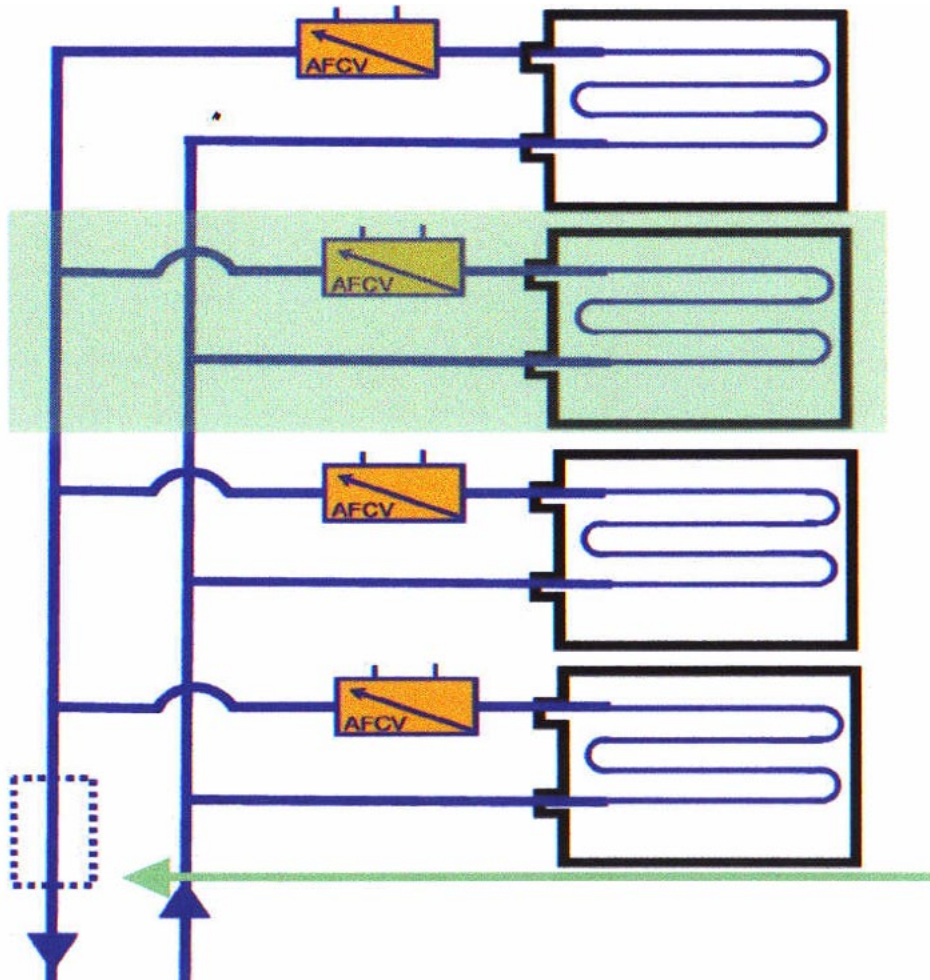




Cost of a System - Manually Balanced

- Circuit Balance Valves required at all terminal units
- System needs to be rebalanced when new terminal unit(s) added
- Manual Balance = No Balancing
 - Balanced at 100% Design Flow
 - Unbalanced at ALL Other Flows



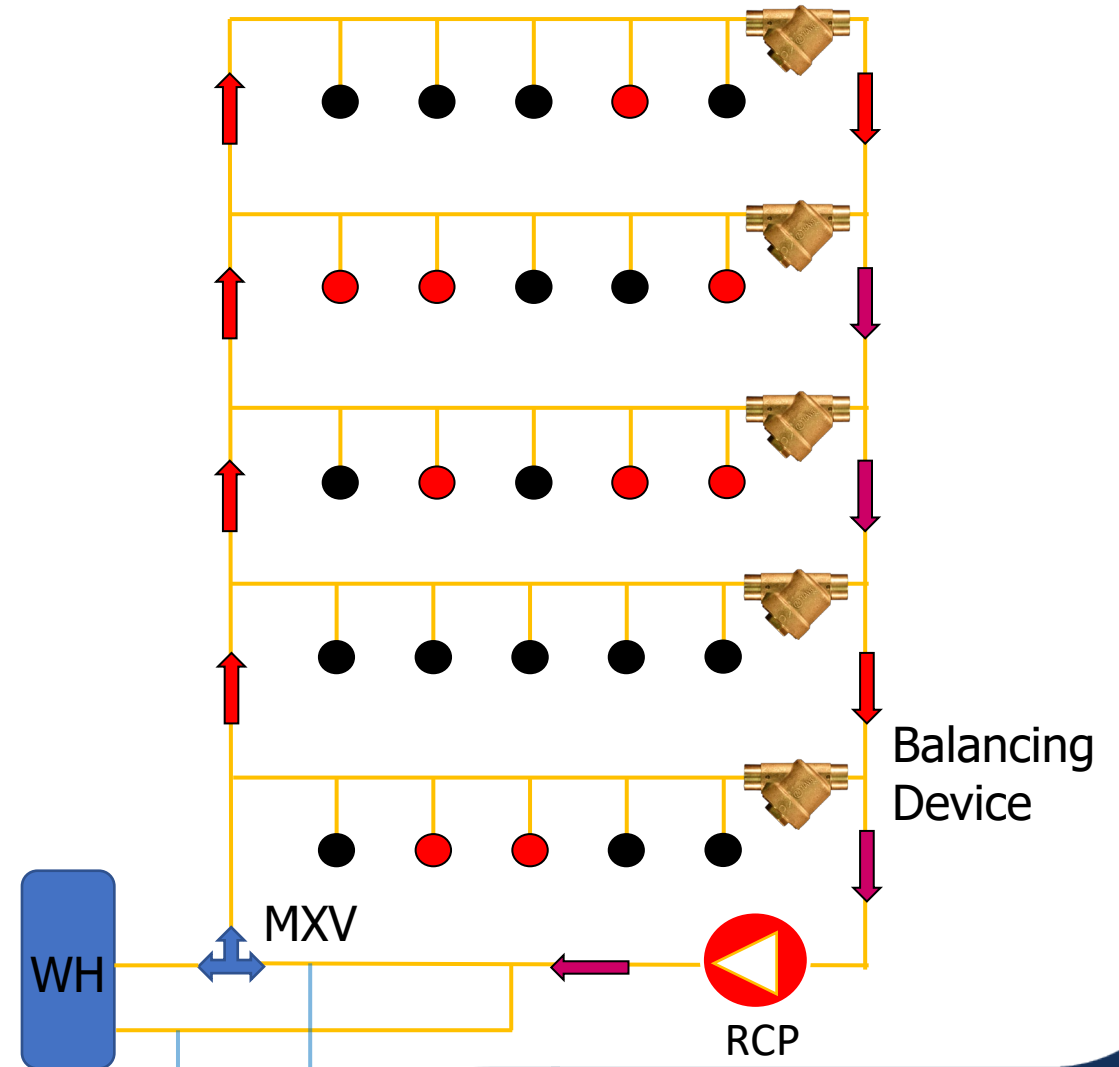


Cost of a System - Automatically Balanced

- Automatic Flow Control Valves only required at terminal units
- No system rebalancing needed when new terminal unit(s) brought on line.
- No AFCV required on riser
- AFCV dynamically adjust to maintain flow

Balancing Domestic HW Systems

- Valves are still installed at the end of each branch
- Factory set to the designed maximum flow rate
- Pressure Independent to system fluctuations based on demand/load
- Allow a reduction of 66% of the Test & Balancing time/cost while ensuring proper flow
- Owners can modify the flow rate in the field if needed by changing cartridges

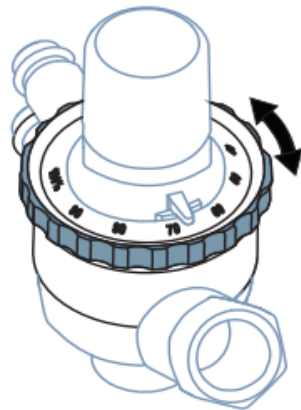


For Your Consideration...

Automatic Flow Control Balance Valves

- (1) Verify that each installed automatic flow control device matches the GPM indicated on the drawings/schedule/unit submittal.
- (2) Verify that the actual pressure differential at each automatic flow control device is within the pressure differential operating range specified by the valve manufacturer for that valve type, inserts, size, and flow rate.

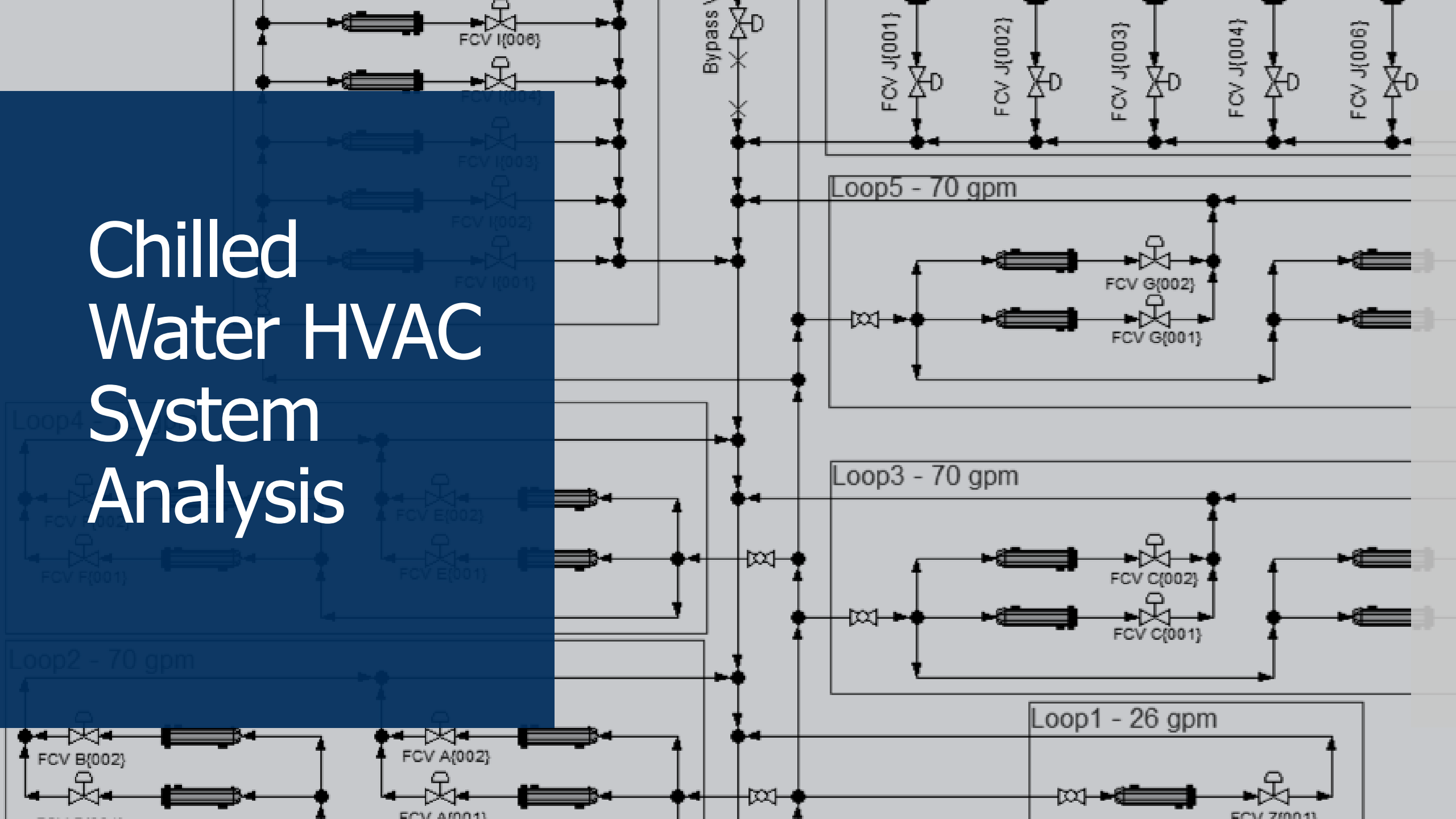
- While Cv rate selection isn't required, the TAB process must set Max Flow by a dial adjustment on site
- The TAB contractor must also confirm operating range
- Varies by manufacturer – confirm the process upon submittal review



Balancing PICVs

*Pressure
Independent
Control Valves*

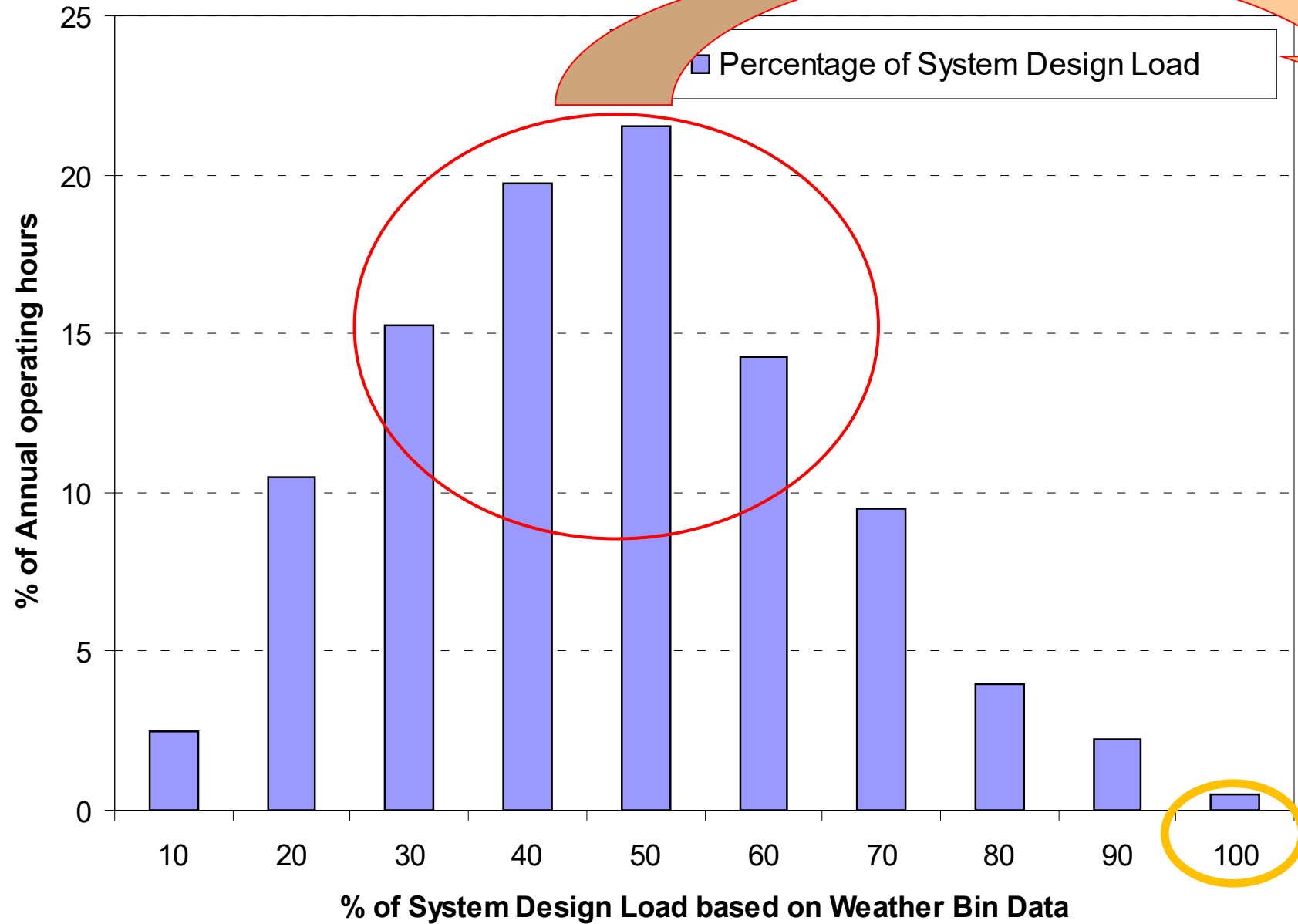
Chilled Water HVAC System Analysis



System Configuration

- Pumps - 2 Primary & 2 Secondary
- Chillers - Inline w/ Primary Pumps
- Designed flow rate – 460 gpm (230 gpm per pump)
- System analyzed under three different balancing options:
 - Fully Open – no balancing
 - Manual balancing
 - Automatic balancing

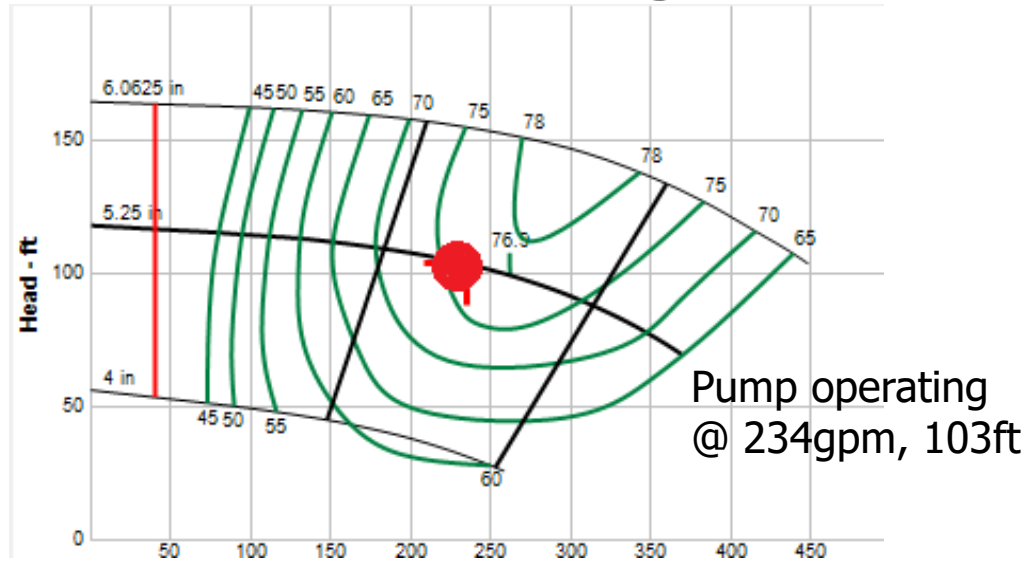
Annual System Load Profile



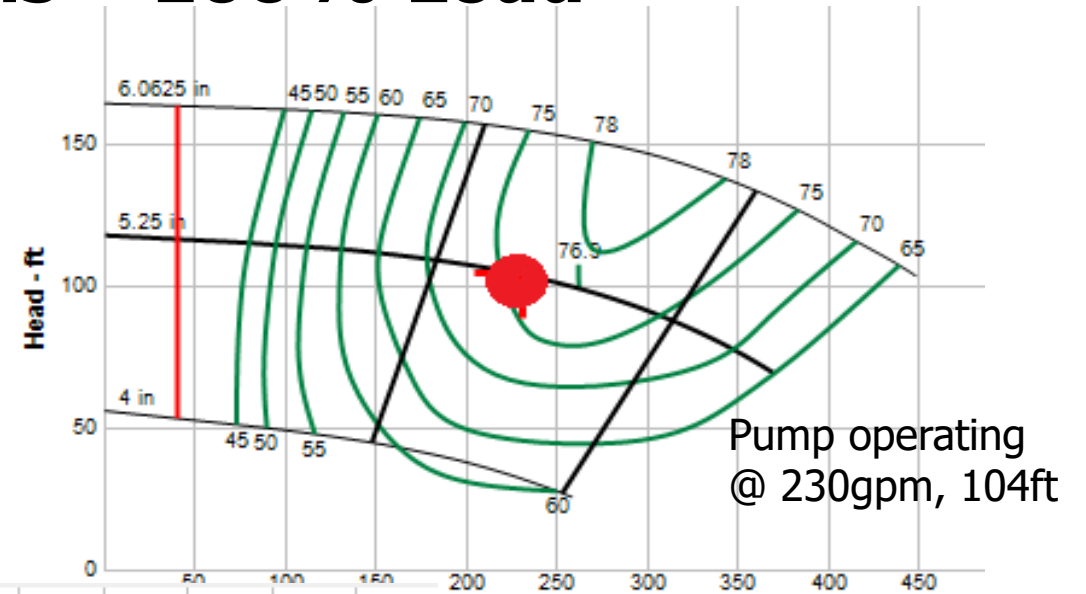
Normal
Operating
Conditions:
30- 60% of
system design
load

System runs
less than 2%
of the time at
full load
design
conditions

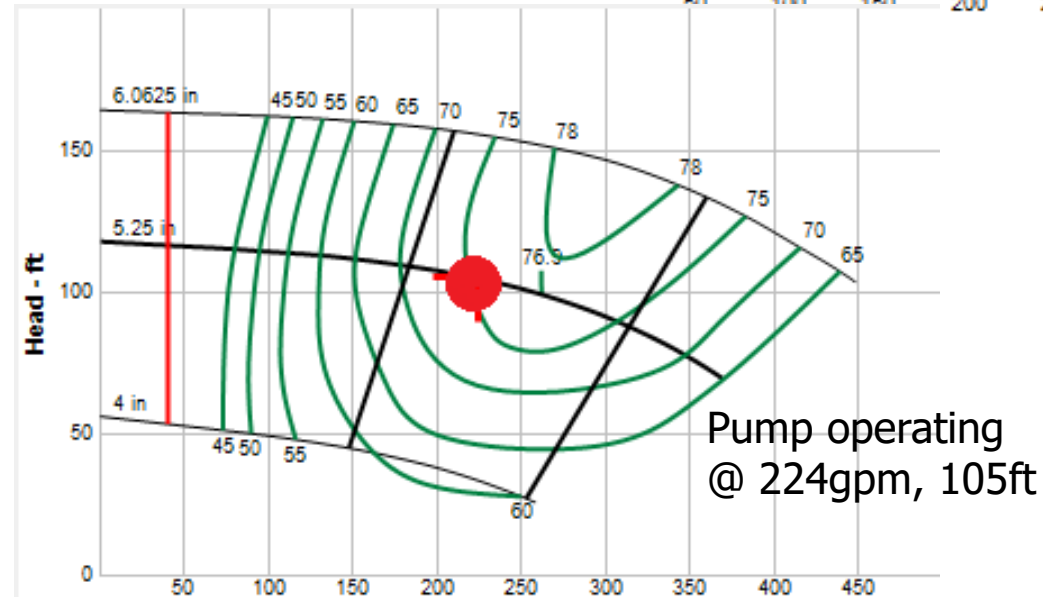
Design Conditions – 100% Load



No Balancing

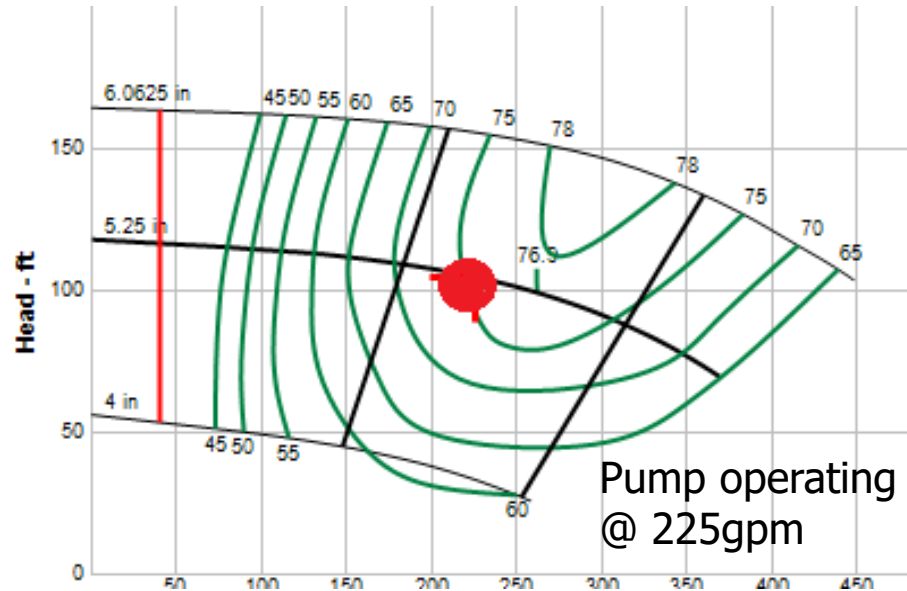


Manual Balancing

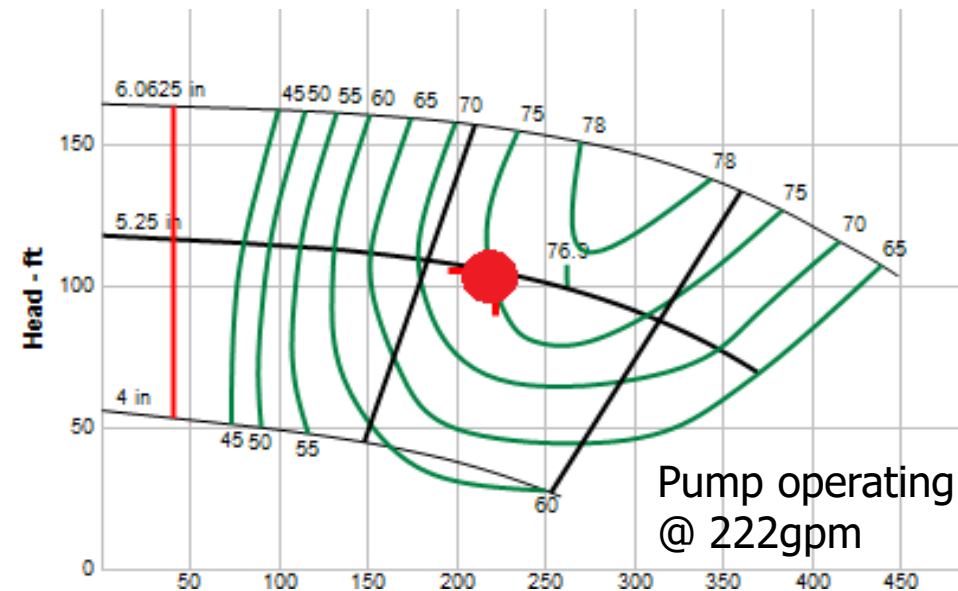


Automatic Balancing

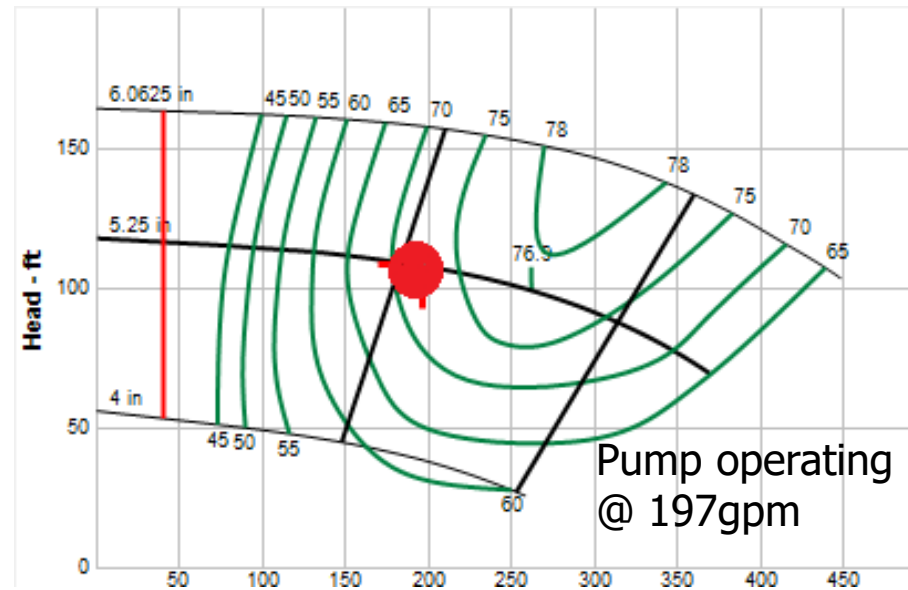
Fixed Speed Pump Curves Comparison: Design Conditions – 90% Load



No Balancing



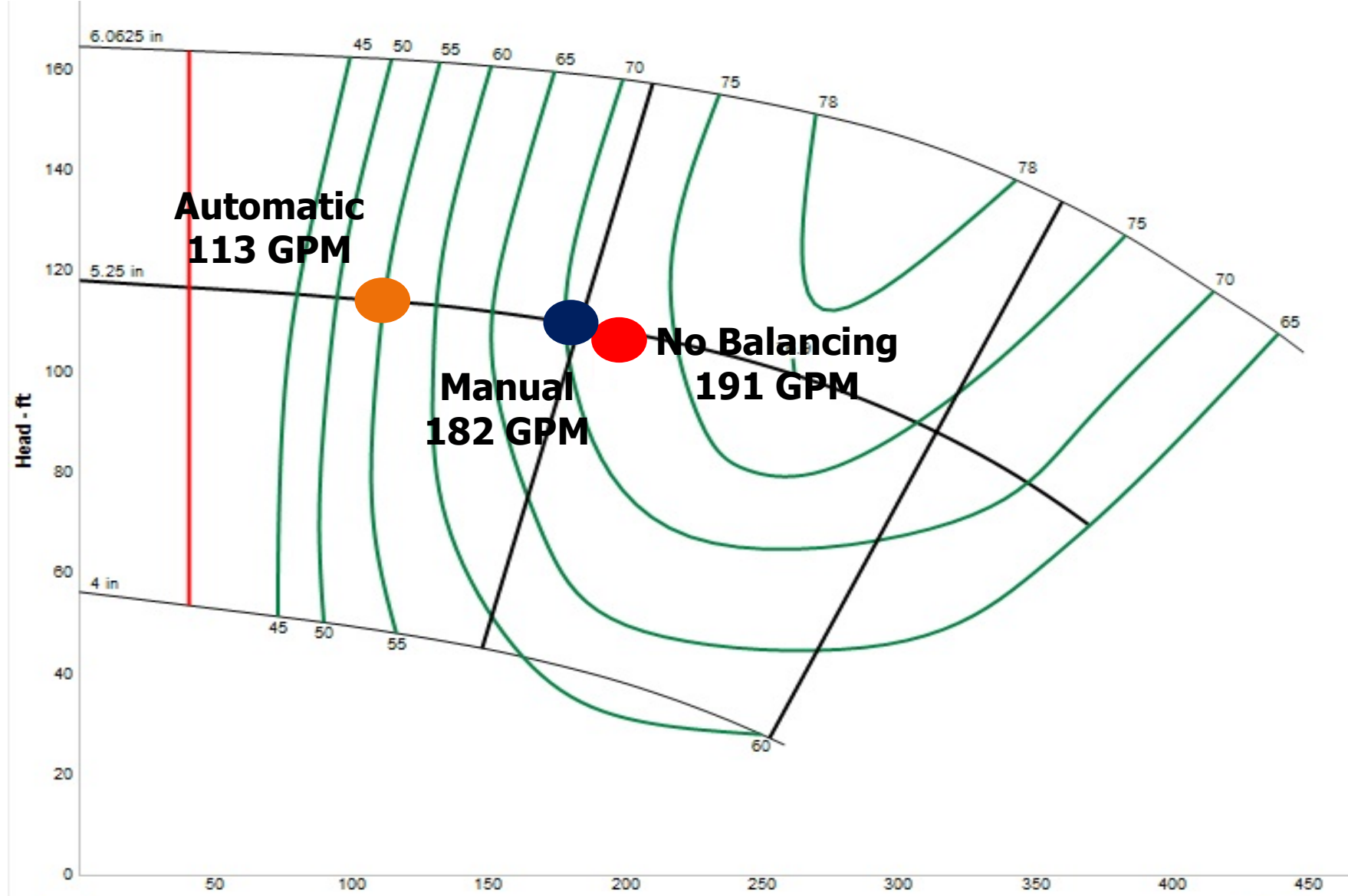
Manual Balancing



Automatic Balancing

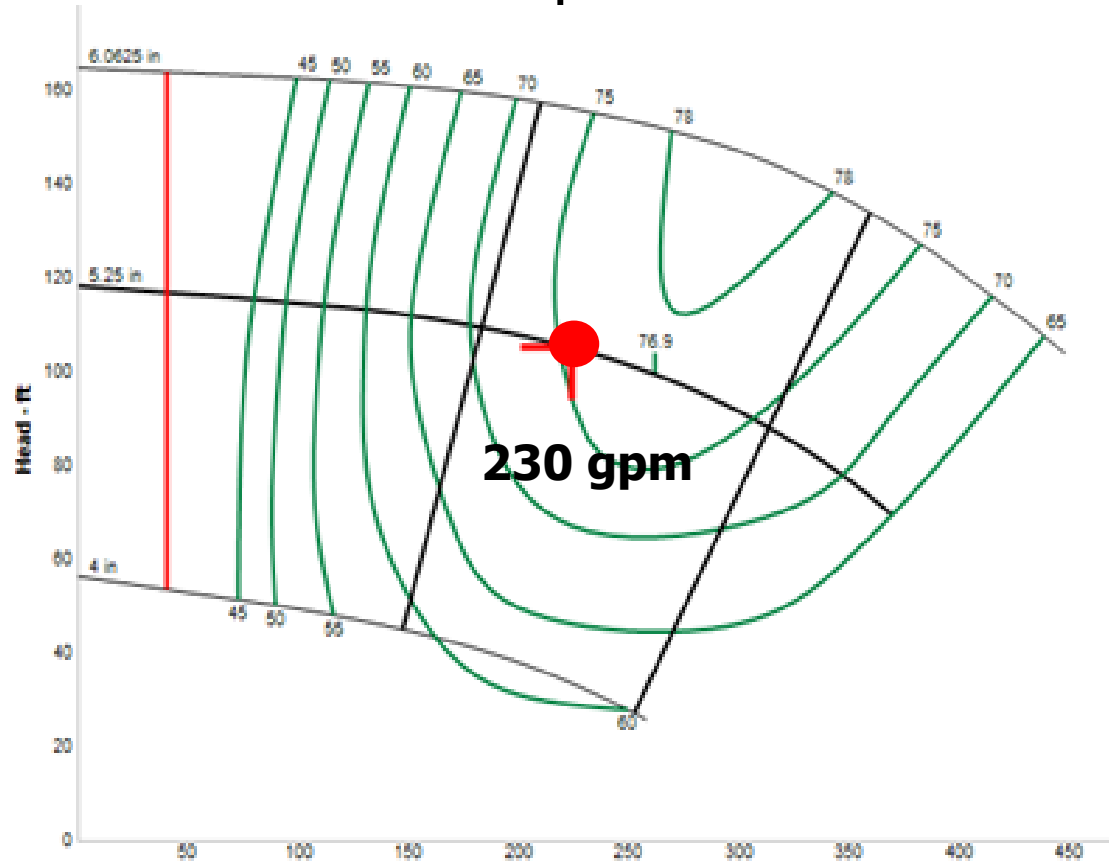
*Pump Operating point
moving to the left on
pump curve =
ENERGY SAVINGS*

Fixed Speed Pump Curves Comparison: Design Conditions – 50% Load



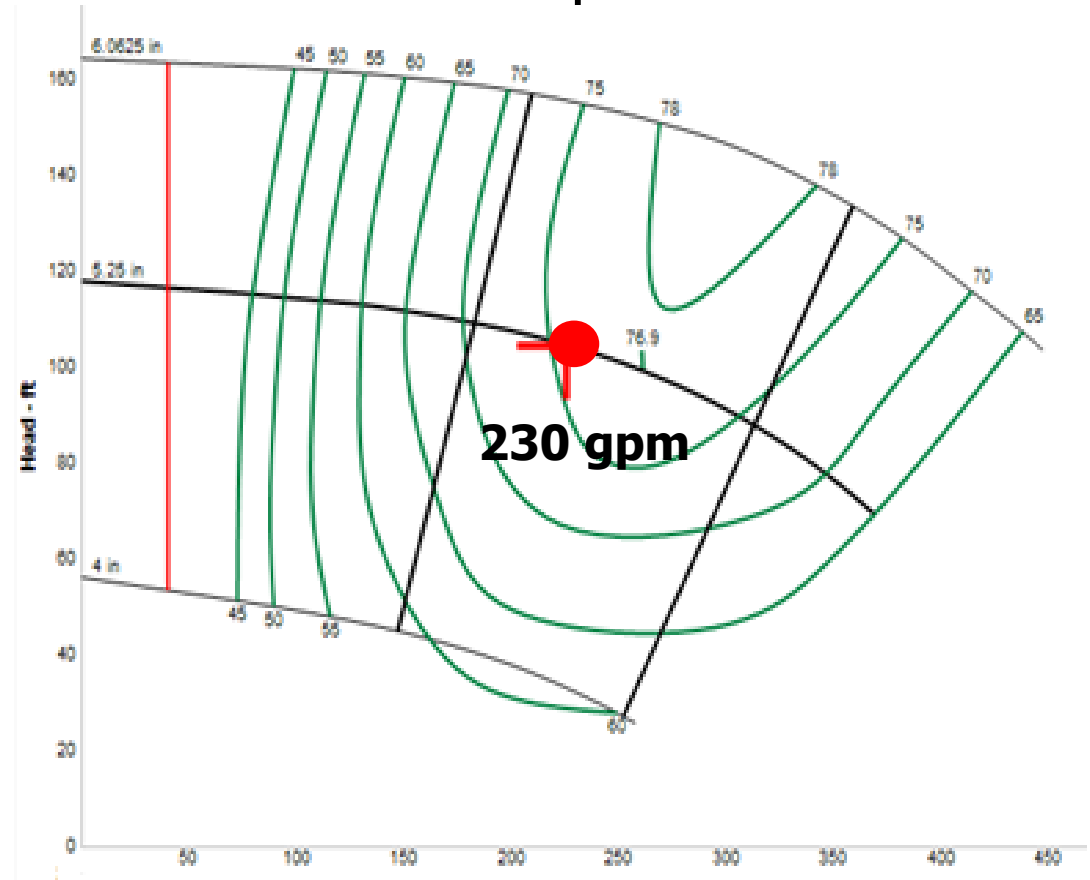
100% Design Flow Condition (Manual Balancing)

Fixed Speed Drive



3,500 rpm
Eff: 75.5 %
Power: 8 hp

Variable Speed Drive



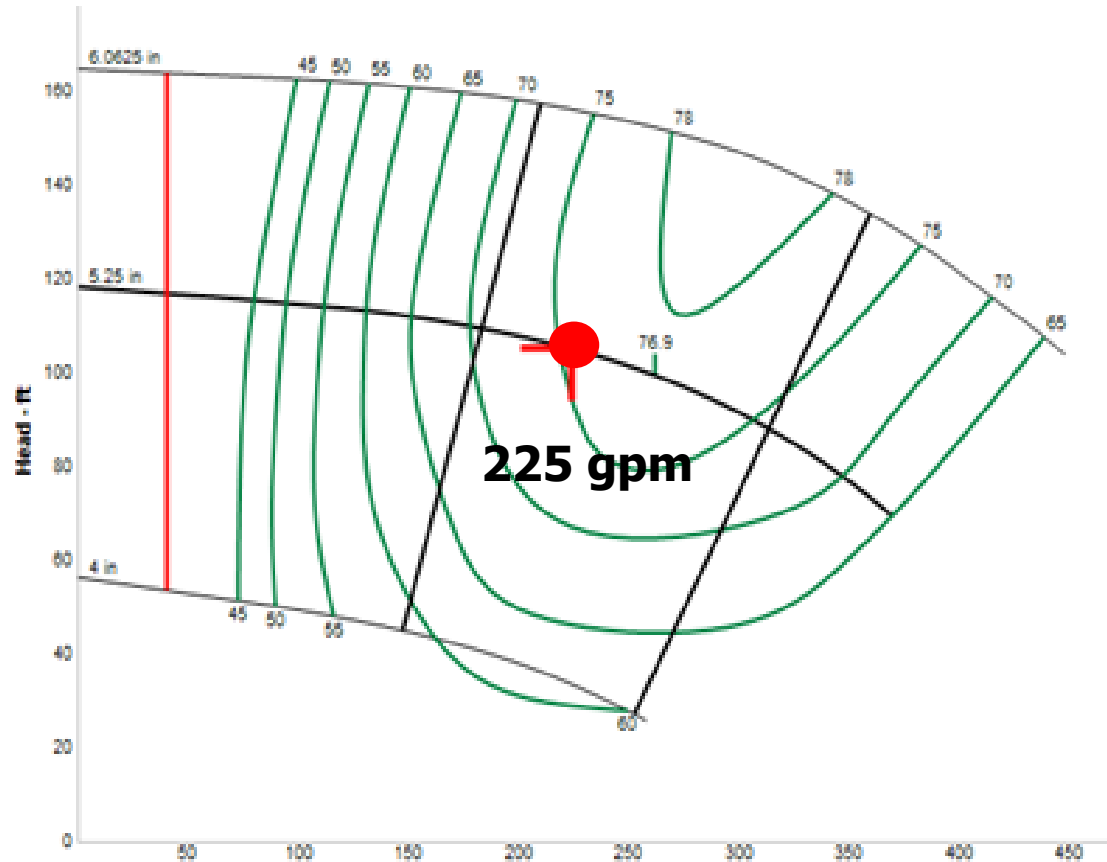
3,500 rpm
Eff: 75.5 %
Power: 8 hp

100% Design Flow Condition

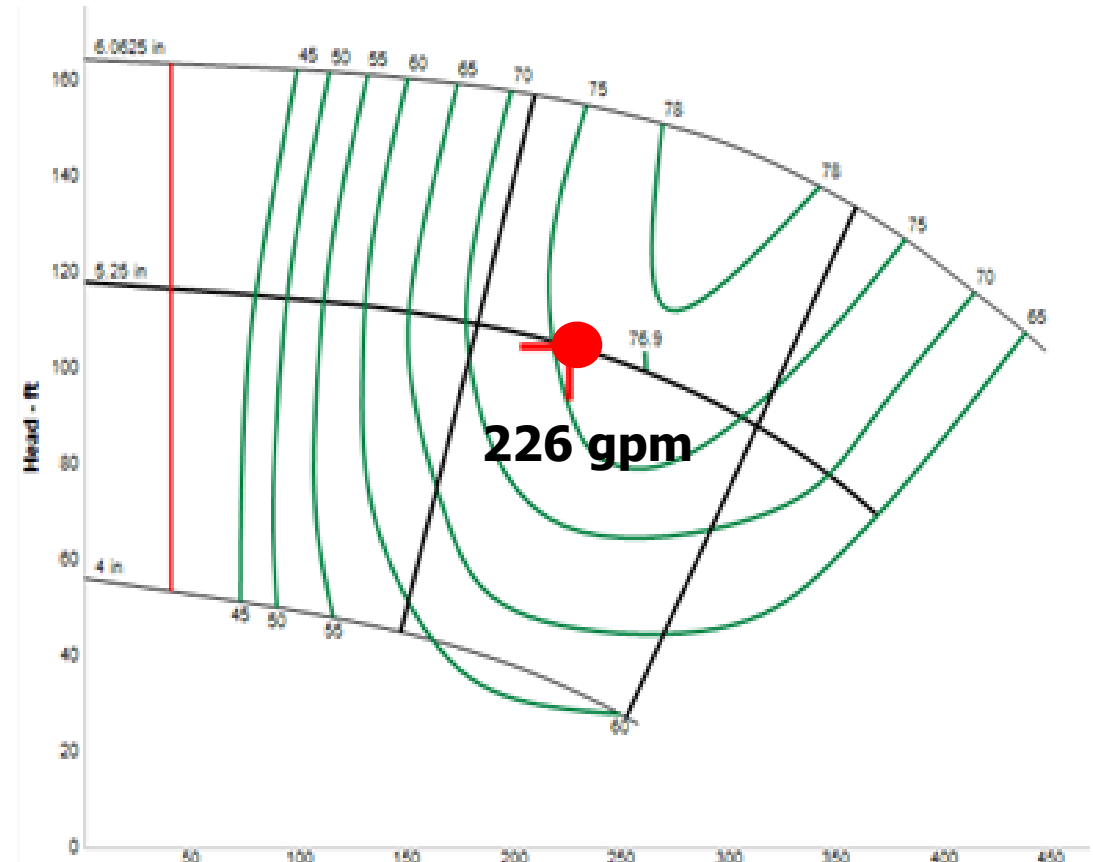
(Automatic Balancing)

Fixed Speed Drive

Variable Speed Drive



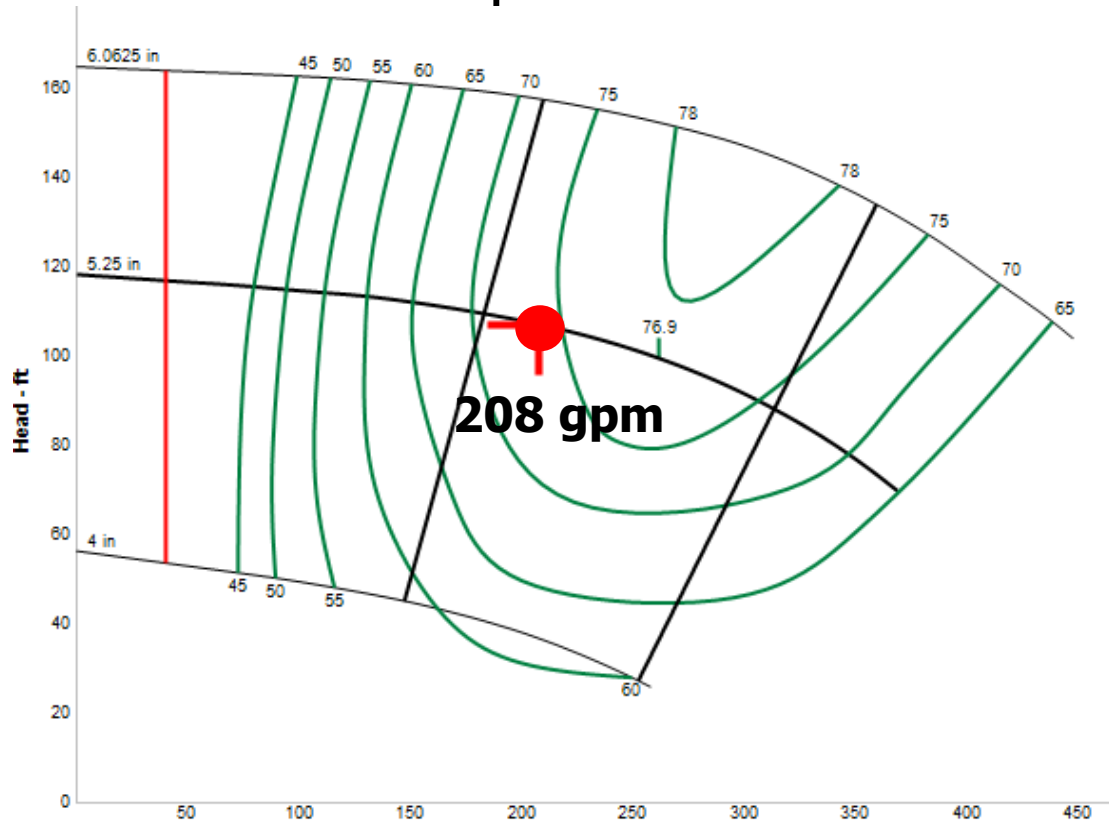
3,500 rpm
Eff: 75.5 %
Power: 8 hp



3,500 rpm
Eff: 75.5 %
Power: 8 hp

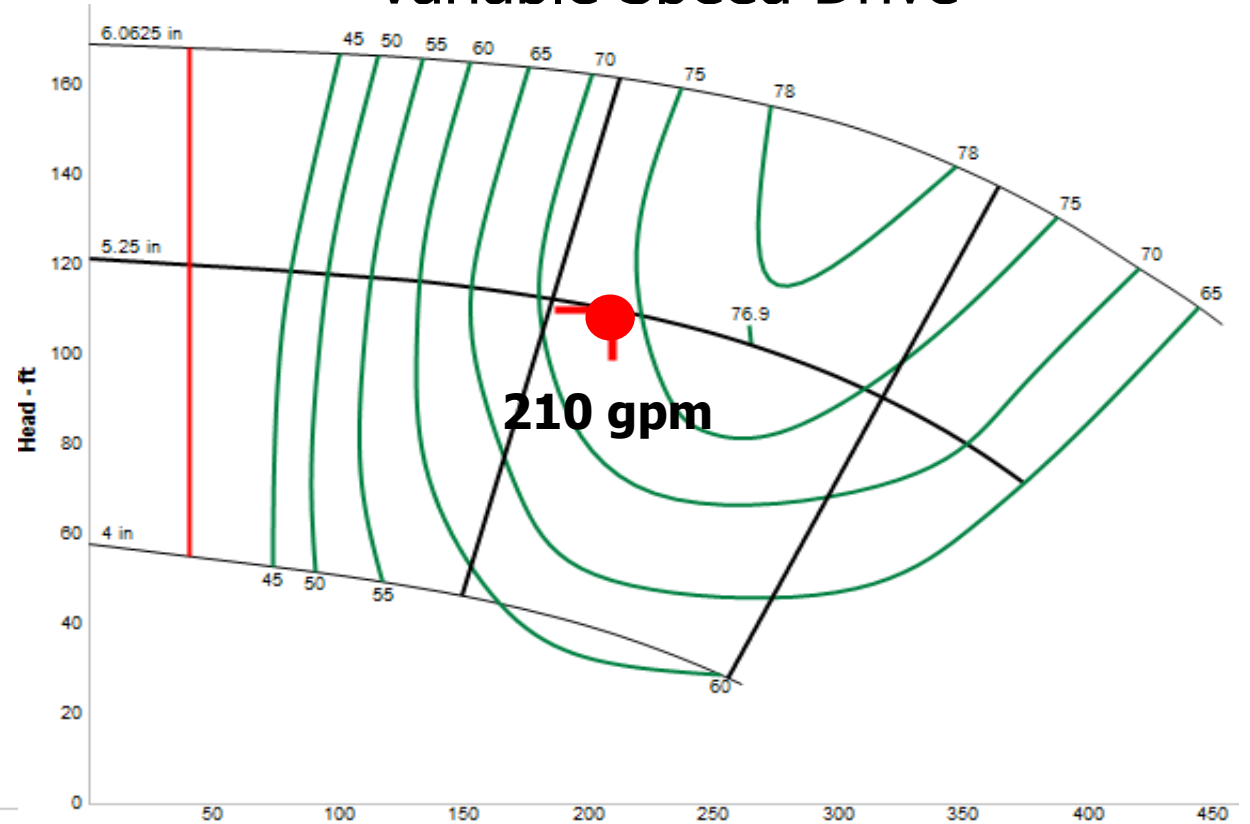
70 % Design Flow Condition (Manual Balancing)

Fixed Speed Drive



3,500 rpm
Eff: 73.8 %
Power: 7.6 hp

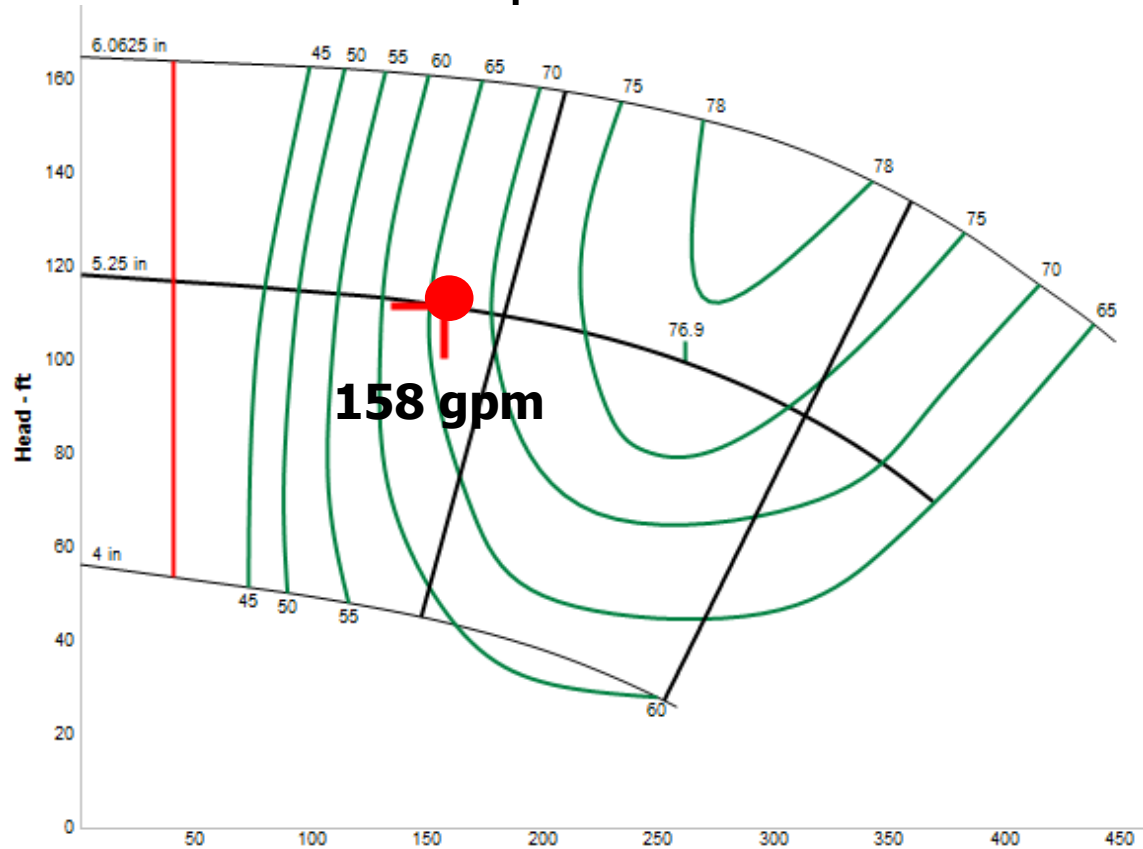
Variable Speed Drive



3,545 rpm
Eff: 73.7 %
Power: 7.9 hp

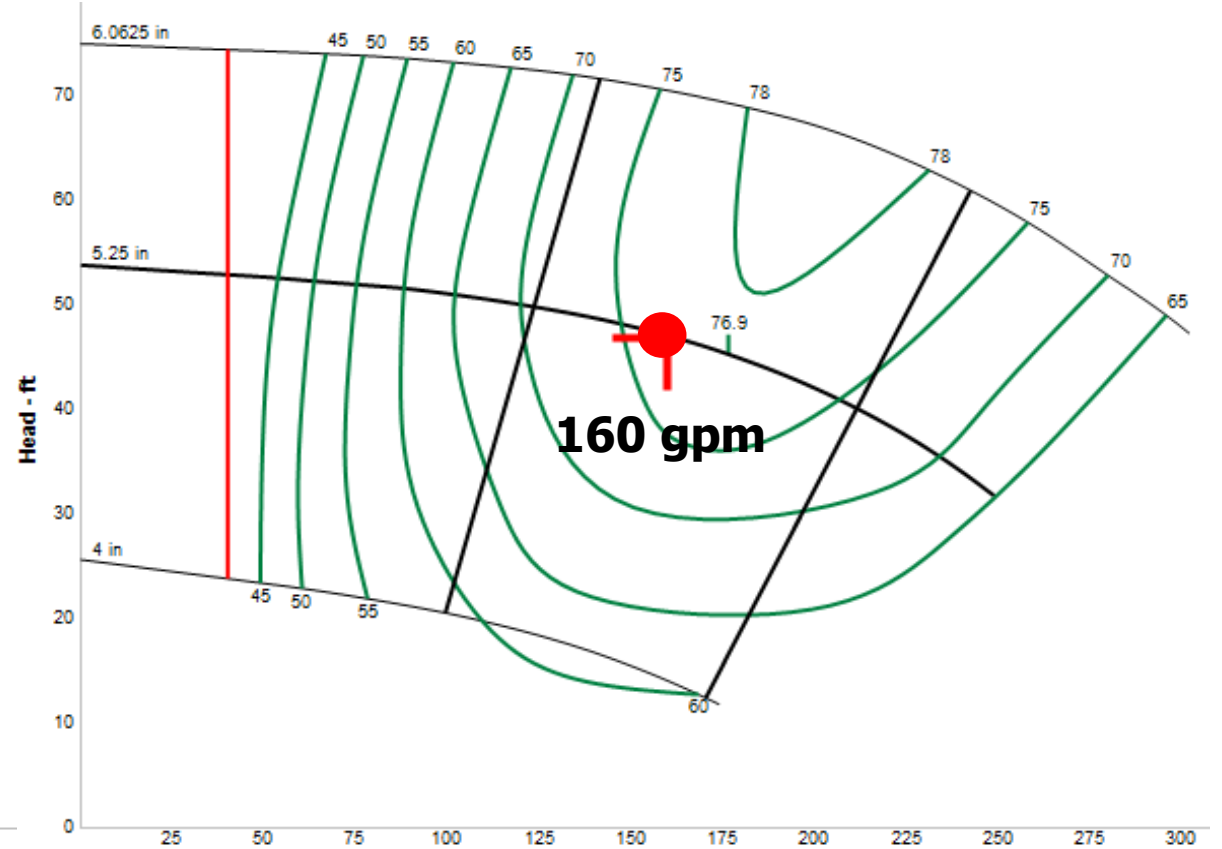
70 % Design Flow Condition (Automatic Balancing)

Fixed Speed Drive



3,500 rpm
Eff: 66.3 %
Power: 6.7 hp

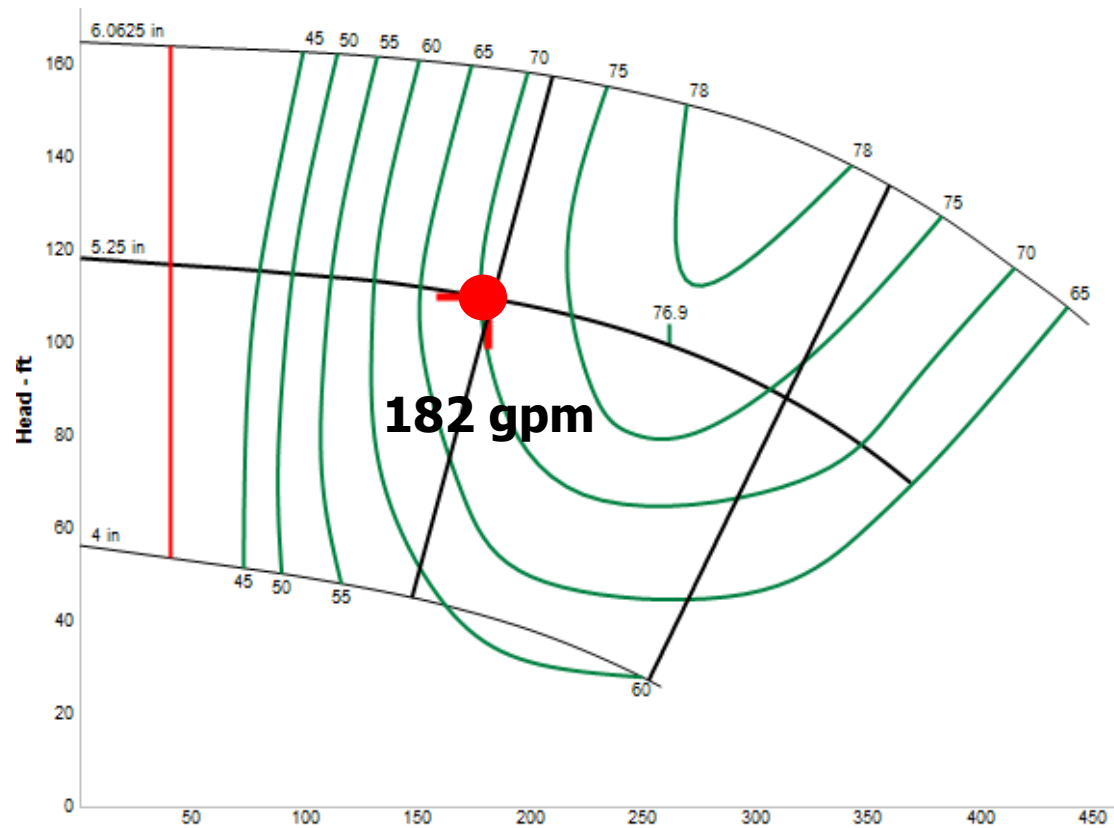
Variable Speed Drive



2,360 rpm
Eff: 75.8 %
Power: 2.5 hp

50 % Design Flow Condition (Manual Balancing)

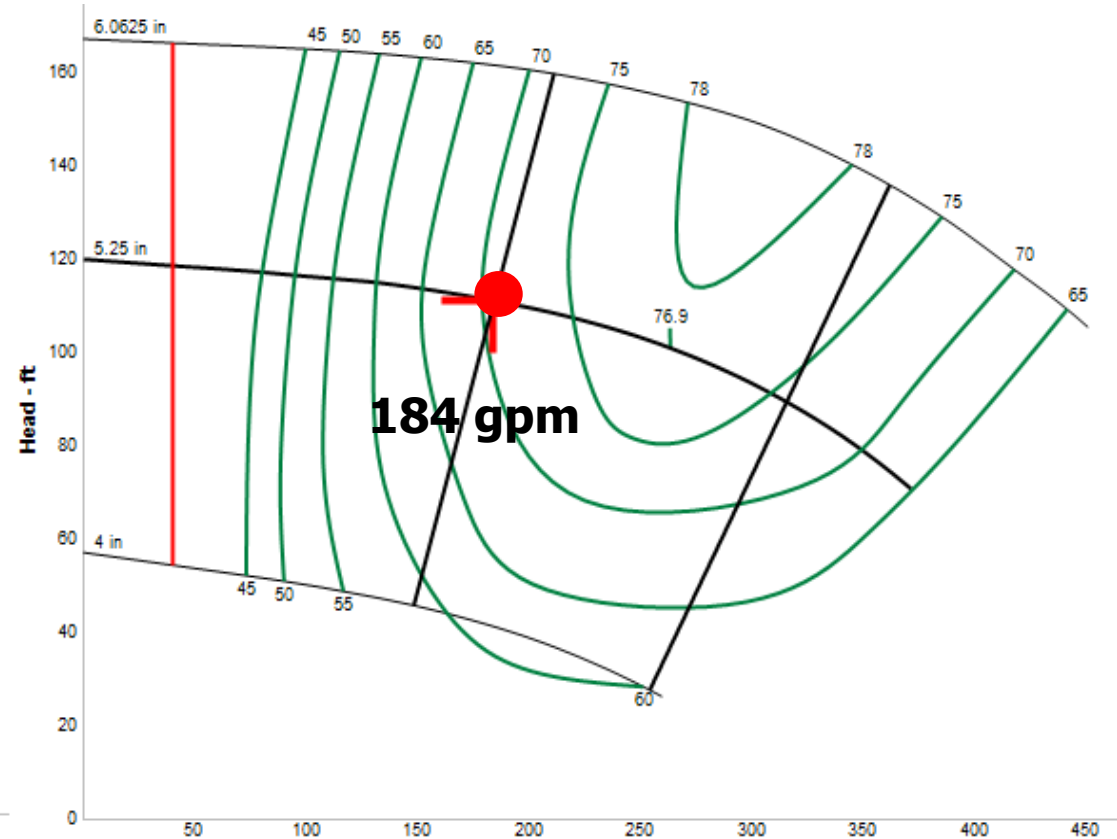
Fixed Speed Drive



182 gpm

**3,500 rpm
Eff: 70.5 %
Power: 7.1 hp**

Variable Speed Drive

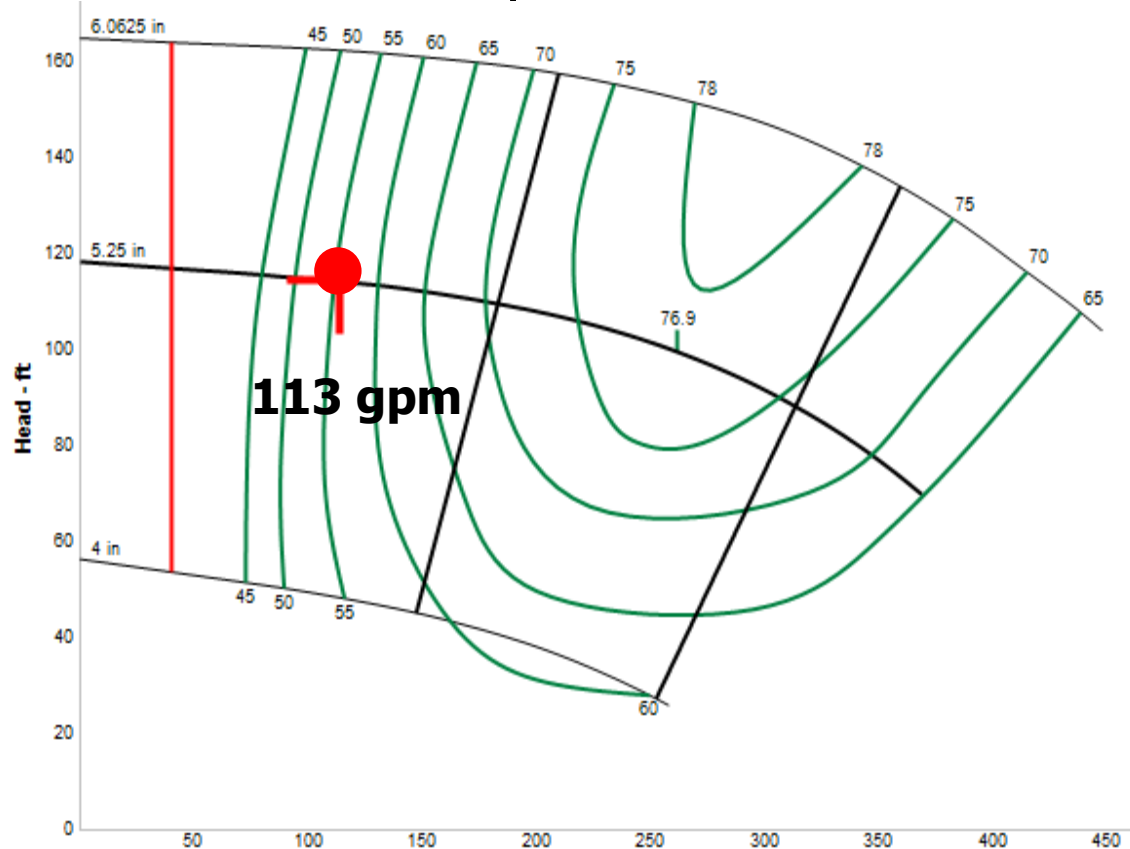


184 gpm

**3,525 rpm
Eff: 70.6 %
Power: 7.3 hp**

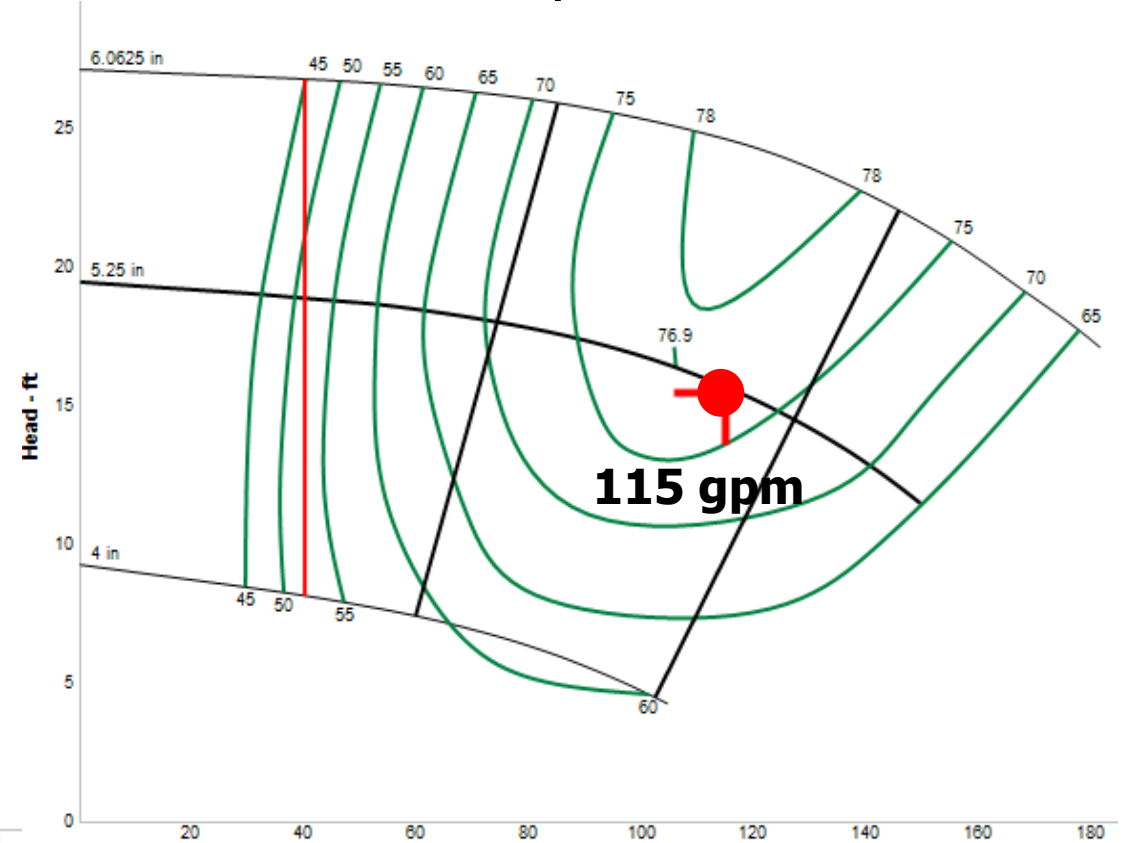
50 % Design Flow Condition (Automatic Balancing)

Fixed Speed Drive



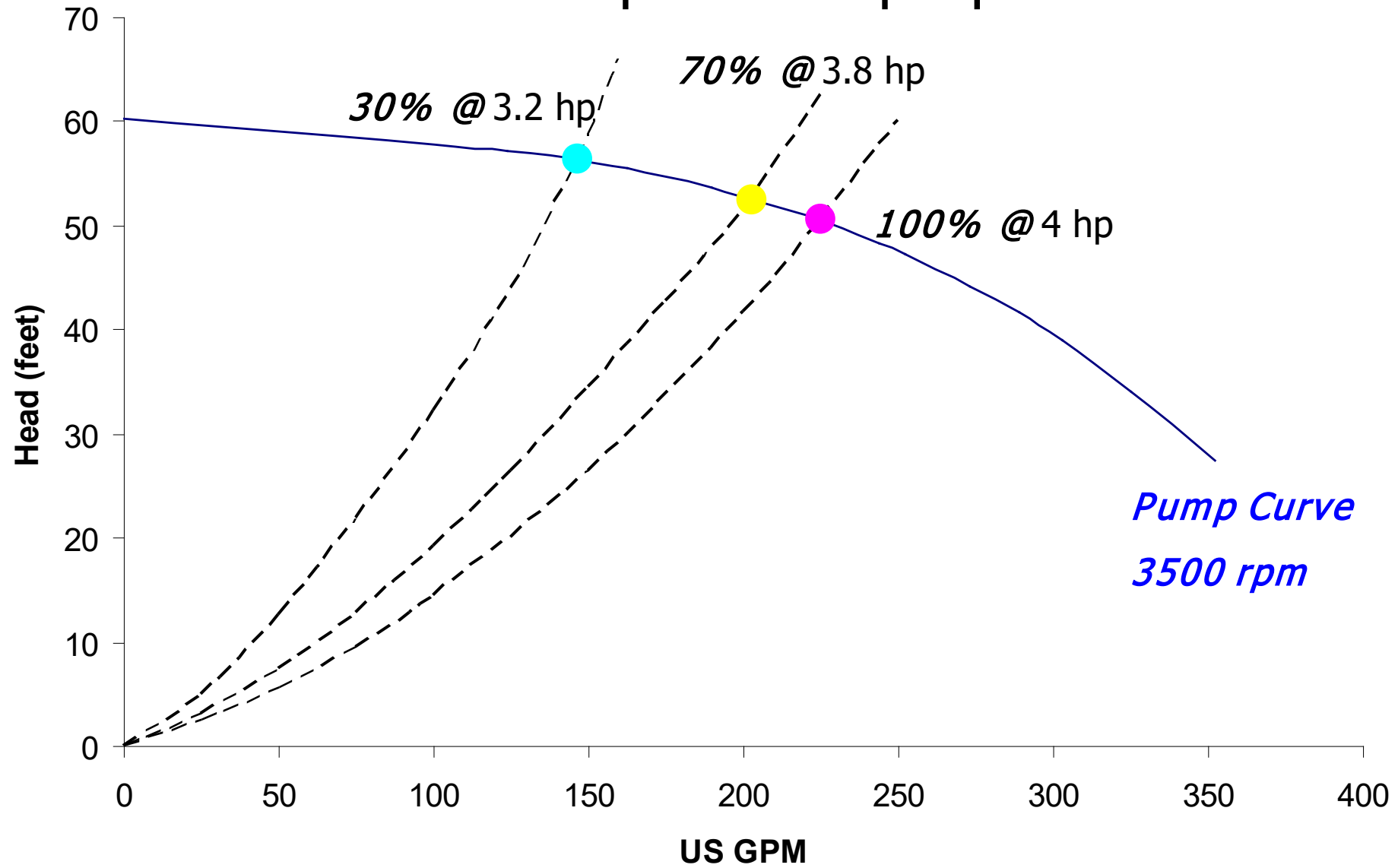
3,500 rpm
Eff: 55.6 %
Power: 5.9 hp

Variable Speed Drive



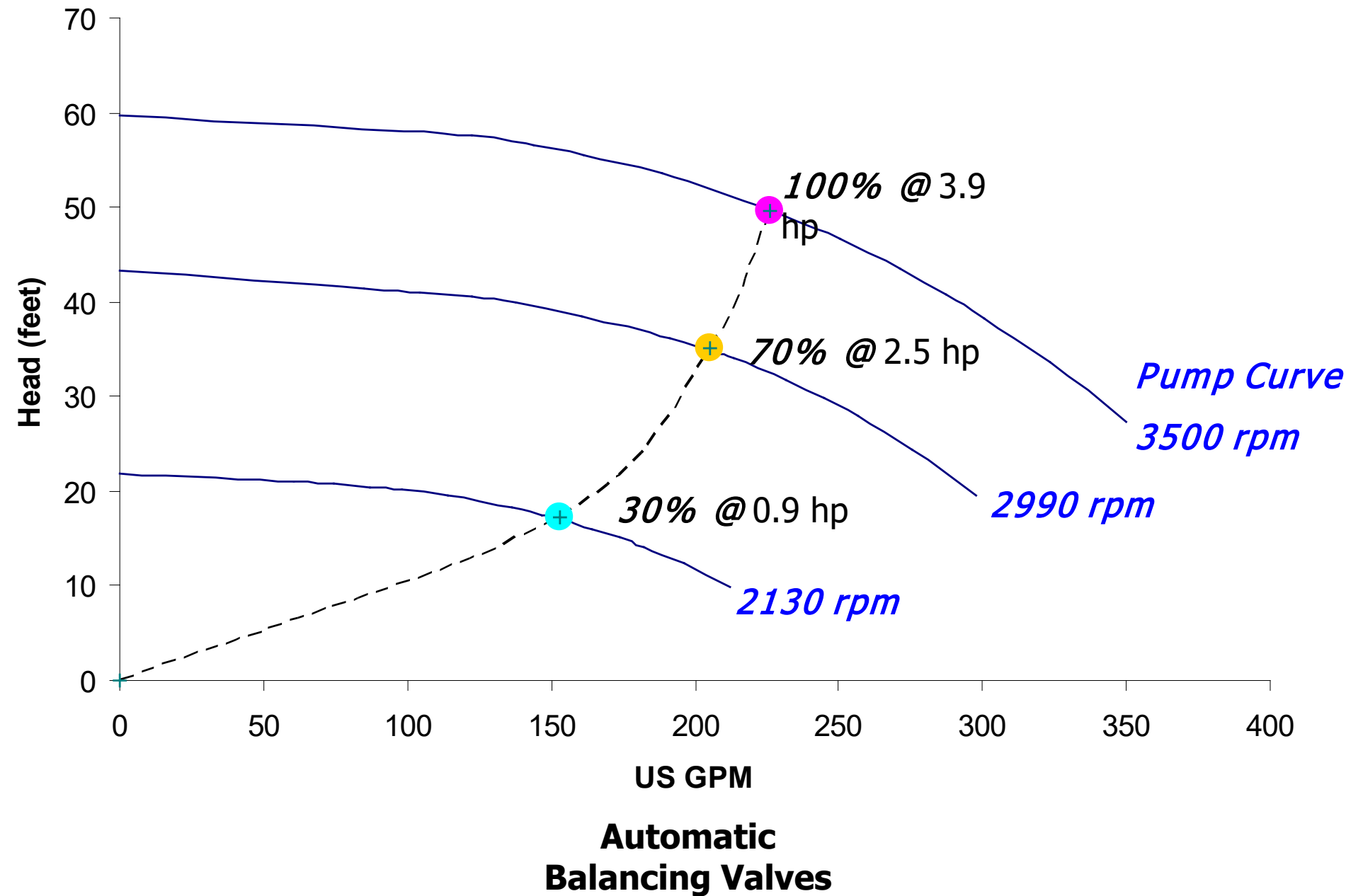
1,420 rpm
Eff: 76 %
Power: 0.6 hp

Fixed Speed Pump Operation



**Automatic
Balancing Valves**

Variable Speed Pump Operation

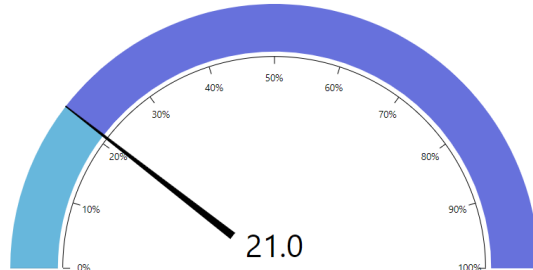


% System Load	% of Operating hours	Operation Cost (\$ per % of operating hours)				
		Fully Open No balancing	Manual Balancing		Automatic Balancing	
			Fixed Speed Pumping	Variable Speed Pumping	Fixed Speed Pumping	Variable Speed Pumping
30	15.25	2026	1961	2031	1088	1084
40	19.75	2834	2744	2828	1961	1810
50	21.5	3251	3169	3275	2618	2186
60	14.25	2228	2185	2238	1841	1777
70	9.50	1521	1497	1545	1307	997
80	4.00	652	644	672	586	459
90	2.25	372	368	370	350	289
100	0.50	83	83	82	82	82
Approx. Annual Pump Running Cost (\$/year)		\$12,967	\$12,650	\$13,041	\$9836	\$8686

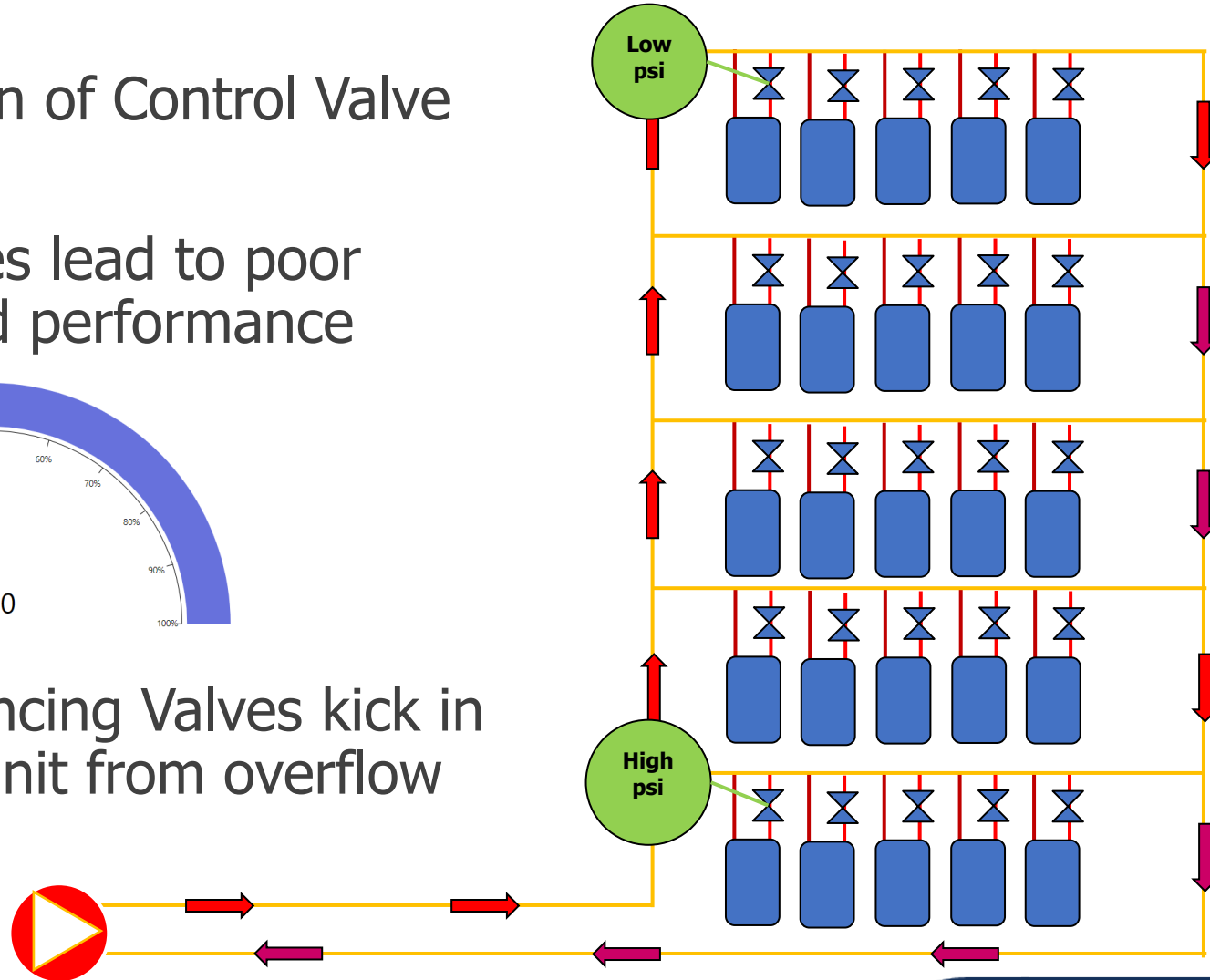
Energy Calculations
 (2-Position Control Valves @ \$0.10 / kwh)

Cv Rate Selection for Modulation

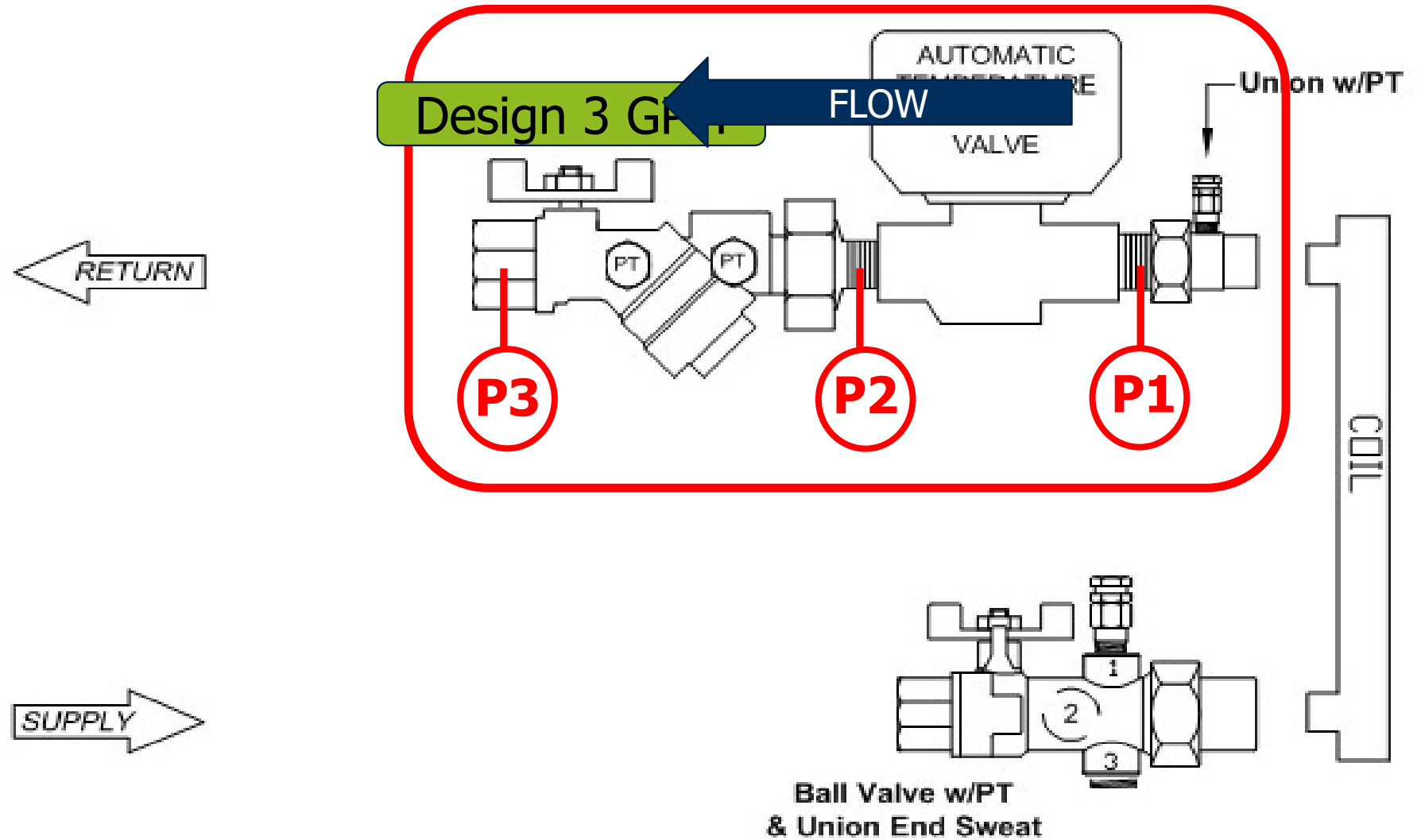
- Cv rate selection of Control Valve body is critical
- Uniform Cv rates lead to poor rangeability and performance



- Automatic Balancing Valves kick in to protect the unit from overflow

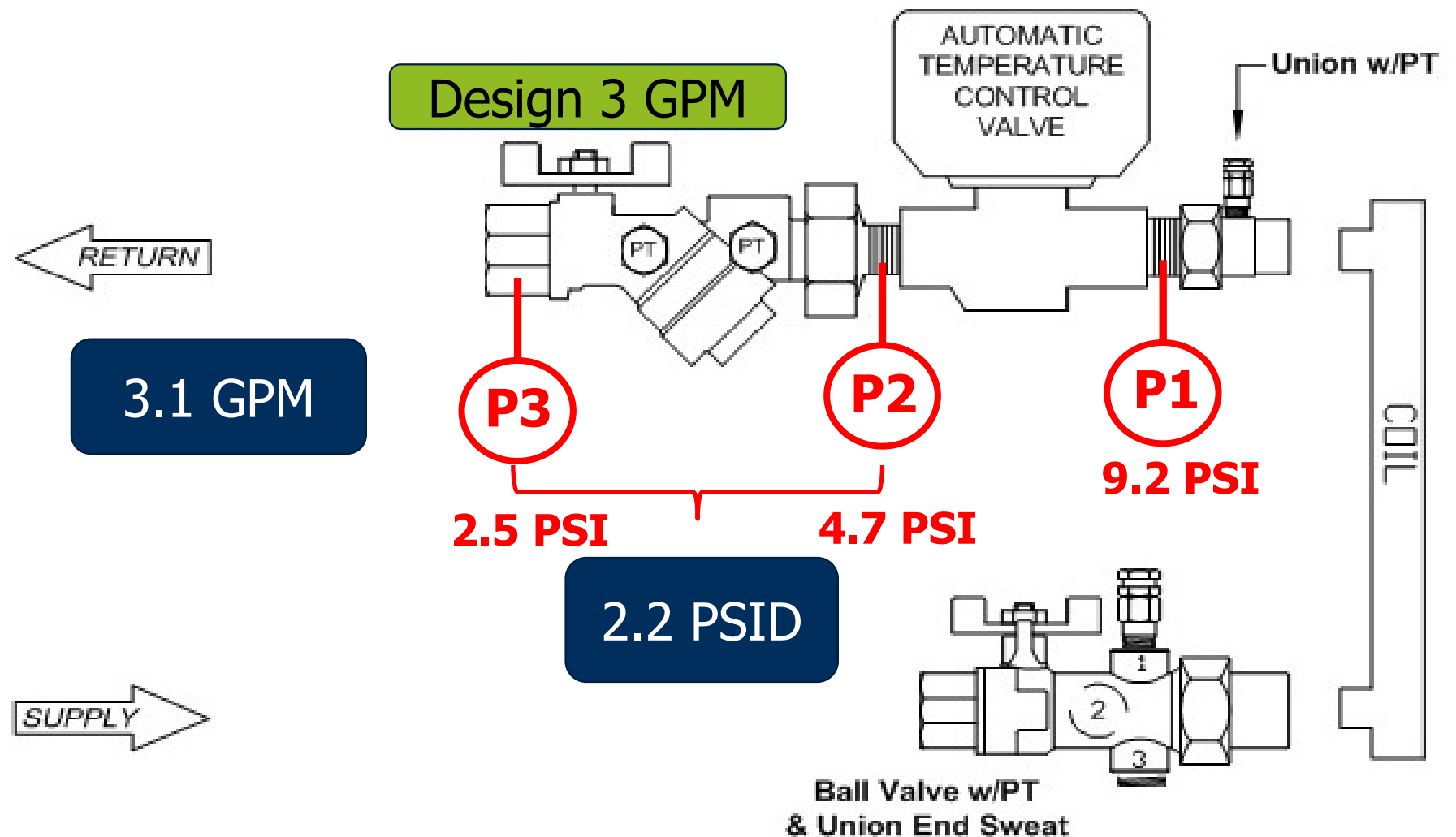


Automatic Balancing Valves & Modulation



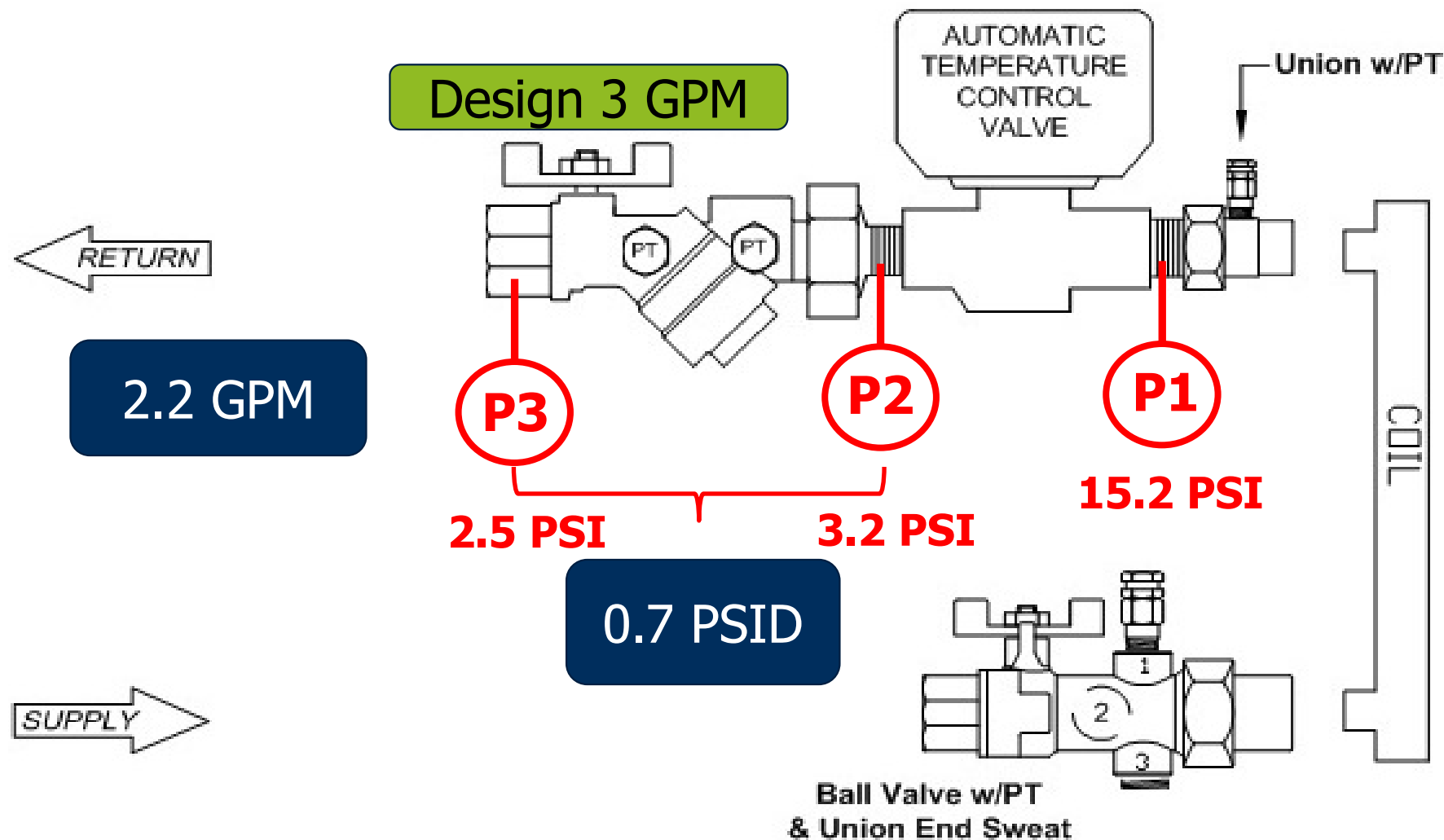
Automatic Balancing Valves & Modulation

(Control Valve = 100%
Open)



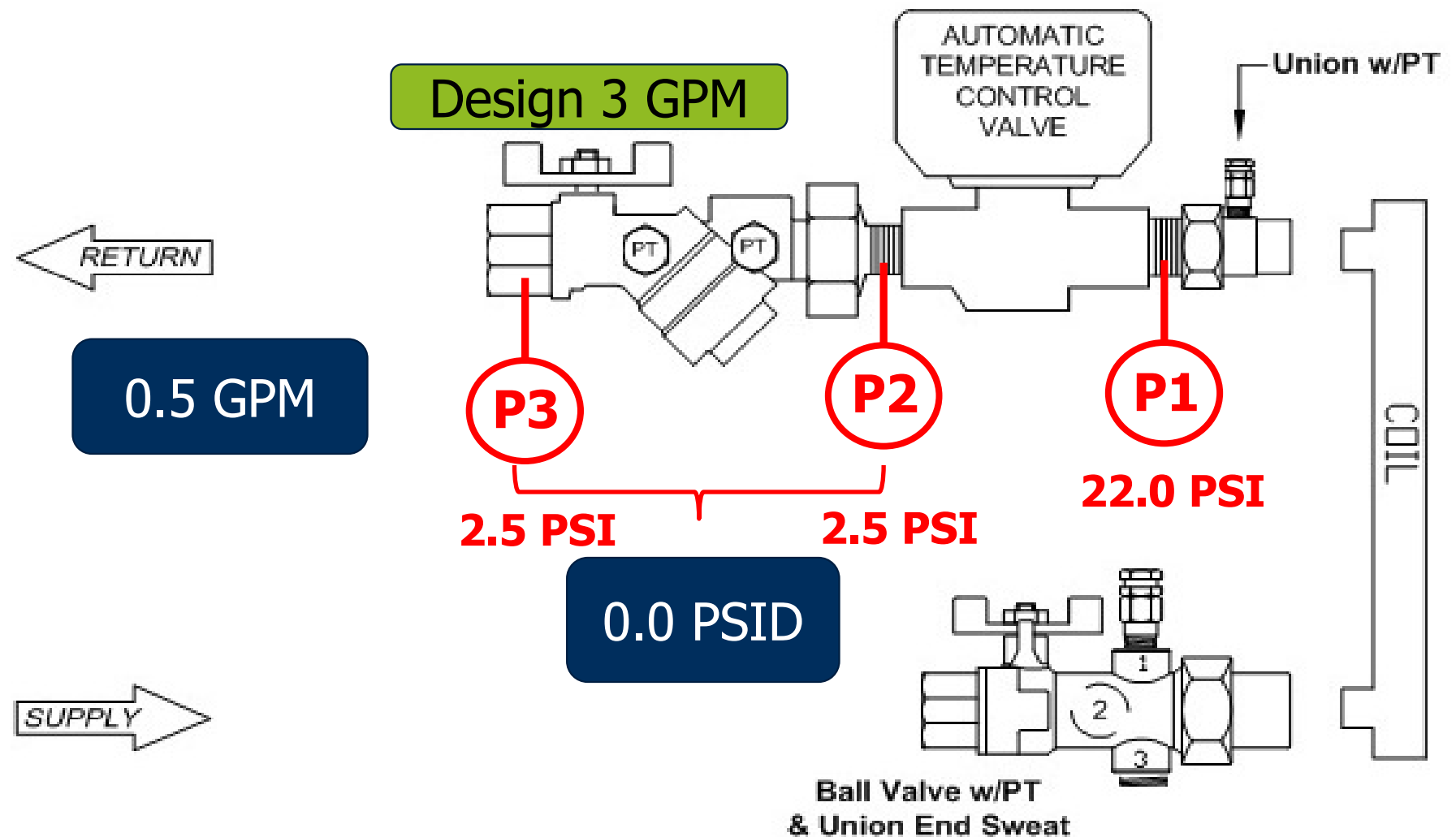
Automatic Balancing Valves & Modulation

(Control Valve = 70%
Open)



Automatic Balancing Valves & Modulation

(Control Valve = 20%
Open)



Conclusion

- Manual balancing valves are costly to install/balance & are ineffective during the system's lifespan
- *Automatic* balancing valves greatly reduce T&B time/cost, eliminate overflow by reacting to system pressure fluctuations, thereby saving energy & improving comfort



QUESTIONS ?