CHILLERS AND VARIABLE PRIMARY FLOW

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HTS Lunch and Learns

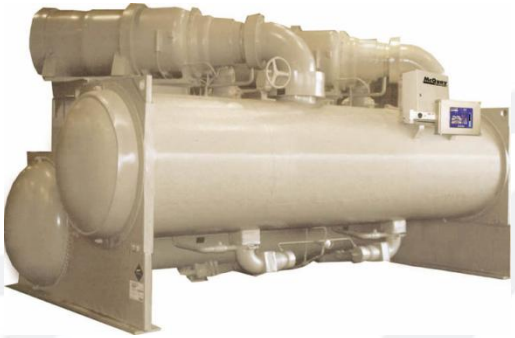
- Once a month
- Covering all topics in HVAC
- February - Fan, Applications, and AHUs
- March – Humidification
- April – Heat Recovery Systems
- May – Optimum Air
- June – Pumps/HX/Hydronics
- Sept – Refrigeration Cycle
- Oct - Chillers

CHILLERS

Chillers

Chiller Basics

- Make cold water by removing heat
- Reject heat to water loop, or ambient air
- Scroll, Screw and Centrifugal compressors
- Constant/Variable Speed
- Ball, Oil, or Magnetic Bearing
- Efficiency rated on IPLV
- Refrigeration Presentation September
- Chiller Presentation October



Air Cooled

Advantages

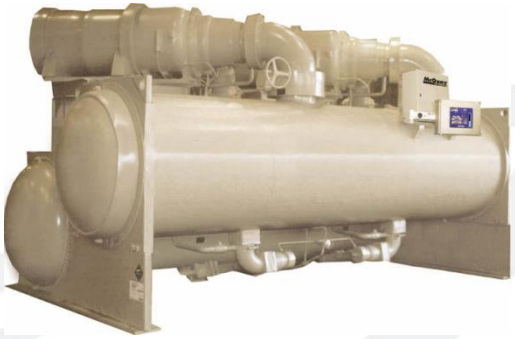
- Packaged product
- No cooling tower or condenser loop
- Can have integral pumps and airside economizer
- Do not take up indoor floor space
- As small as 3 Tons

Disadvantages

- Inefficient compared to water cooled (IPLV 0.85 kW/Ton)
- Must be outside, can cause noise/architectual concerns
- Not custom designed
- Limited to about 500 tons, biggest that fits on a truck
- Glycol may be required

Water Cooled

Advantages



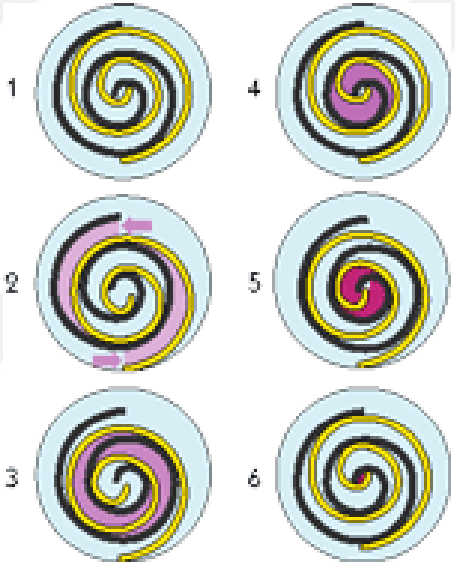
- Very efficient (IPLVs <.35 kW/Ton) (chiller only)
- Located inside a building
- Wider size range (30-8000Tons)
- Centrifugals are semi-custom designed for each application

Disadvantages

- Require separate condenser water loop and cooling towers
- Require additional set of pumps
- Take up floor space indoors

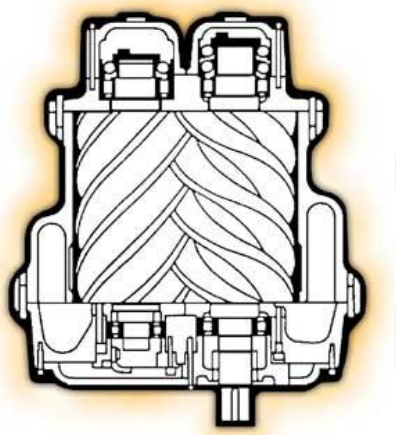
Compressors – Scroll

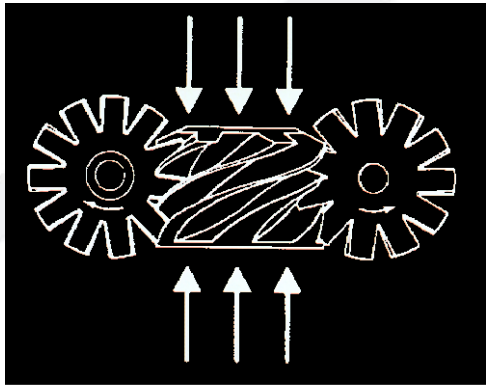
- Physically compress the refrigerant
- Contains two scrolls meshed together
- One rotates off-center to the other fixed one
- Used in a wide variety of applications, largest operating envelope
- Copeland Digital Scrolls – disengage scrolls
- Daikin Inverter Scrolls – VFD scrolls



Compressors – Screw

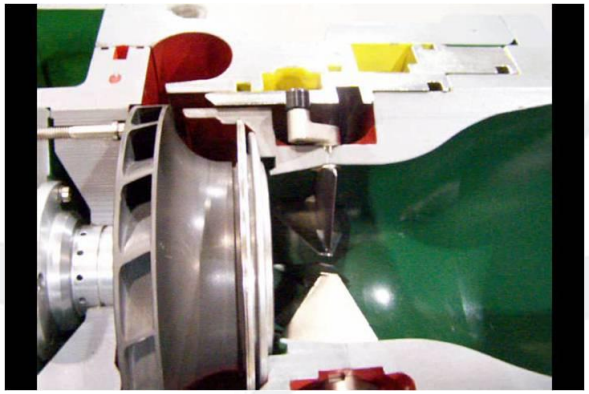
- Physically compress the refrigerant
- Contains 1 or 2 interwinding screws
- The space between the screws becomes smaller as the refrigerant moves through
- Can be unloaded better than a scroll compressor
- Use slide valves to uncover the screw

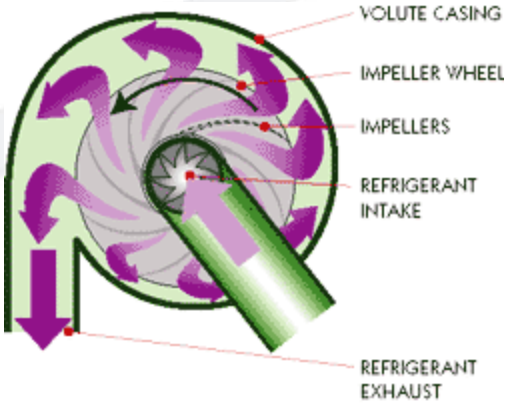




Compressors – Centrifugal

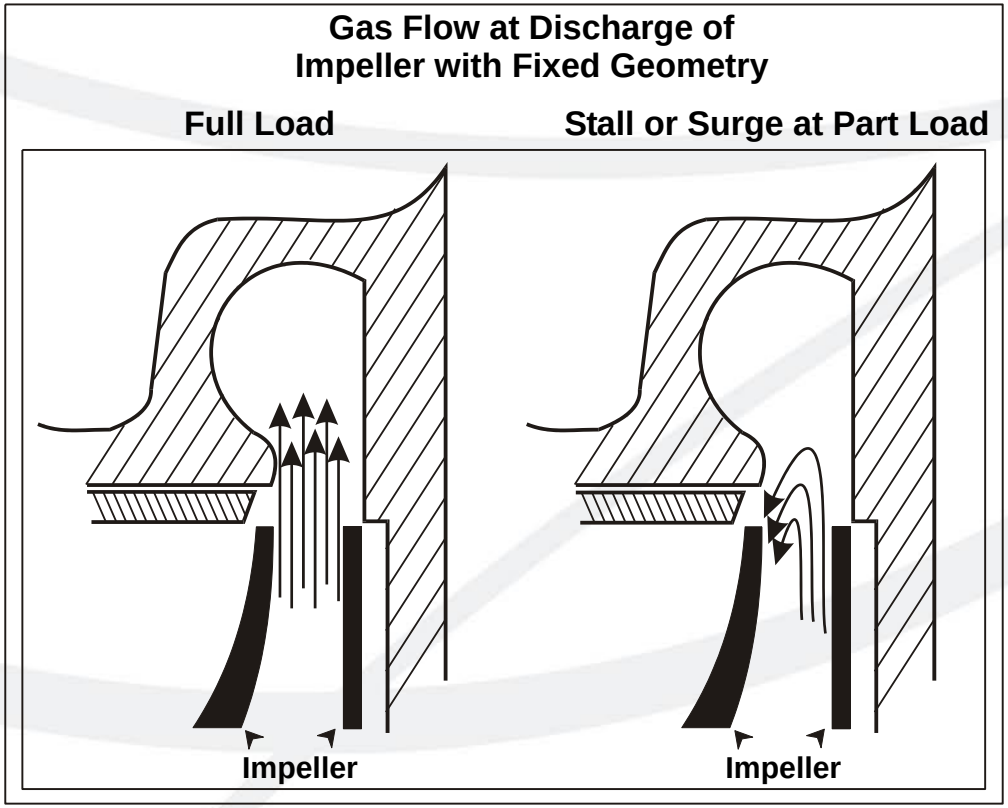
- Similar to a pump
- Uses velocity pressure to compressor the refrigerant
- Most efficient, tightest operating envelope
- McQuay uses a Hydrodynamic Bearing, shafts rotates on a film of oil
- McQuay uses a high speed (20000 RPM), smaller impellers, smaller compressors, gear ratio
- Use variable inlet vanes, diffuser plates to unload

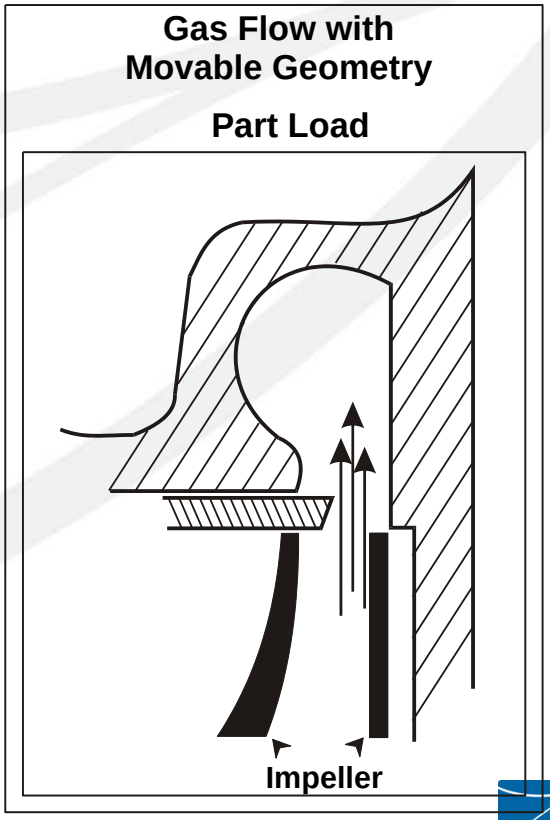




Compressors – Unloading Centrifugal

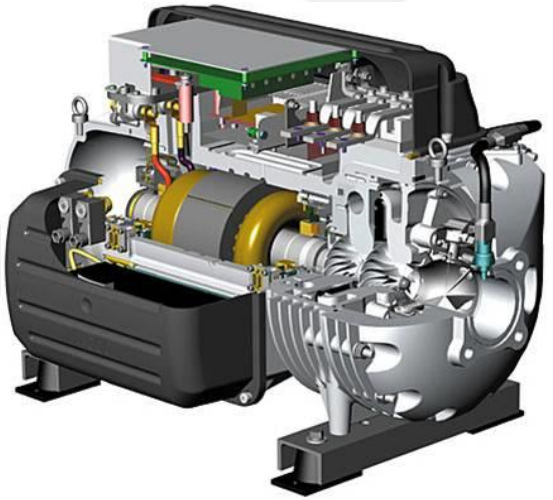
- McQuay uses diffuser plates and variable inlet vanes





Compressors - Magnetic Bearing

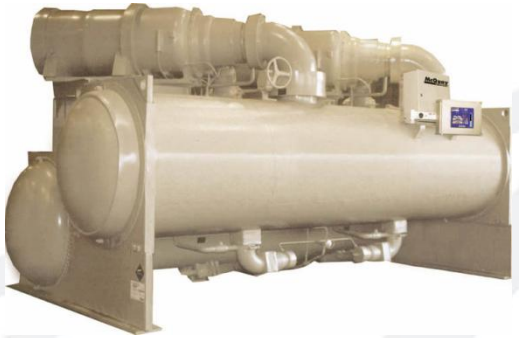
- Shaft rests on magnets
- 60-1200 Tons
- McQuay is planning on matching the 1200 tons
- Power loss – rundown can power the magnets
- Come standard with VFDs
- IPLV of <.40kW/ton is common, <.35 kW/ton possible
- Very quiet, pump next to it was louder



Dual Compressor

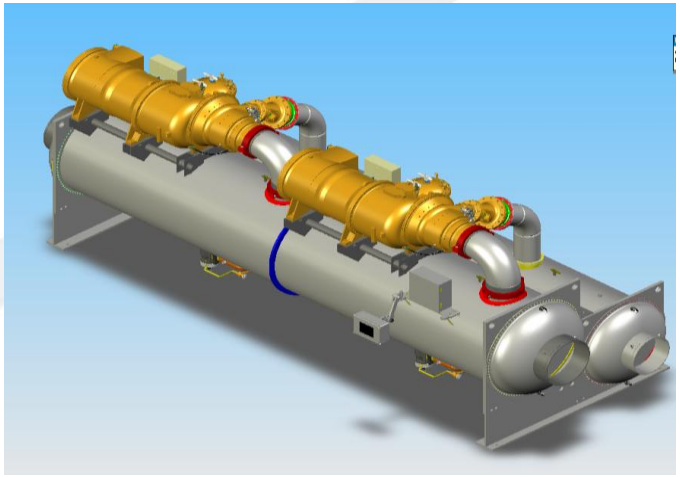
Single Circuit Dual Compressor

- 60% capacity with one compressor running
- Offers excellent part load performance



Dual Circuit Dual Compressor

- Fully independent systems
- Offers full redundancy in a single machine
- Counter flow design offers improved full load efficiency



Drive

Open Drive - York

- Motor is open to the outside
- Contaminants can reach the motor
- Refrigerant seals may fail and cause leaks
- Adds heat to mechanical room

Hermetic – Trane, Carrier, McQuay

- Compressor is completely sealed as part of the refrigeration circuit
- Motor is cooled by refrigerant, no excess heat
- No seals on moving parts

Positive vs. Negative Pressure

Positive Pressure – York, McQuay, Carrier

- Refrigerant circuit is always a higher pressure than the ambient
- Leaks out rather than in, easy to find a leak

Negative Pressure - Trane

- At some points the refrigerant is a lower than atmospheric pressure
- If a leak develops can suck in contaminants to refrigerant cycle
- Used with R-123, production of new machines banned after 2020, production of refrigerant banned after 2030, 19 years away

Aermec

New line by HTS

- Made in Verona Italy
- Worlds Quietest Fan Coil with NC-25
- Line of chillers and air to water heat pumps from 3-250 tons
- Integral pump and buffer tanks
- Full waterside economizer (free cooling below 30F for 44F water)

AERMEC air conditioning

HTS

VARIABLE PRIMARY FLOW

Hydronic Systems

- Move thermal energy around a building with water
- Interact with heat exchangers (coils, chillers, etc.)
- Chillers designed for 2.4 GPM/Ton chilled water loop
- Chiller efficiency improved by large temperature delta and high LWT
- Old systems used constant flow, flow through chiller could not vary
- Pumps operated at 100% all the time, only needed 1% of the time

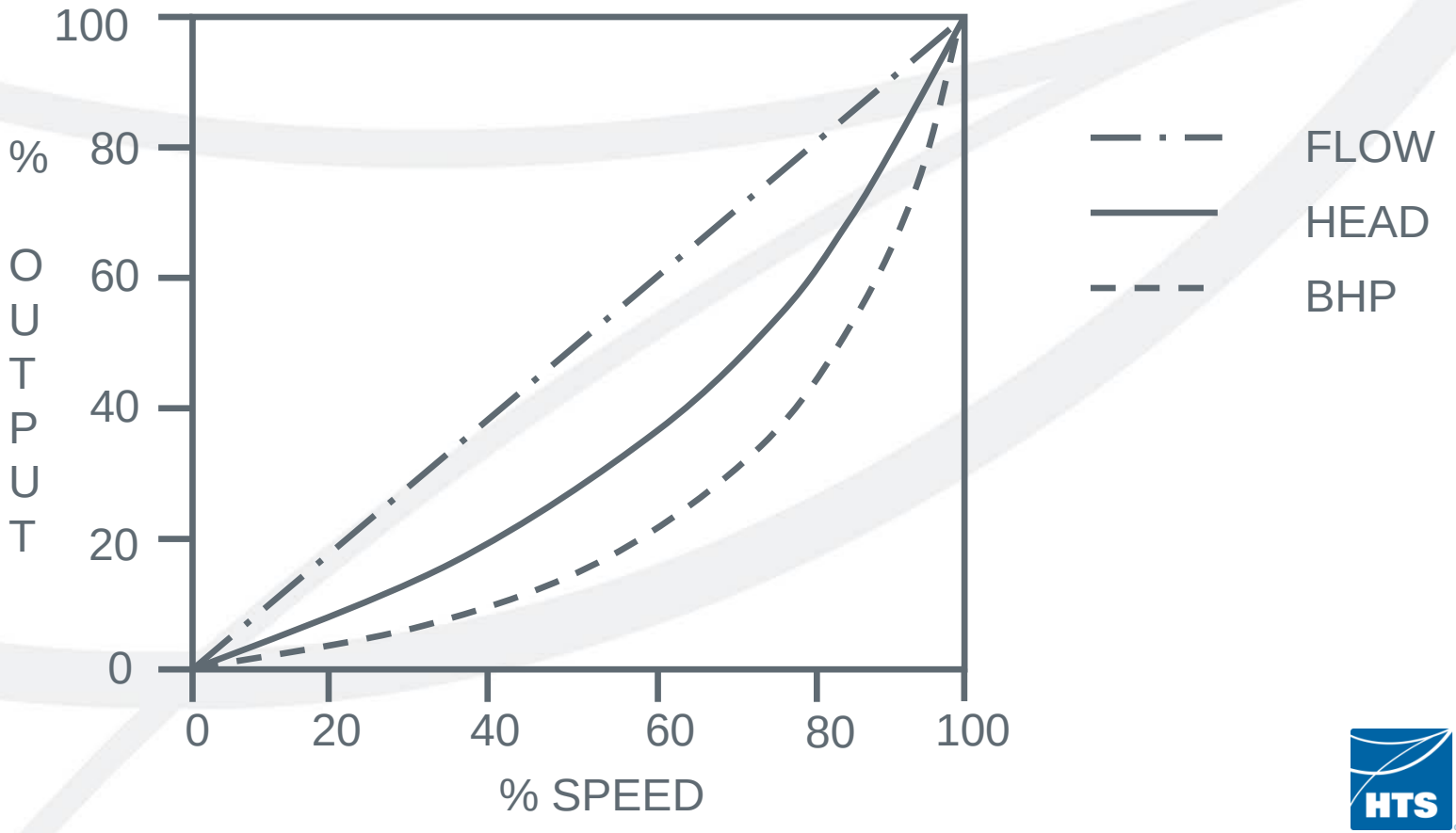
Variable Primary Flow

- First attempted 1996
- Allow flow through chillers to vary
- Temperature delta maintained during operation
- Required new technology and control advances
- Offers lowest energy consumption
- Simple

Motivation

Why Does VPF interest Owners?

- They can save money!



Constant Flow – The original

Advantages

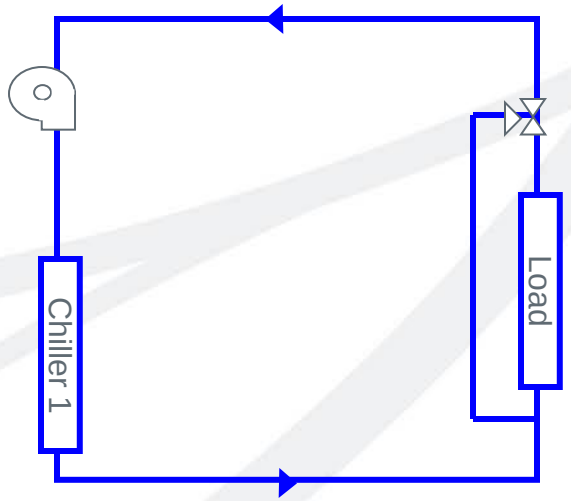
- Simple Design
- Easy Control
- No VFDs

Pitfalls

- Flow is constant at all loads
- Poor low load operation

Why Not Variable Speed

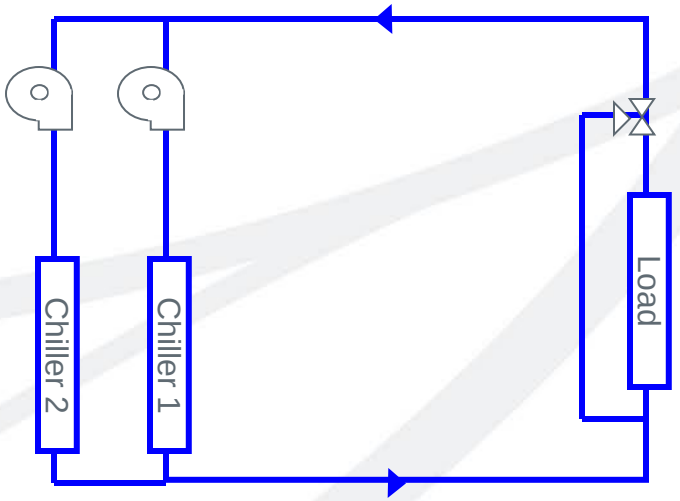
- Chiller required constant flow
- Chiller could not handle both changing flow and temperatures



Constant Flow – Dual Chillers Split Pumps

Advantages

- Good for part Load
- Can stage chillers
- Easier to turn on/off chillers



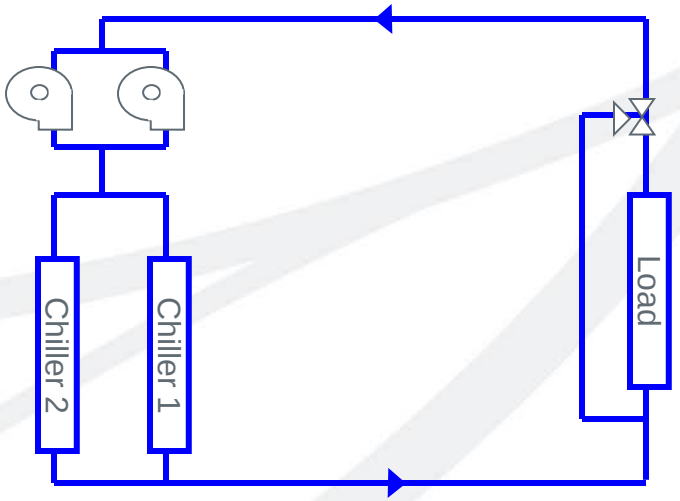
Pitfalls

- N+1 redundancy for each chiller
- Flow is at minimum the design of smallest chiller
- Chiller mixing raises LWT
- Isolation Valves

Constant Flow – Dual Chillers Headered Pumps

Advantages

- Better staging of pumps
- Chillers/Pumps independent
- N+1 redundancy is cheaper



Pitfalls

- Chillers see same part load
- More expensive and complex than split pumps
- LWT can rise due to mixing

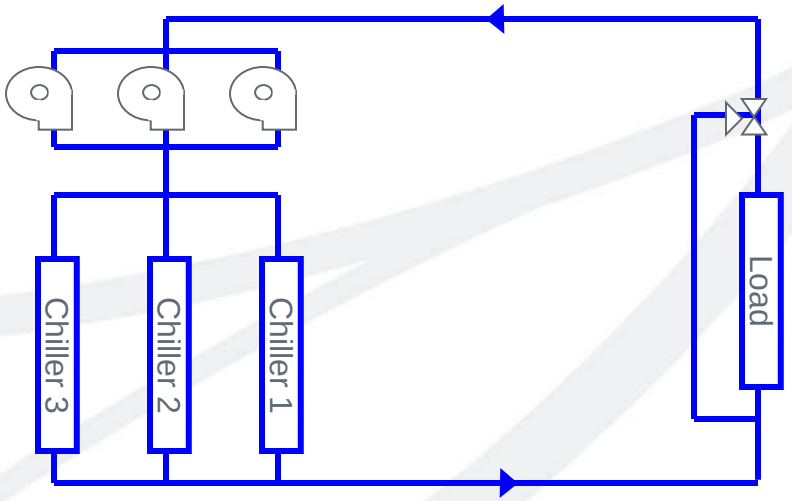
Constant Flow – Multiple Chillers Multiple Headered Pumps

Advantages

- Better turndown

Pitfalls

- Problems exaggerated
- Worse Mixing



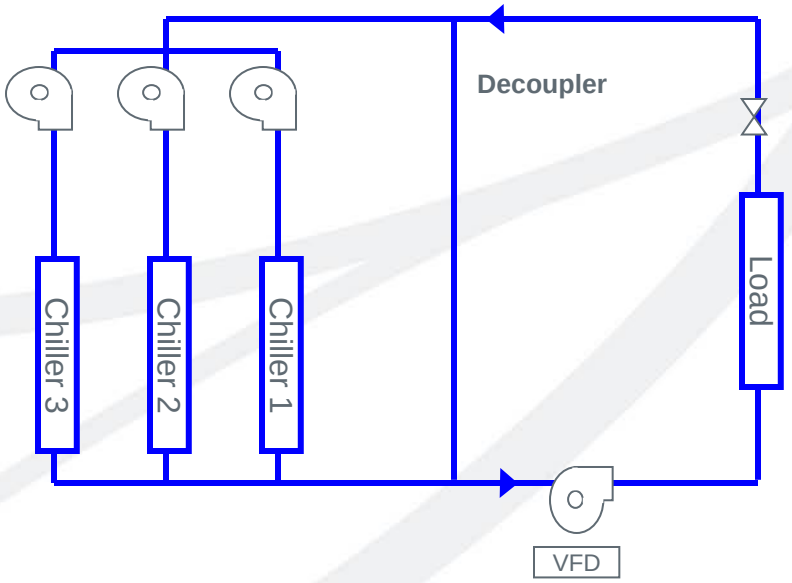
Variable Flow – Primary-Secondary Loops

Advantages

- Variable flow in the building
- Chillers still experience constant flow
- Can run loops at different temperature ranges

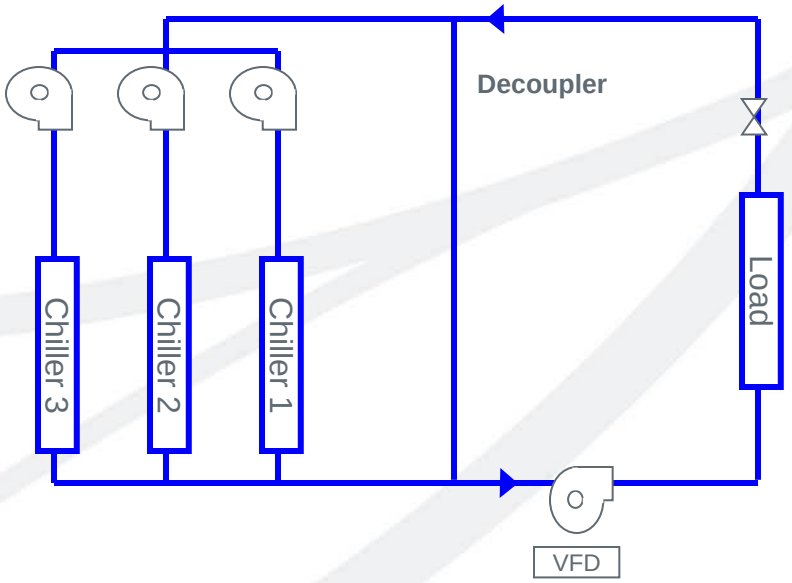
Pitfalls

- Primary loop still constant flow
- Two sets of pumps



Low Delta-T Syndrome

- Problem on Load side
- Caused by valves opening
- Flow becomes too high for load
- Additional chillers/pump turn on
- Can happen with any design



- Keep coils clean
- Do not lower AHU setpoint below design

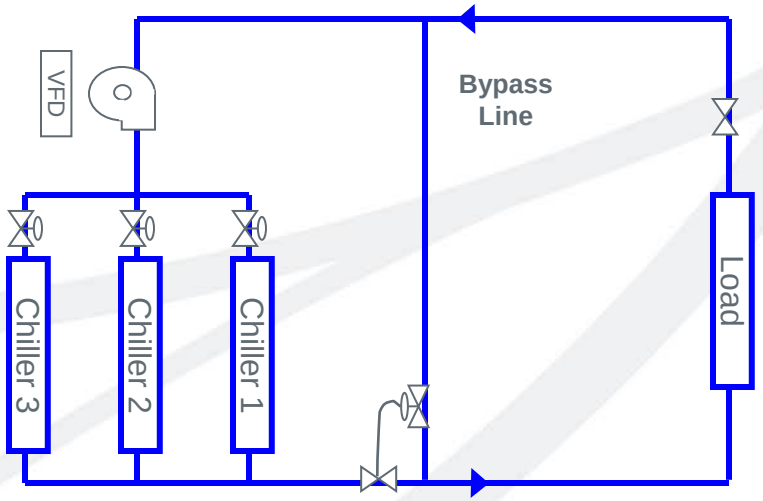
Looking Back - Pitfalls

- Poor modulation
- Constant flow at all loads
- Two sets of pumps
- Complicated design
- Poor control on water side
- No preferential loading
- Water mixing raises LWT

Variable Primary Flow

Advantages

- Variable flow through the entire loop
- Removes secondary pumps
- Allows preferential loading and staging of chillers/pumps
- Simple design

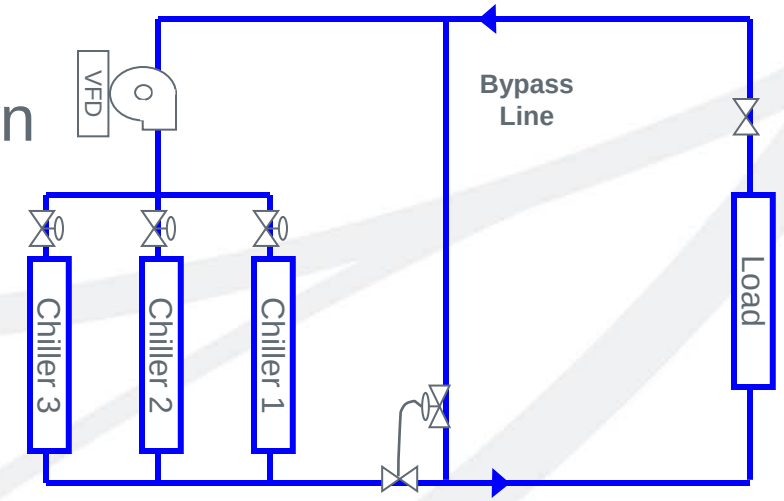


Disadvantages

- Still requires a minimum flow in bypass line
- Require flow monitoring and isolation valves

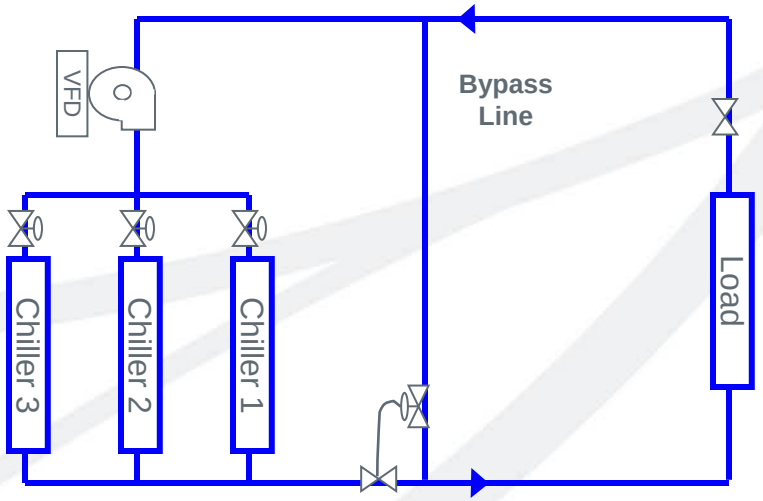
Variable Primary Flow – Chillers

- Let us know if you want VPF
- Chiller selected for high turndown
- High design pressure drop vs. low minimum flow
- Identical chillers
- Selected for plateau loading
- One good part load, other good full load machines
- Staging on/off



Variable Primary Flow – Piping

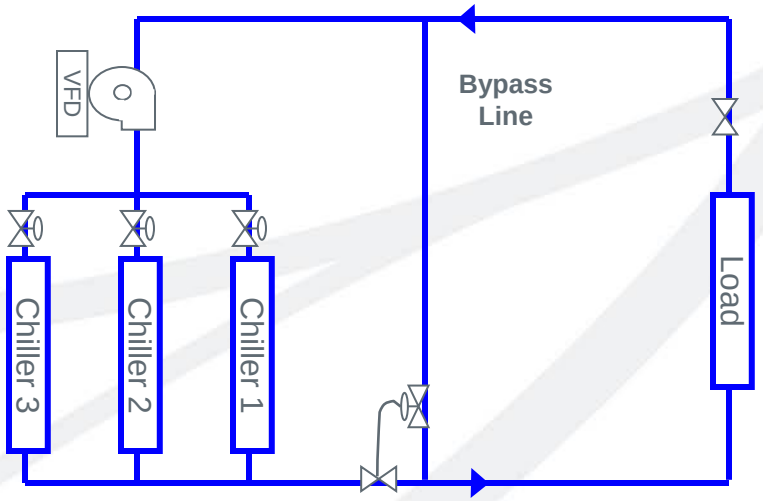
- Isolation valves in front of each chiller
- Valves must be slow opening type
- Bypass line sized for 30-50% of largest chiller



- Bypass line can be near chillers with two way valve or using three way valves around load
- Pumps can be before/after chillers
- Design pump head can be higher than Primary-Secondary

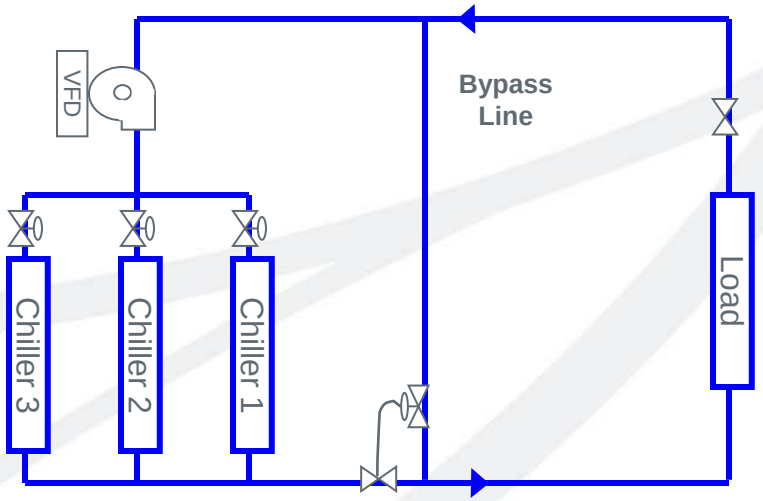
Variable Primary Flow - Controls

- BAS required
- VFD modulates to pressure across load
- Chiller must have sufficient onboard controls
- Each chiller requires flow meter or pressure differential
- Important to slowly open isolation valves
- Max flow change of 10%/min
- Bypass valve is normally closed



Variable Primary Flow - Summary

- Advanced Chiller Controls
- Bypass Line
- Single Set of Pumps
- Reduced Energy Consumption
- Flow change 10%/min
- Simple Design



- Questions?

Next Time – February 16th

Fan, Applications, and AHUs

- Fan Types
- Fan Laws, Curves
- Direct vs. Belt Drive
- Inline, Centrifugal, Roof, Indoor
- Haakon Vs. McQuay
- Indoor Vs. Outdoor