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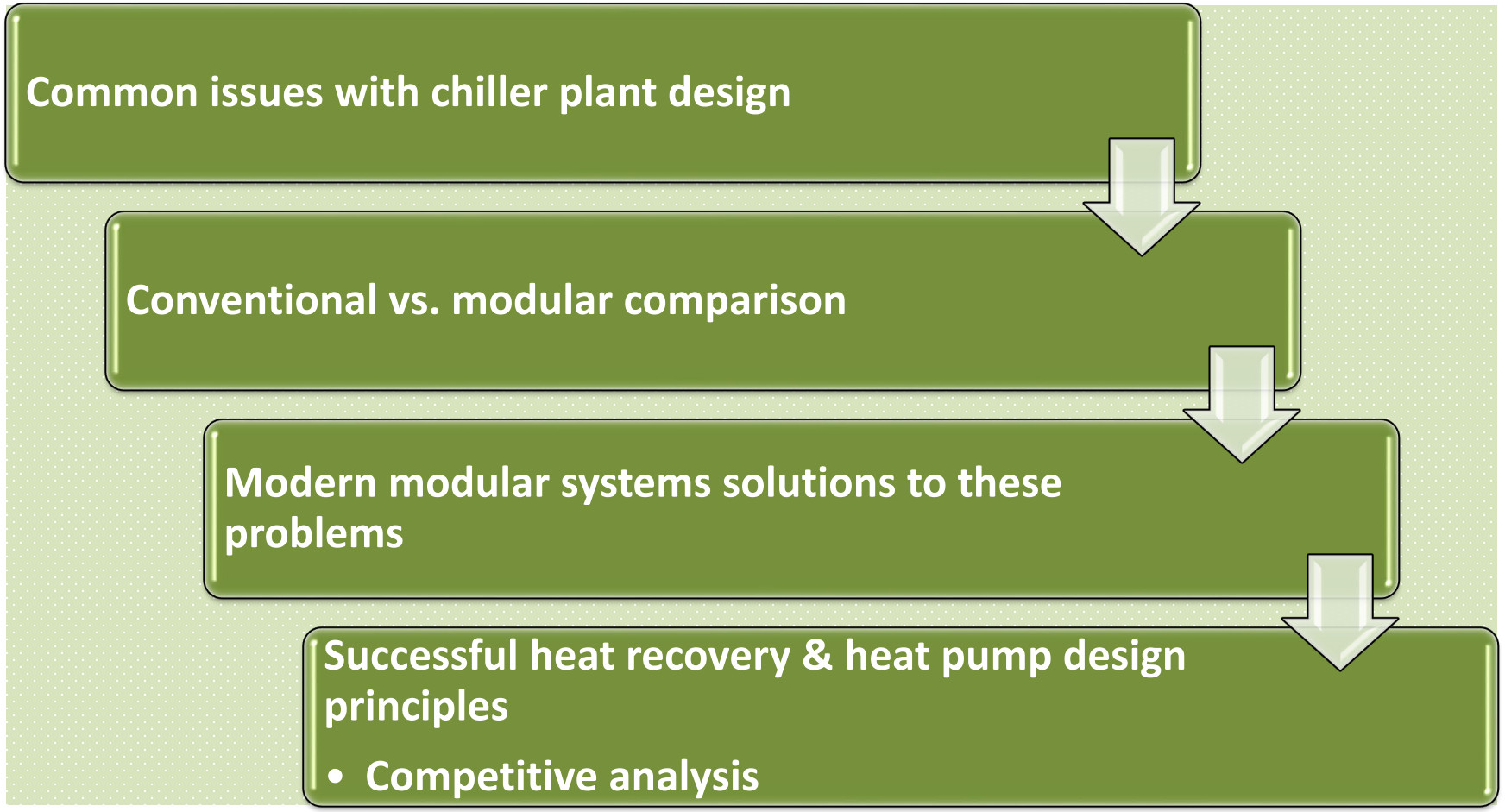
Modular Chiller Plant Design for Cooling and Heating Applications

Objectives

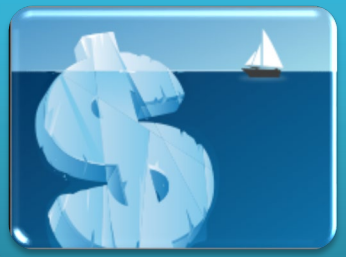

Common issues with chiller plant design
Conventional vs. modular comparison
Modern modular systems solutions to these problems
Successful heat recovery & heat pump design principles
• Competitive analysis

Common Problems With Chilled Water Plant Design

No flexibility in design

Water flow control

Not enough redundancy



Total cost of ownership is too high

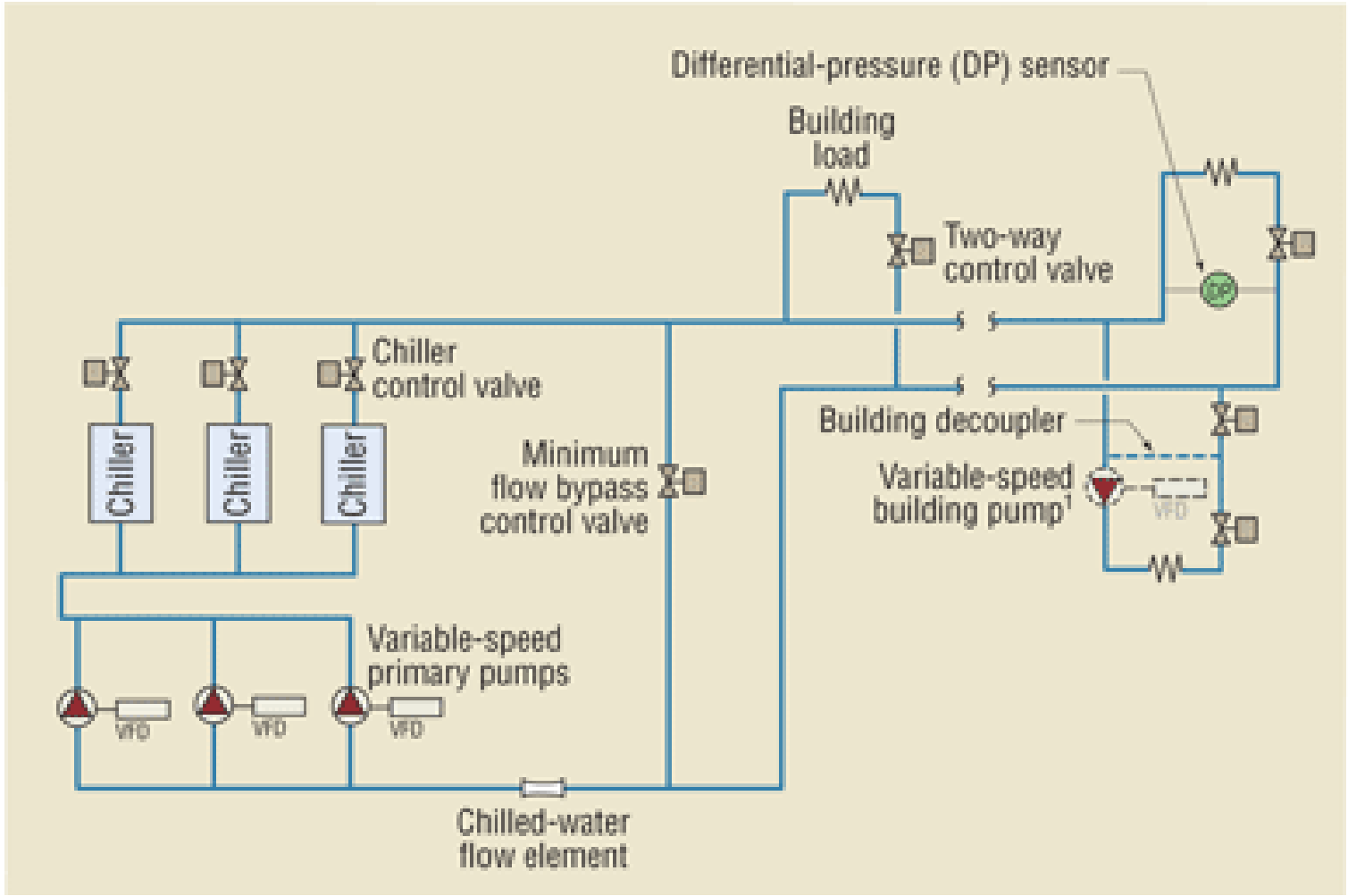
- Heat recovery system size & design
- Ease of maintenance

Chiller Systems: Design Principles Refresher

Conventional Chiller Design – variable primary flow

- VFD controlled pumps
- System differential pressure reading
- System water bypass valve
- Chiller flow sensor
- Temperature sensors

Conventional Chiller Design



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WHAT IS THE WATER FLOW CONTROL STRATEGY FOR MODERN MODULAR CHILLERS?

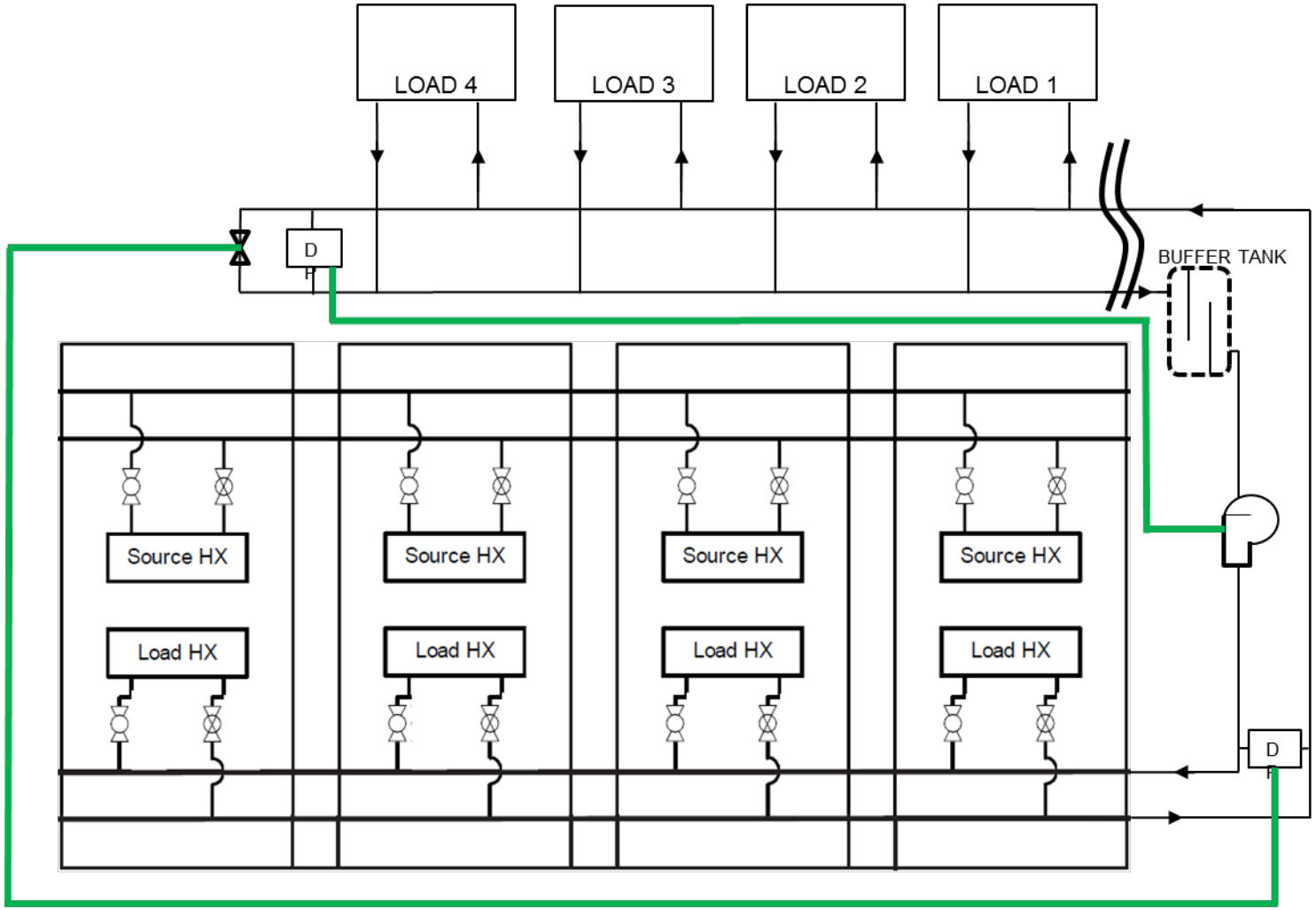
An Easy Update to an Older Approach:

Modern Modular Chiller Design – variable primary flow

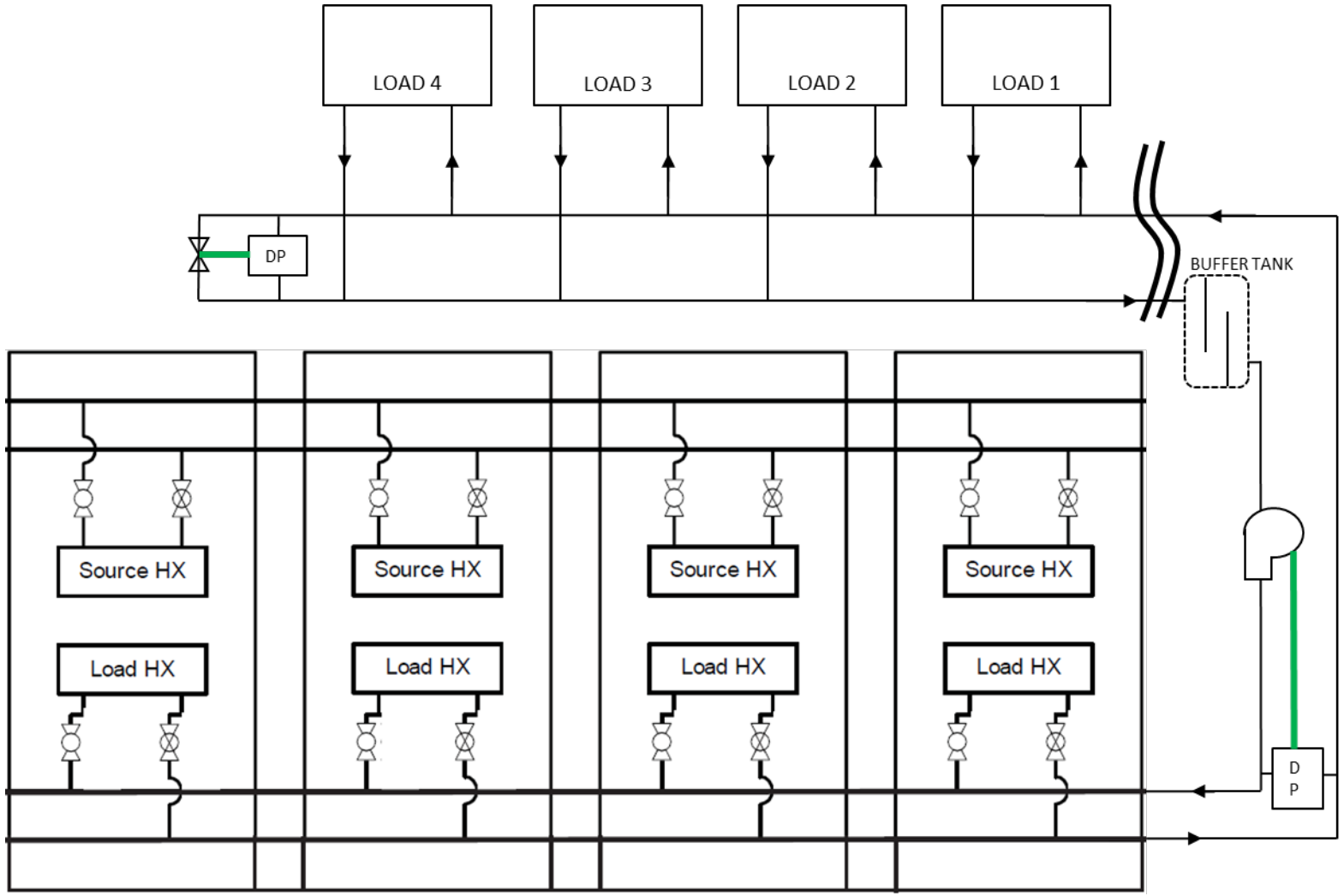
- VFD controlled pumps
- System differential pressure reading
- System water bypass valve
- Chiller flow sensor
- Temperature sensors
- Chiller water bypass valve
- Strainers

Not much difference from traditional chiller design

Maintaining Correct Chiller and System Flow Strategies (1)



Maintaining Correct Chiller and System Flow Strategies (2)



Designing for System Flow Control Success

- Loop Volume
  - 4 to 6 gallons/ton
- Differential Pressure Control
  - System & chiller
- System bypass valve location/sizing
  - Varies by minimum flow needs
  - Must maintain loop volume
- Maintaining correct chiller & system flow

Cooling Condition Example

(5) 50 ton modules - **cooling**	Design	Non Design Condition
Flow rate	614 GPM	420 GPM
Evaporator Inlet/Outlet	54/44	54/40
Evaporator ΔT	10	14
Pressure Drop	11.3 ft	5.5 ft
Flow Rate/module	123 GPM	84 GPM

1. Large water temperature differential
2. Low cooling supply water temperatures
3. Low suction pressure/low flow
4. Compressor trips
5. Chiller shuts down to protect itself
6. Customer thinks the modular chiller is the problem

Proper control keeps chiller operating

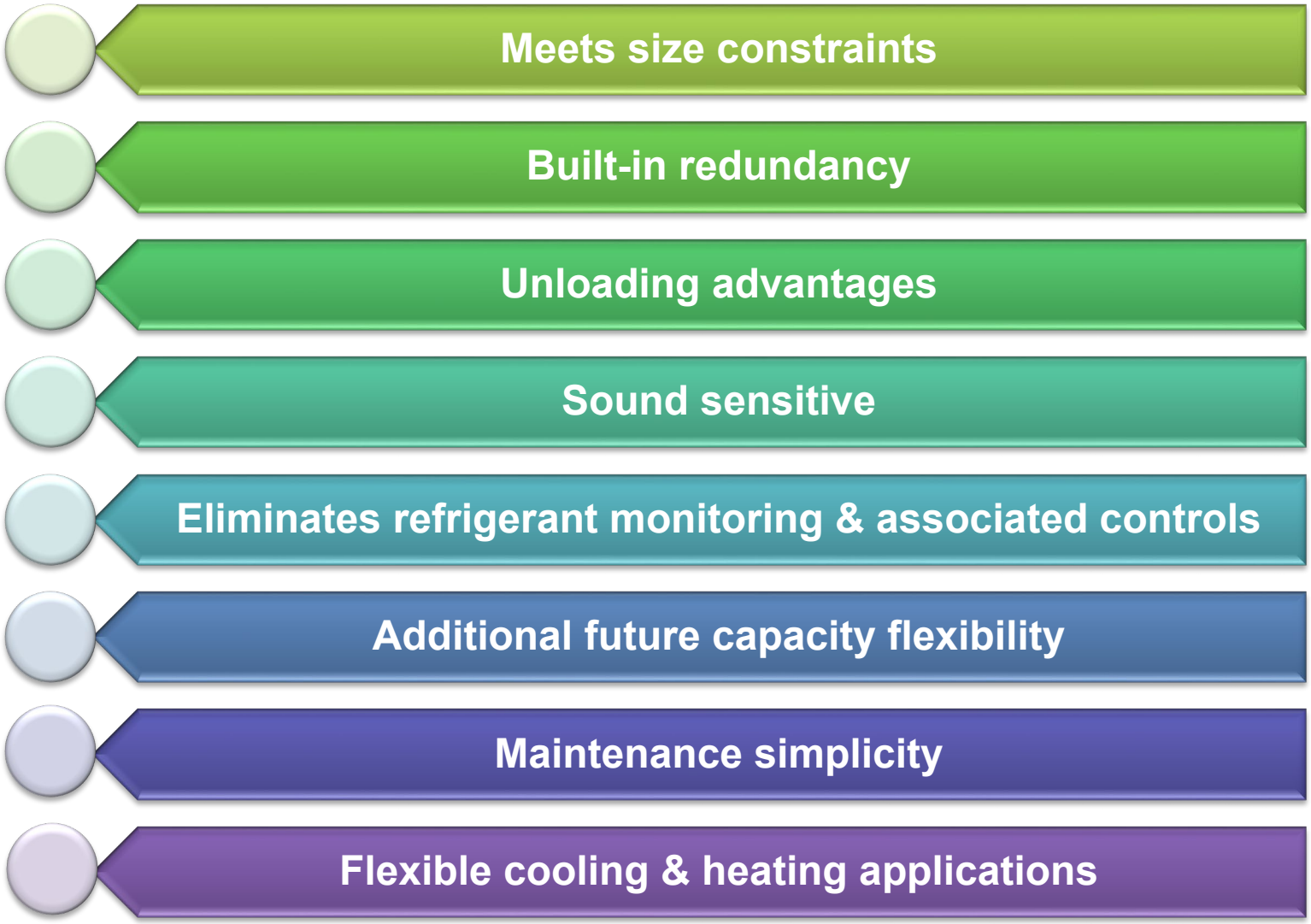
Heating Condition Example

(5) 50 ton modules - heating	Design	Non Design Condition
Flow rate	334 GPM	263 GPM
Condenser Inlet/Outlet	115/135	115/140
Evaporator ΔT	20	25
Pressure Drop	3.8 ft	2.5 ft
Flow Rate/module	67 GPM	53 GPM

1. Large water temperature differential
2. High heating supply water temperatures
3. Low suction pressure/low flow
4. Compressor trips
5. Chiller shuts down to protect itself
6. Customer thinks the modular chiller is the problem

Proper control keeps chiller operating

Modular Chillers: Superior to Conventional Chillers



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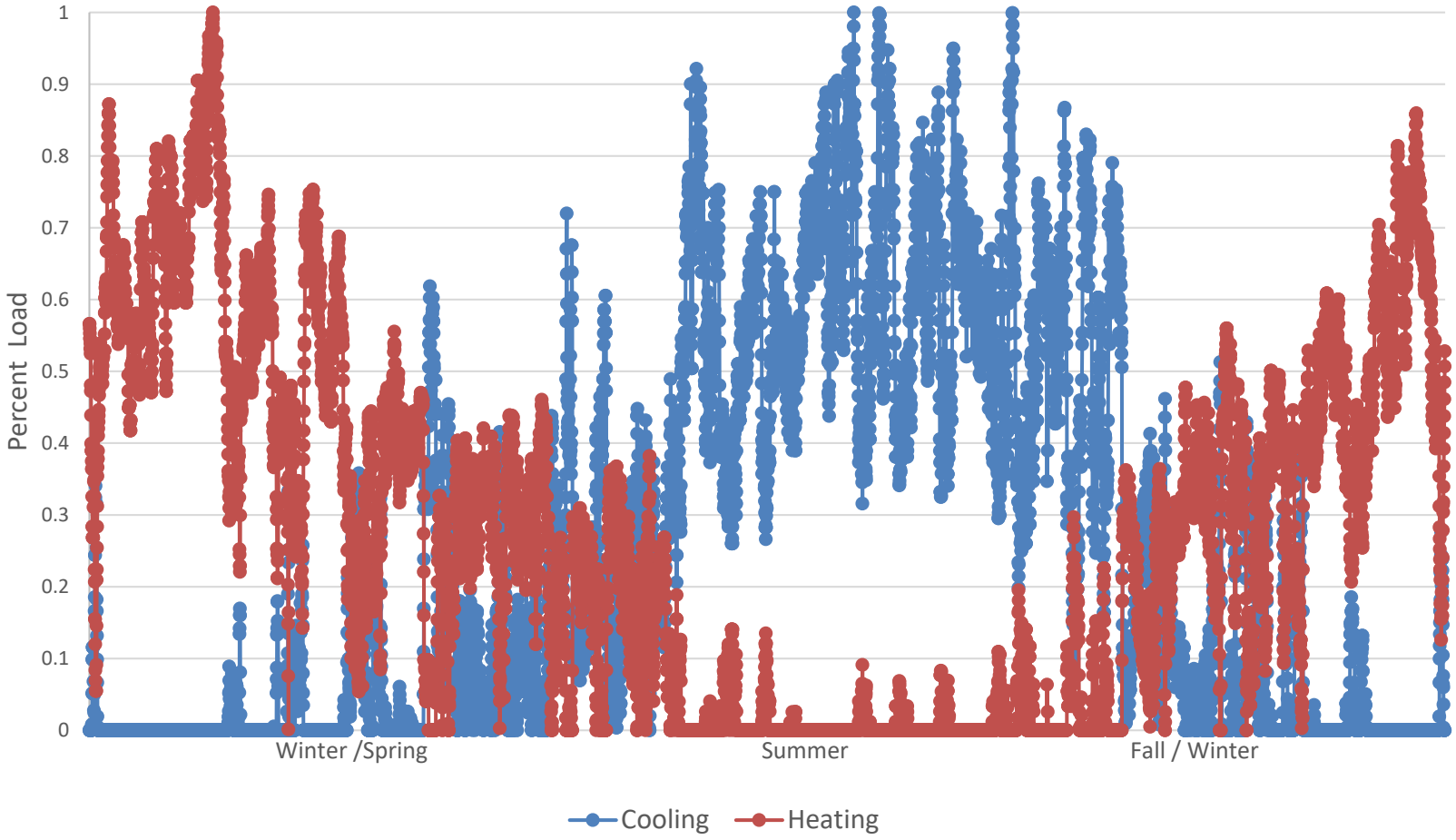
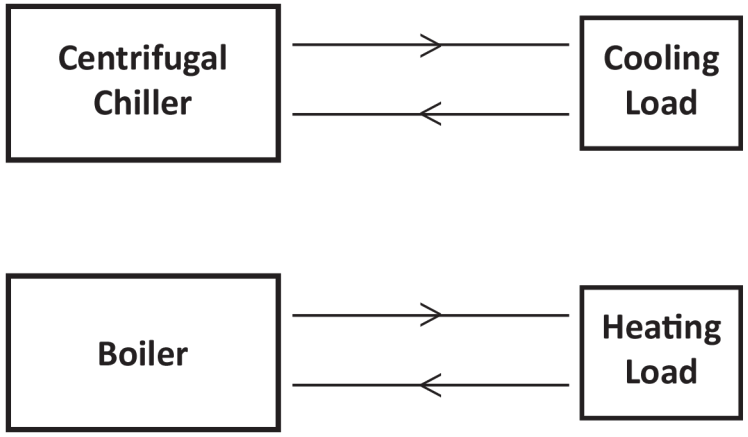
HEAT RECOVERY APPLICATION AND DESIGN

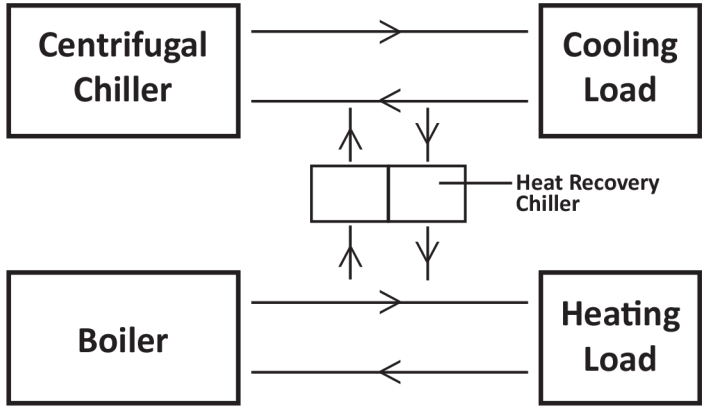
Heat Recovery Application and Design – 4 Header Model UCH



Year-round cooling and heating load in most buildings

Heat Recovery Application and Design – 4 Header Model UCH



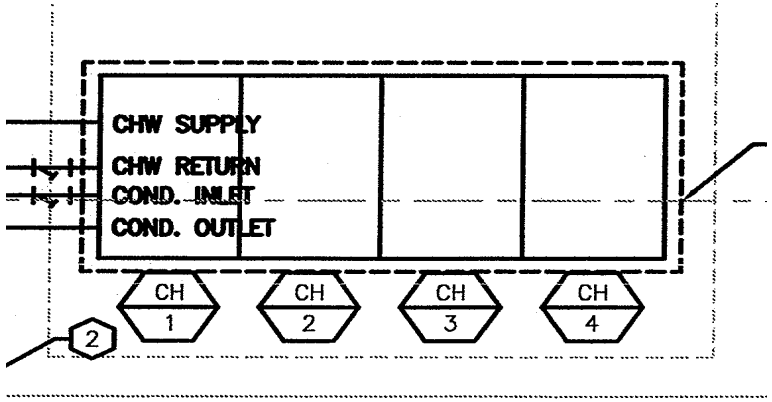


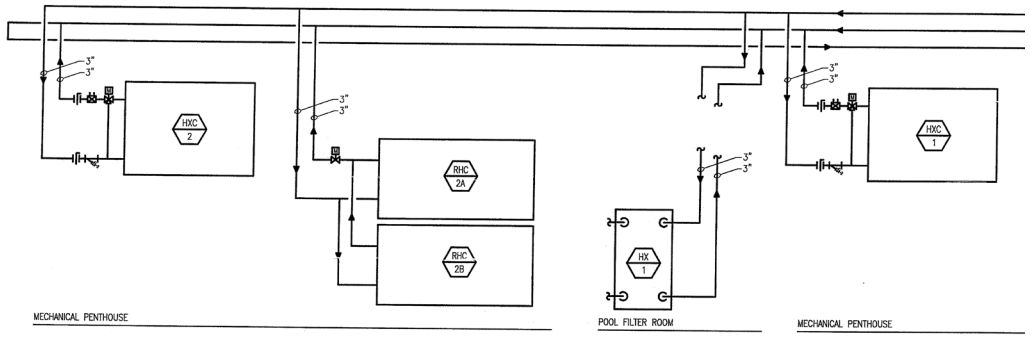
Centrifugal Chiller and Boiler line diagram

Control to smallest load

Heat Recovery Application Examples:
4 Header Model UCH

- Any 4-pipe system
- Heating & Reheat Coils
- Baseboard heating
- Snow melt systems
- Swimming pools





Look for SHC loads beyond traditional HVAC

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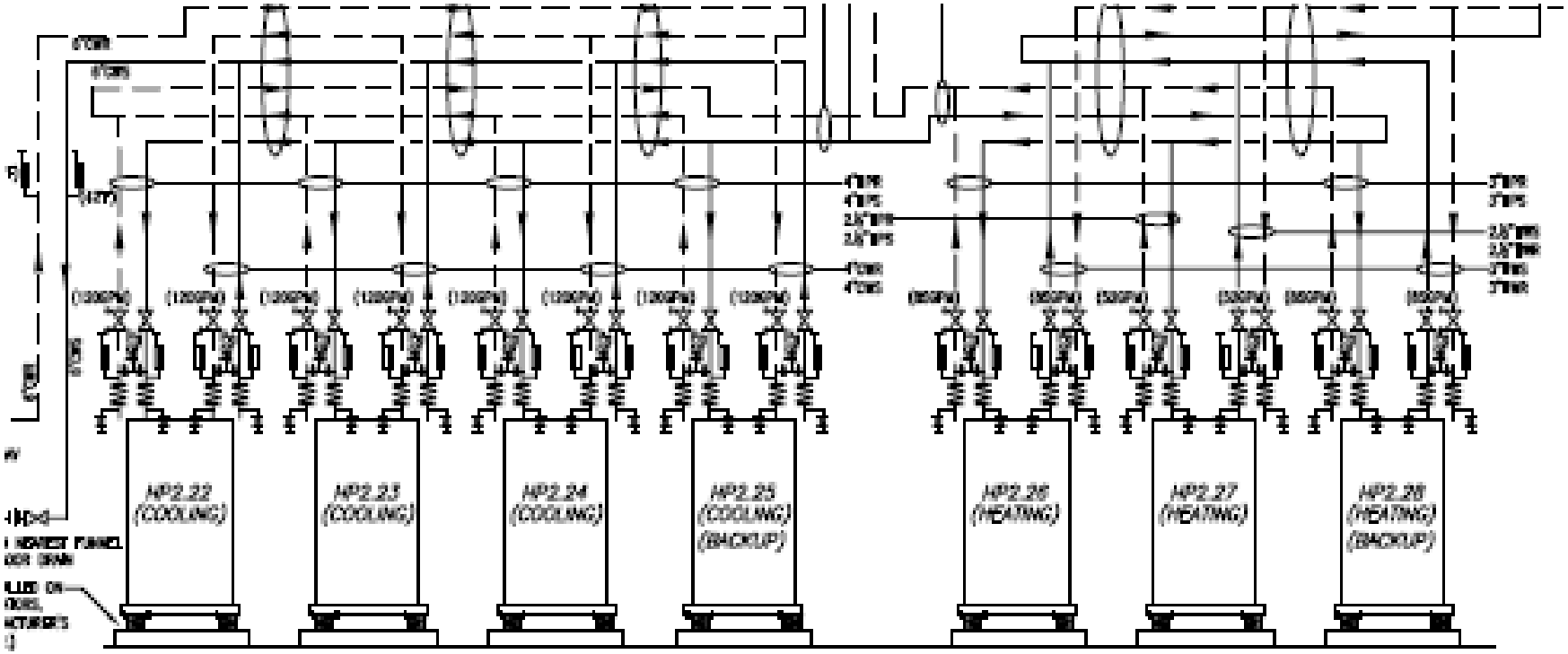
SIMULTANEOUS HEATING AND COOLING APPLICATION AND DESIGN
6-HEADER MODEL UCH

Source Water Chillers Application and Design:
6 Header Model UCH SHC

2012 AHR Expo® INNOVATION AWARDS Value Impact Application WINNER

AQUACOOL®

Geothermal or Boiler/Tower **Centralized vs Decentralized**



SHC design eliminates complexity

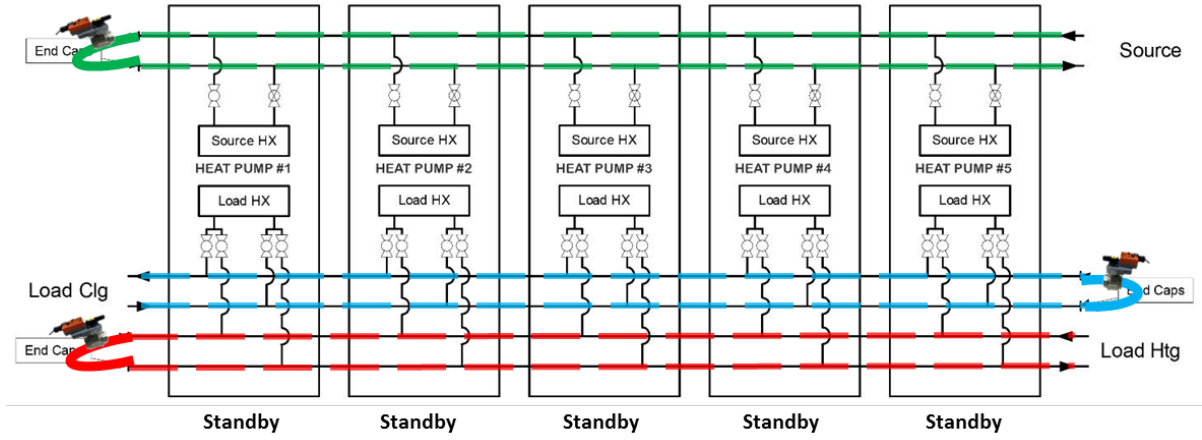
Design and Applications

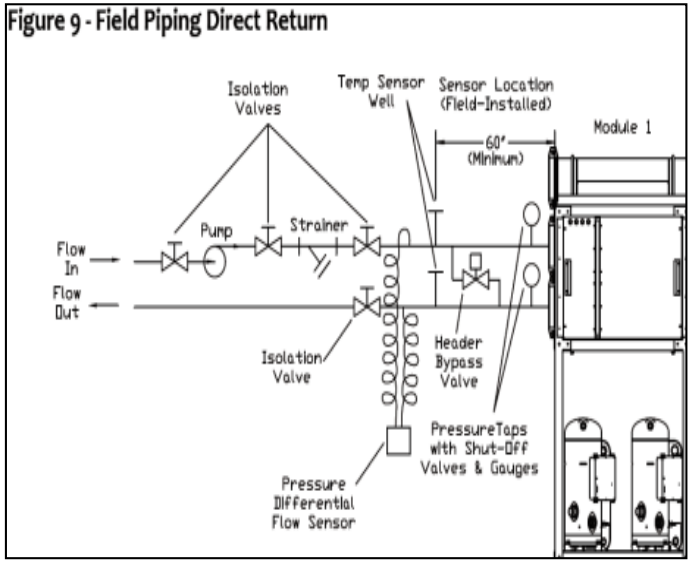
Heat Pump	Heat Recovery
Has refrigerant reversing valve	No refrigerant reversing valve
Index any module for heating or cooling at any time	Index any module for heating, cooling or heat recovery at any time
External heat source/sink	Utilize free heat to reduce energy consumption
No mixing of source and load liquids (water/glycol) solutions	All water/glycol loops mix

Air-cooled AND water-cooled available in both of these designs

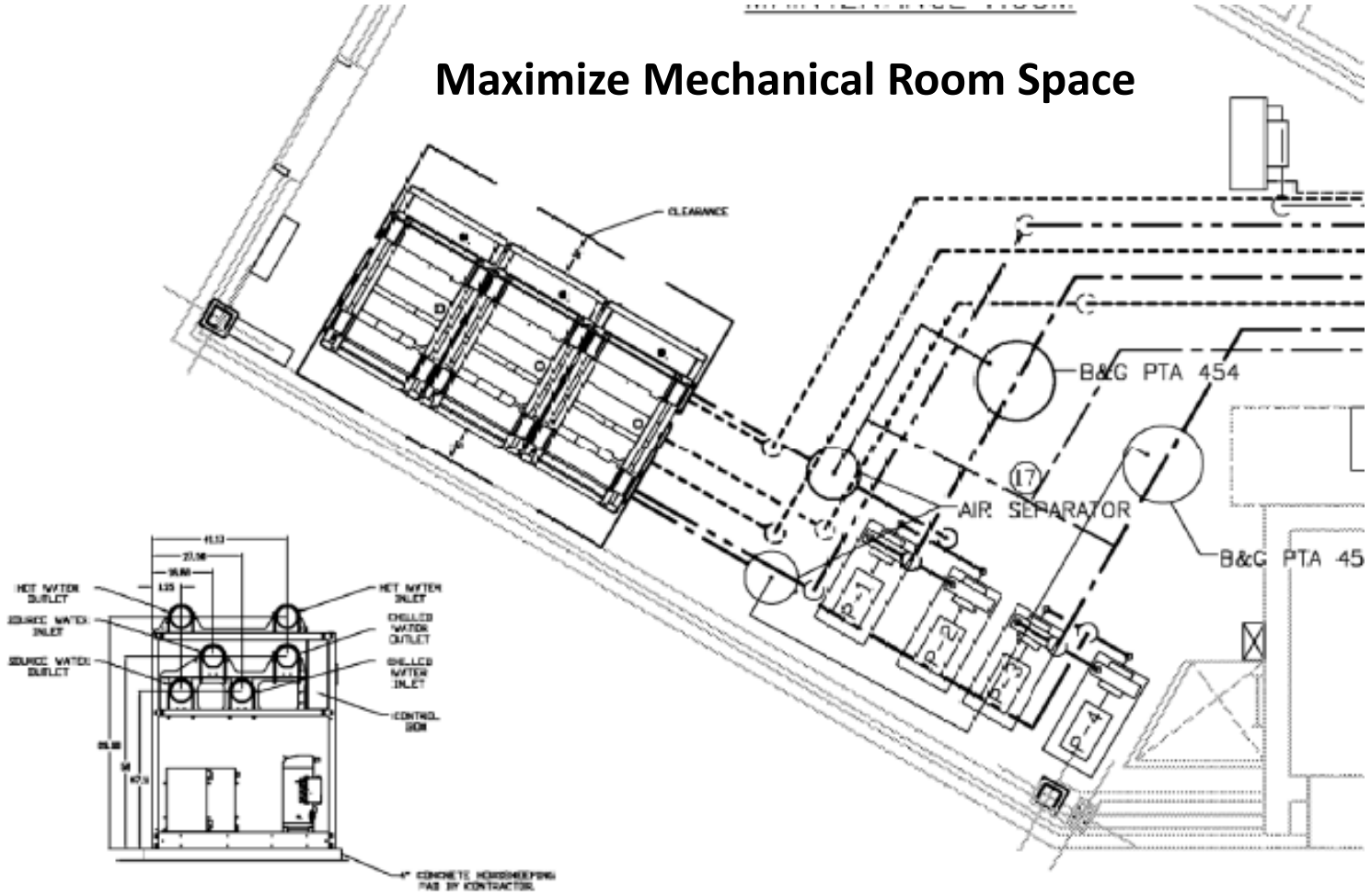
SHC Design and Applications – Heat Pump

- VARIABLE FLOW OPERATION: maintain header dp and system dp
- MAINTAIN LOOP VOLUME: 4-6 gallons per ton
- SOURCE AND LOAD LOOPS DO NOT MIX



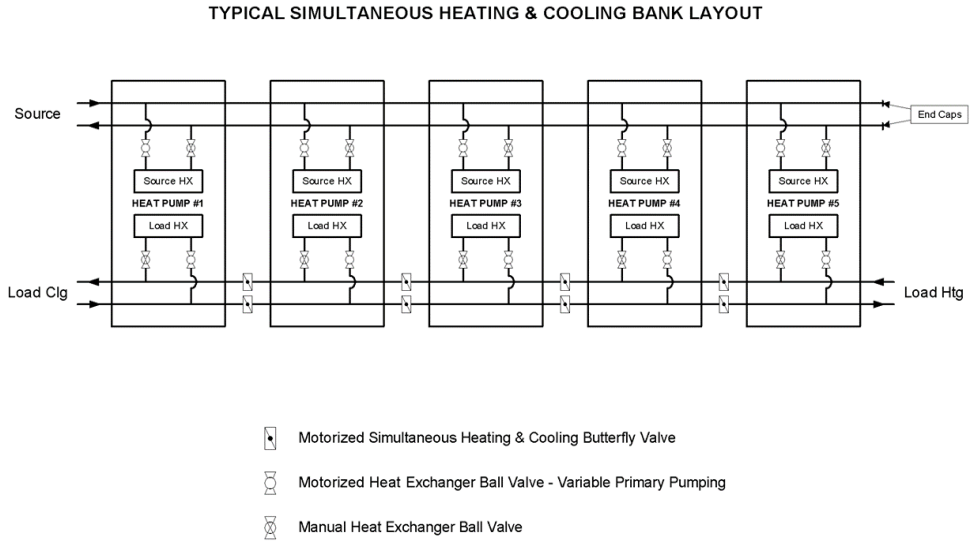


SHC Design and Applications – Heat Pump



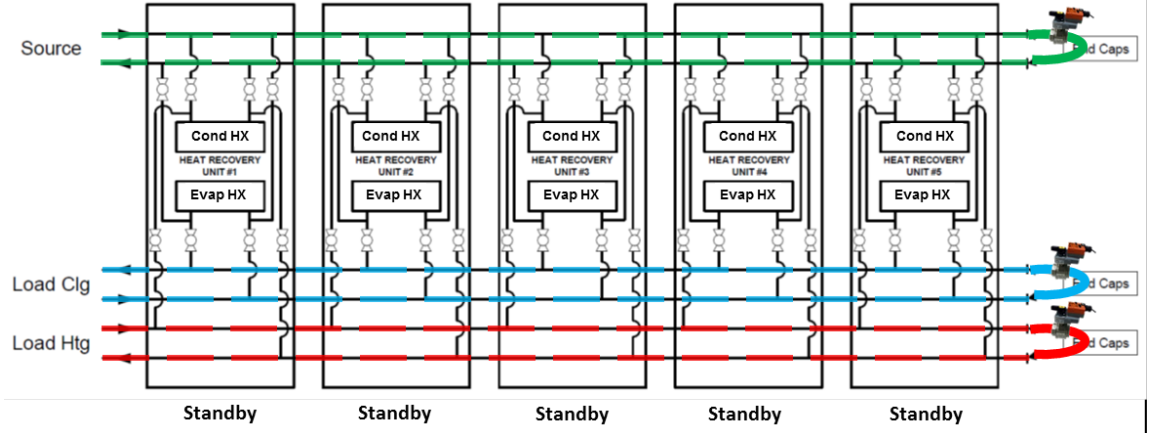
ClimaCool Design Advantages vs VME I (Heat Pump)

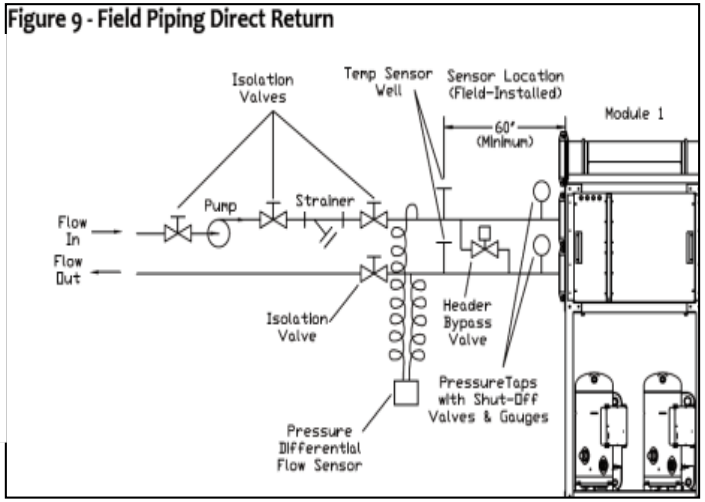
- Equalize run hours of compressors
- Numerous piping configurations
- Less mechanical room real estate



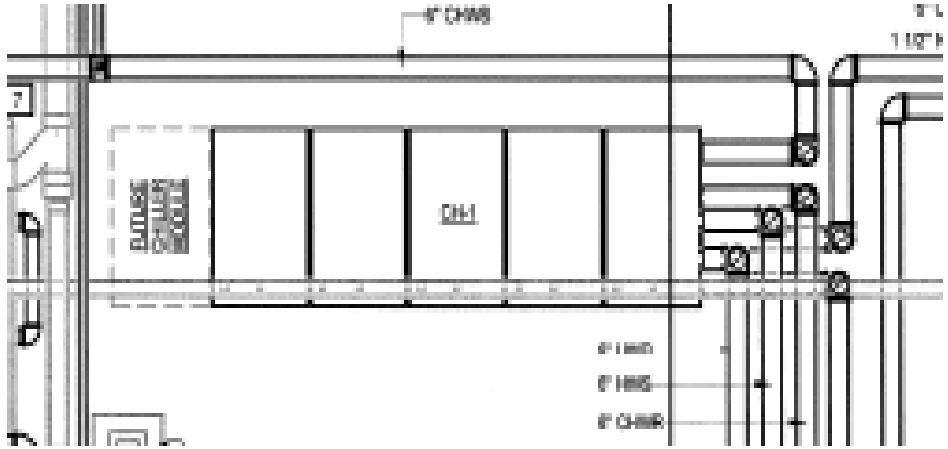
SHC Design and Applications – Heat Recovery

- VARIABLE FLOW OPERATION: maintain header dp and system dp
- MAINTAIN LOOP VOLUME: 4-6 gallons per ton
- SOURCE AND LOAD LOOPS MIX





SHC Design and Applications – Heat Recovery

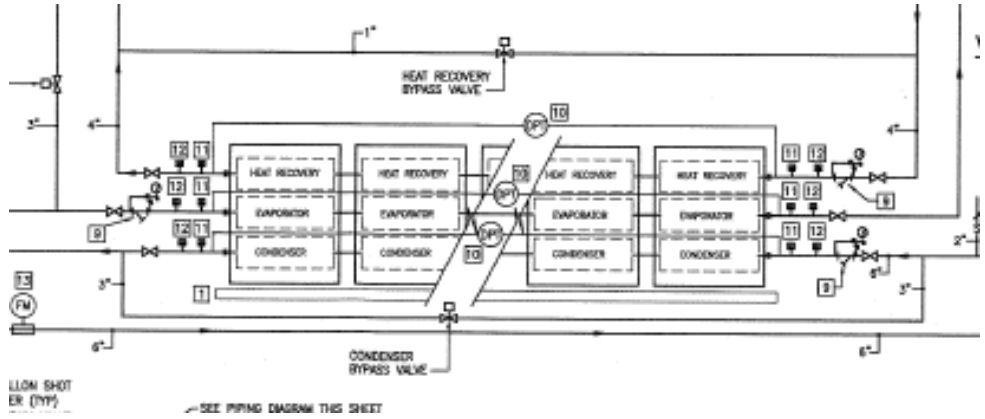


Direct Return Piping for all 6

- **Easiest for expansion**
- **Spec Stopper**

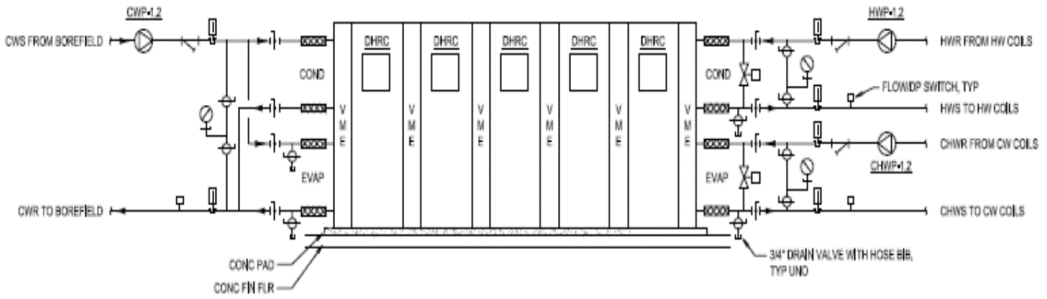
Reverse Return Piping

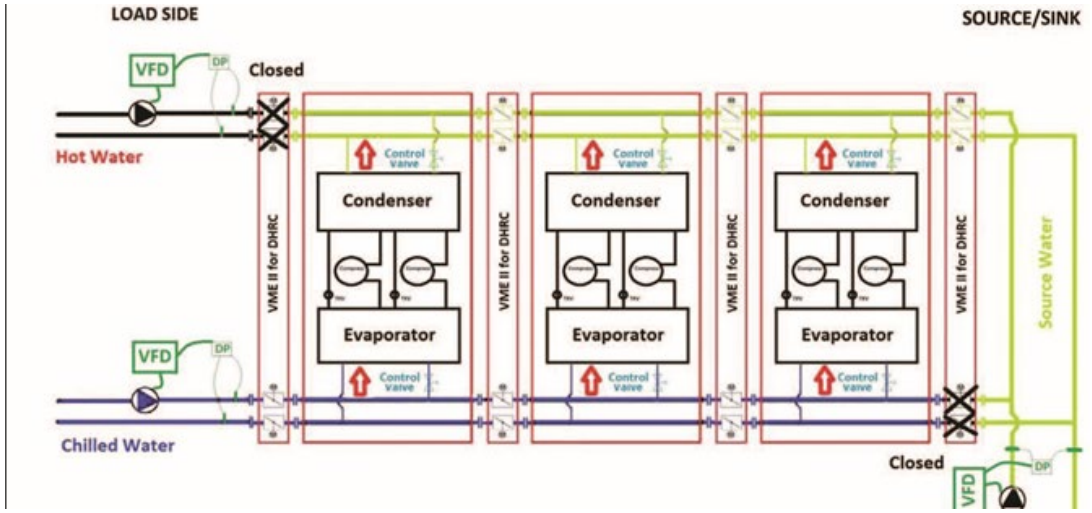
- **Spec Stopper**



ClimaCool Design Advantages vs VME II (Heat Recovery)

- Equalize run hours of compressors
- Numerous piping configurations
- Less mechanical room real estate
- Less piping & control

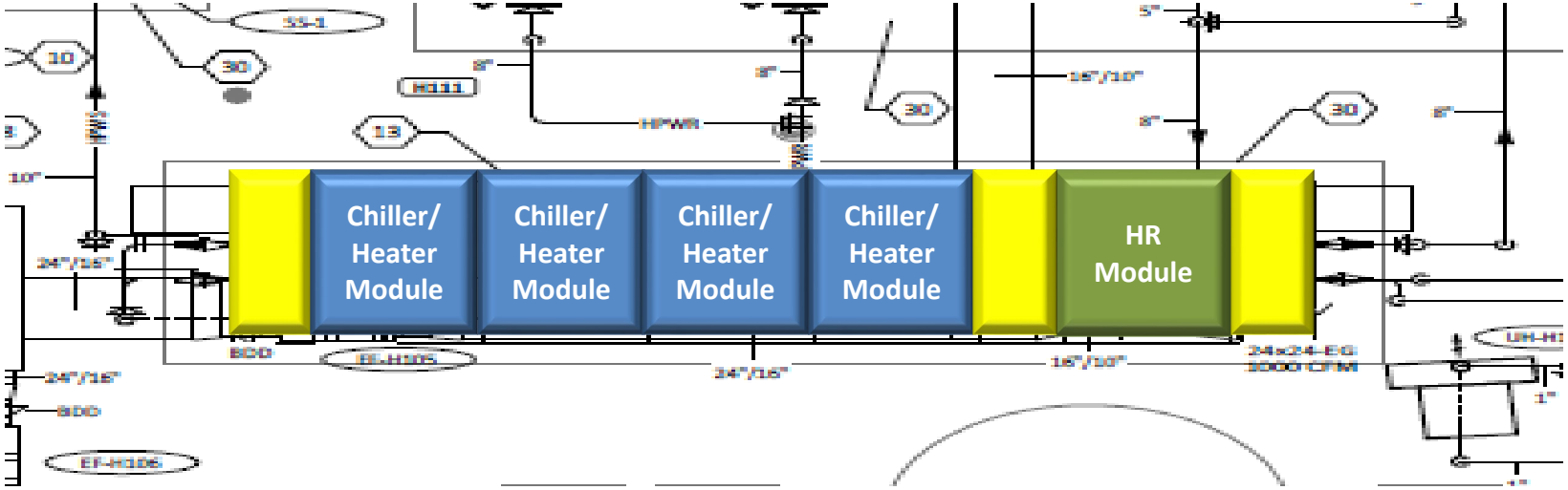




SHC Design and Applications – Heat Recovery

One Isolated HR Module??

No HR Redundancy



HRCHLR-1: GEOTHERMAL CHILLER / HEATER SCHEDULE

MODE	COOLING					HEATING					GEOTHERMAL				ENERGY	CHILLER	NO. OF	VALVE	NO. OF
	CAPACITY (TONS)	FLOW (GPM)	EWT (F)	LWT (F)	WPD (FT)	CAPACITY (MBH)	FLOW (GPM)	EWT (F)	LWT (F)	WPD (FT)	FLOW (GPM)	EWT (F)	LWT (F)	WPD (FT)	POWER INPUT (KW)	MODULE MODEL	MODULES	SECTION MODEL	SECTIONS
PEAK COOLING, NO HEATING (5 MODULES)	433.1	692.5	60.0	45.0	10.9	-	-	-	-	-	1251.5	85.0	95.0	16.4	310.8				
PEAK HEATING, NO COOLING (3 MODULES)	-	-	-	-	-	3137	209.2	100.0	130.0	6.0	453.3	50.0	40.0	16.4	254.8	MS085XC2H2H2AAC-410A	5	VME2H8A2	3
SIMULTANEOUS MODE (1 MODULES)	70.6	112.8	60.0	45.0	10.9	1140	76.0	100.0	130.0	6.0	-	-	-	-	86.1				

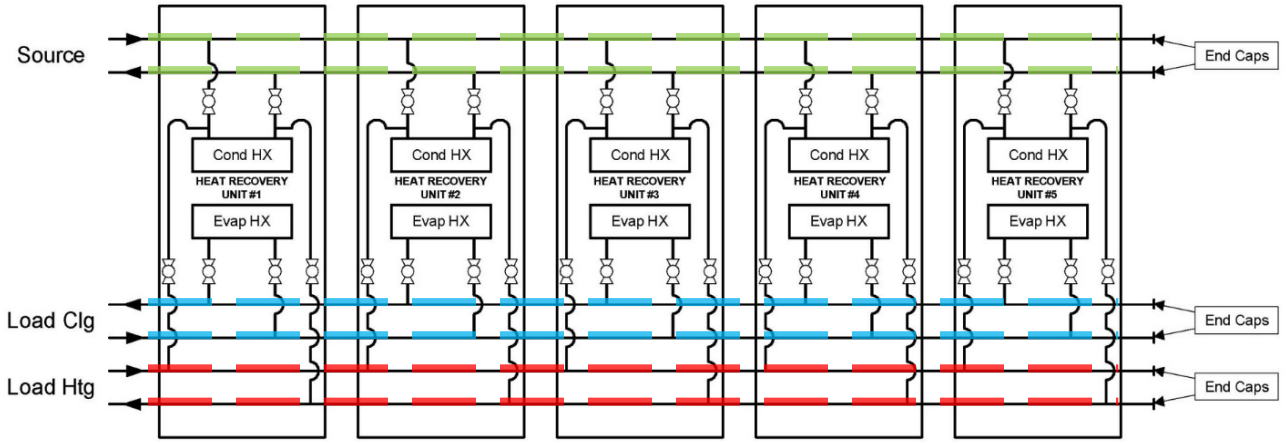
NOTES:
1. UNITS AS SCHEDULED ARE MANUFACTURED BY MULTISTACK.
2. MOUNT UNIT ON 3-1/2" CONCRETE PAD. PAD BY DIVISION 23 CONTRACTOR.
3. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
4. FLUID TYPE FOR CHILLED WATER LOOP, HEATING WATER LOOP, AND GEOTHERMAL LOOP IS WATER.
5. ONE OF THE FIVE MODULES SHALL BE CAPABLE OF SIMULTANEOUS OPERATION.
6. UNIT DIMENSIONS (LxWxH): 278"x63"x73"
7. UNIT SHALL HAVE TWO POWER CONNECTIONS. BOTH FEEDS SHALL BE 460V/3PH. FEED 1 = 471 MCA/600 MOP. FEED 2 = 320 MCA/400 MOP.

ClimaCool 6 header SHC design ensures complete redundancy

SHC Design and Applications:
Heat Recovery with Cooling Priority

- Stop designing with chillers that only cool the building
- Control to chilled water AND hot water temperature
- For use with standard cooling tower design
- Provide only the hot water you need

SHC - INTEGRAL 6 HEADER DUAL MODE SIMULTANEOUS HEATING & COOLING HEAT RECOVERY BANK LAYOUT
COOLING PRIORITY

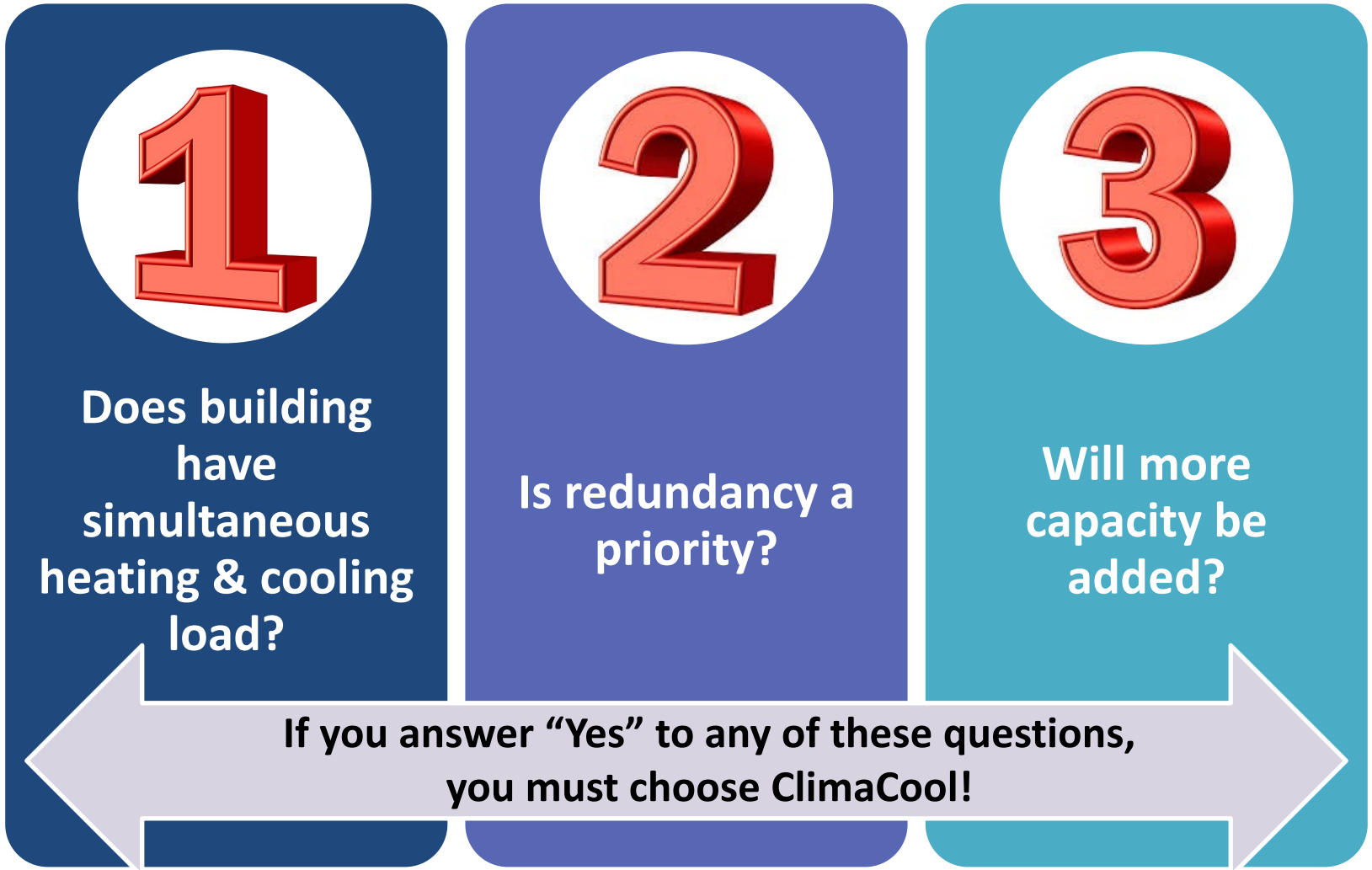


Modular Chillers: Superior to conventional chillers

Engineer & Owner benefits to modular approach

- Meets size constraints
- Built-in redundancy
- Unloading advantages
- Sound sensitive
- Eliminates refrigerant monitoring & associated controls
- Additional future capacity flexibility
- Maintenance simplicity
- Flexible cooling & heating applications

Sales Qualifying:
Choosing Modular vs. Conventional Chiller Plant



Summary

- Slight difference between conventional & modular chiller design
- Broad application benefits with modern modular chillers
  - Nearly every job can use 4 header heat recovery chiller
  - Most jobs soon will use some sort of simultaneous heating and cooling (SHC)
- ClimaCool design advantages makes us leader for all SHC applications

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Thank You!