A NIBE GROUP MEMBER

MODULAR CHILLER SYSTEMS

APPLICATION GUIDE

Part#: C99D1010N08 | Created: April 28, 2025

U.S.A. BUILT Manufactured in the U.S.A. of U.S. and imported parts

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INTRODUCTION

The use of modular chiller products has distinct advantages over a typical chiller/boiler system such as space savings, built-in redundancy, and better flexibility to load match.

ClimaCool Water-Source Modular Chiller System using a bank of four SHC Heat Recovery units in Mechanical Room.

Multiple independent modules and refrigeration circuits lessen the amount of down time during routine servicing and repairs. The Modular Chiller System can be designed with as many incremental steps in capacity as required. The system also has potential for expansion to match nearly any project requirement. It is important for the designer to understand not only the maximum Btuh requirement of the load, but also the minimum step of capacity during light loads to properly select the right tonnage of modules.

REFERENCES/NOMENCLATURE CONVENTIONS IN THIS MANUAL

This manual describes the operation and provides illustrations of various system applications of ClimaCool Modular Chillers, both water source and air source. Model nomenclature used in this manual refers to ClimaCool Modular Chiller models. For simplicity and clarity, single line (intending to indicate both supply and return) water piping drawings are used to illustrate load (chilled or hot water) and condenser (source water).

TERMS AND DEFINITIONS:

- **Bank Controller:** The CoolLogic Touch™ Control System which controls the staging of the chiller modules and provides all operational data from the modules to a central location.
- **BPHX:** Brazed Plate Heat Exchanger.
- **Chiller Bank:** The entire chiller including all individual chiller modules.
- **Chiller Module:** An individual chiller within the Bank.
- **DP:** Delta Pressure or pressure difference.
- **DPT:** Water Differential Pressure Transducer that monitors the water flow through each of the chiller headers. Its purpose is to provide a loss of flow shutdown of the chiller when the differential pressure across its headers falls below the trip point.
- **DT:** Delta Temperature or temperature difference.
- **Headers or Pipe:** The 6-inch or 8-inch steel headers that run through the chiller bank from one end to the other and are field connected between modules with grooved couplings.
- **Load HX:** This terminology is used for Heat Pump modules instead of using of the term Evaporator for non-heat pump modules. In a heat pump module, the evaporator acts as the chilled water load or hot water load depending on the position of the unit's reversing valve.
- **Loads:** The devices being served with chilled or hot water system for heating or cooling the building zones.
- **Refrigeration Circuit:** Each individual chiller module contains two independent refrigeration circuits. These two refrigeration circuits share the same water circuits within a module.
- **Source HX:** The terminology used for Heat Pump modules instead of the use of the term Condenser for non-heat pump modules. In a heat pump module, the evaporating and condensing of refrigerant inside a heat exchanger changes with the usage of the heat exchanger depending on the mode the module is operating in. This is the heat exchanger within a chiller module that is used to reject heat to (Cooling mode), or absorb heat from (Heating mode) an external device such as a cooling tower, geothermal well field, dry cooler, etc.
- **System:** The entire chilled and condenser water system outside of the chiller itself. This includes all external piping, pumps, tanks, building loads such as air handlers, fan coils, chilled beams, etc.
- **SHC:** Simultaneous Heating & Cooling. Each module within the bank can operate in a different mode as needed to meet the load demand.

REFERENCES/NOMENCLATURE CONVENTIONS IN THIS MANUAL

MODE DEFINITIONS:

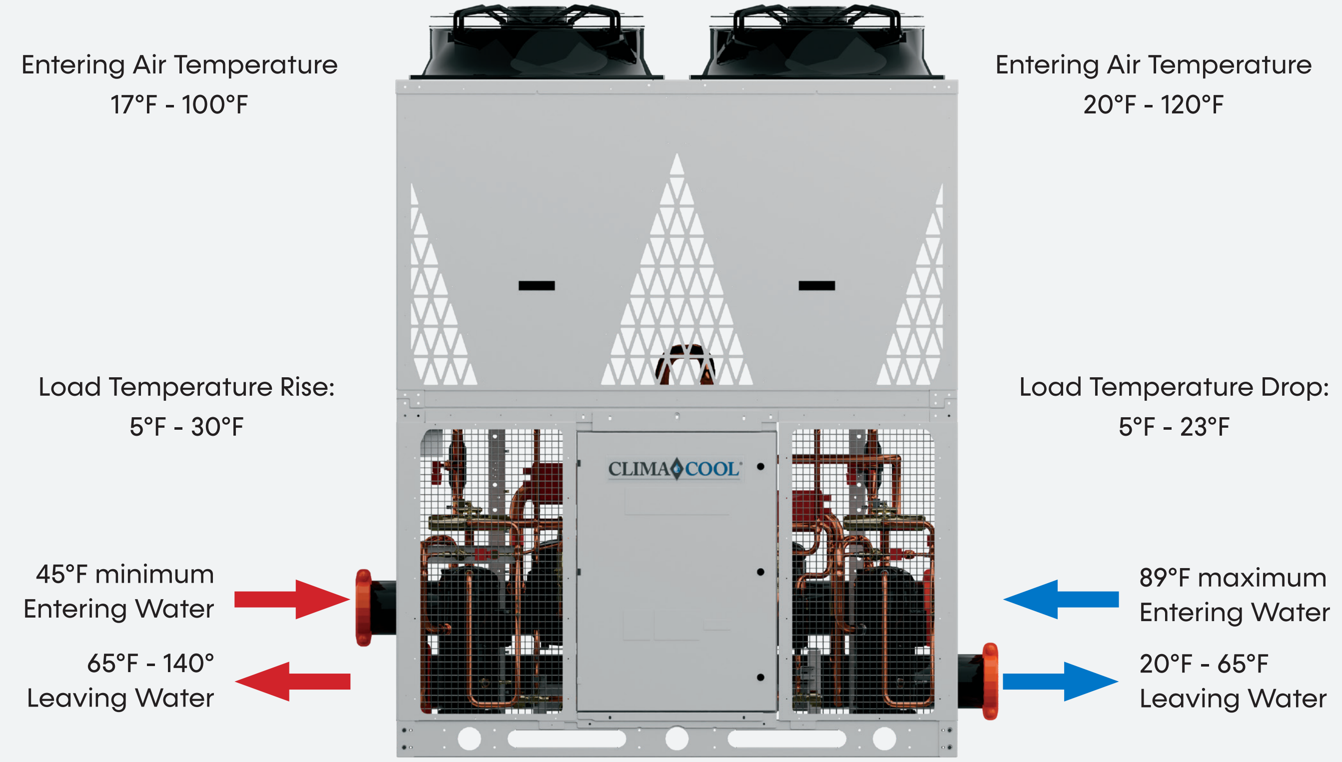
- **Cooling:** The module is producing chilled water to meet the cooling demand.
- **Heating:** The module is producing hot water to meet the heating demand.
- **Heat Recovery:** The module is simultaneously producing chilled and hot water to meet the lowest set point. The higher set point will need backup to meet the demand.
- **SHC Heat Pump:** Each module can operate in heating or cooling; the bank can provide hot and chilled water simultaneously.
- **SHC Heat Recovery:** Each module can operate in heating, cooling, or heat recovery. The bank will operate in heat recovery until the lowest set point is met, then the remaining modules will stage on to meet the higher set point. The bank can simultaneously provide hot and chilled water.

AIR-SOURCE MODULAR CHILLERS

OPERATING PARAMETERS

WATER HEATING MODE

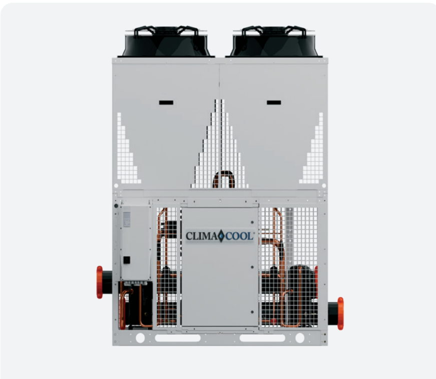
WATER COOLING MODE



95°F maximum difference between **leaving water** and **ambient air** temperatures.

- Freeze protection required when ambient temperatures are below 36°F
- Water temperatures below 40°F require glycol mixture for freeze protection
- Additional heat source may be needed. See manufacturer engineering data

AIR-SOURCE MODULAR CHILLERS

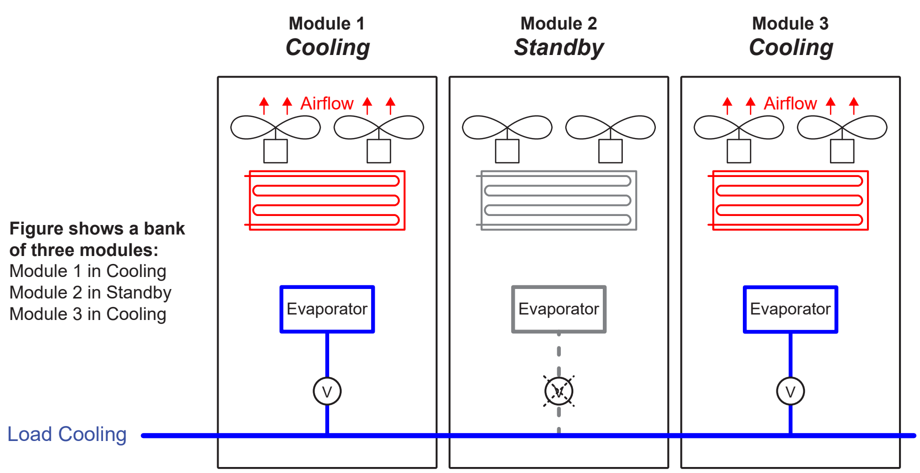


CHILLERS (UAC)

The UAC (2-Pipe Cooling Only) modules reject heat using the air cooled condenser. The ambient air serves as the source for the UAC (see Figure 1). Each refrigerant circuit includes an electronic expansion valve and an accumulator. Two (2) headers shall be provided – supply and return for the cooling loop. Motorized isolation valves shall be provided with ¾" flush port connections – two (2) motorized proportional valves shall be provided between the evaporator and chilled supply and return headers.

The whole bank is in cooling mode.

Figure 1: UAC, Cooling Only



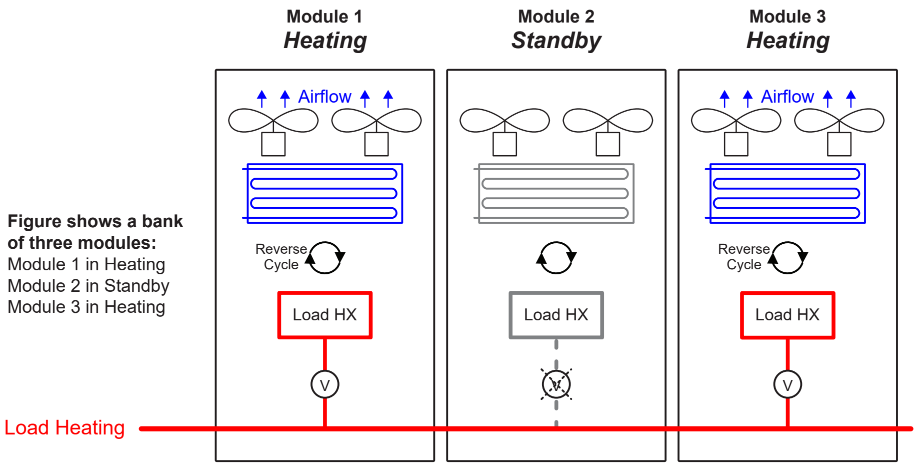
* Simplified single line water circuit shown; V = motorized isolation and control valve

HEAT PUMPS (UAT)

The UAT (2-Pipe Heat Pump) modules use the load heat exchanger to produce chilled water in cooling mode and hot water in heating mode (see Figure 2). The load heat exchanger will provide chilled water to the load loop in cooling mode or hot water to the load loop in heating mode. The source heat exchanger will reject heat to the source in the cooling mode and absorb heat from the source in the heating mode. The ambient air serves as the source for the UAT.
Each refrigerant circuit includes a reversing valve, an electronic expansion valve, and an accumulator. Controls include a variable flow defrost cycle controlled by head and suction pressure. Two (2) headers shall be provided–supply/return for the heating/cooling loop. Motorized isolation valves shall be provided with ¾-inch flush port connections–two (2) motorized proportional valves shall be provided between the evaporator and shared chilled/hot water supply and return headers.

The whole bank is either in cooling or heating mode.

Figure 2: UAT, Heat Pump



* Simplified single line water circuit shown; V = motorized isolation and control valve

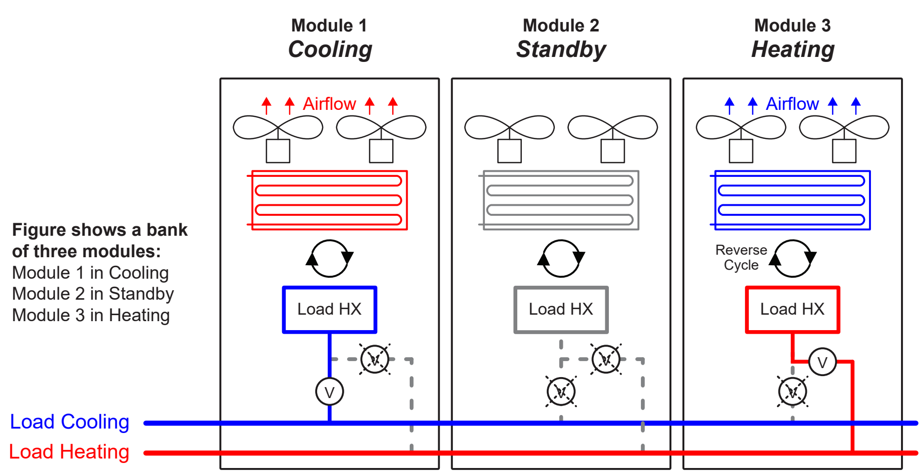
AIR-SOURCE MODULAR CHILLERS

SHC HEAT PUMPS (UAU)

The UAU (4-Pipe/SHC Heat Pump) modules utilize four pipes, two for hot water and two for chilled water (see Figure 3). The ambient air serves as the source for the UAU.
Each refrigerant circuit includes a reversing valve, an electronic expansion valve, and an accumulator. Controls include a variable flow defrost cycle controlled by head and suction pressure. Motorized isolation valves shall be provided with ¾-inch flush port connections – four (4) motorized proportional valves shall be provided between the evaporator and heating and cooling supply and return headers. The CoolLogic Touch Control System will index modules to heating or cooling based on building load requirements and leaving hot and chilled water set points.

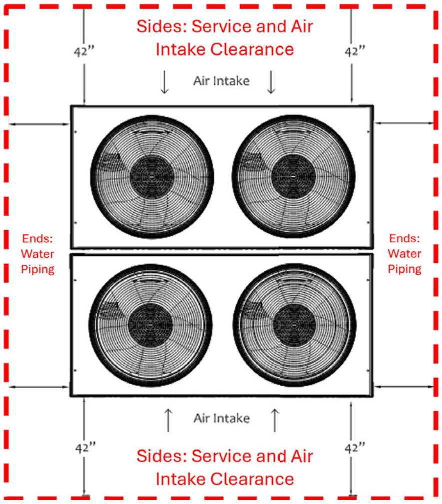
Any module can operate in either mode, heating or cooling, regardless of the position within the bank. The bank will simultaneously produce hot and chilled water.

Figure 3: UAU, SHC Heat Pump



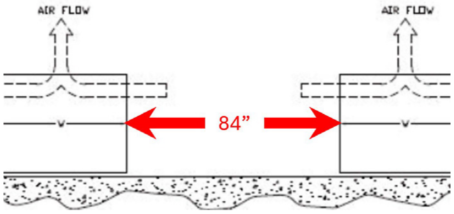
* Simplified single line water circuit shown; V = motorized isolation and control valve

AIR-SOURCE CLEARANCES



UNIT CLEARANCE

- **Sides:** 36-42" minimum
- **Ends:** 36-60" and as needed
  for field piping connections and components
- **Above:** No obstructed airflow above unit



BETWEEN BANKS

- 84" minimum clearance between banks to reduce air recirculation (major concern
  in heat mode)
- Consider staggering multiple bank installations

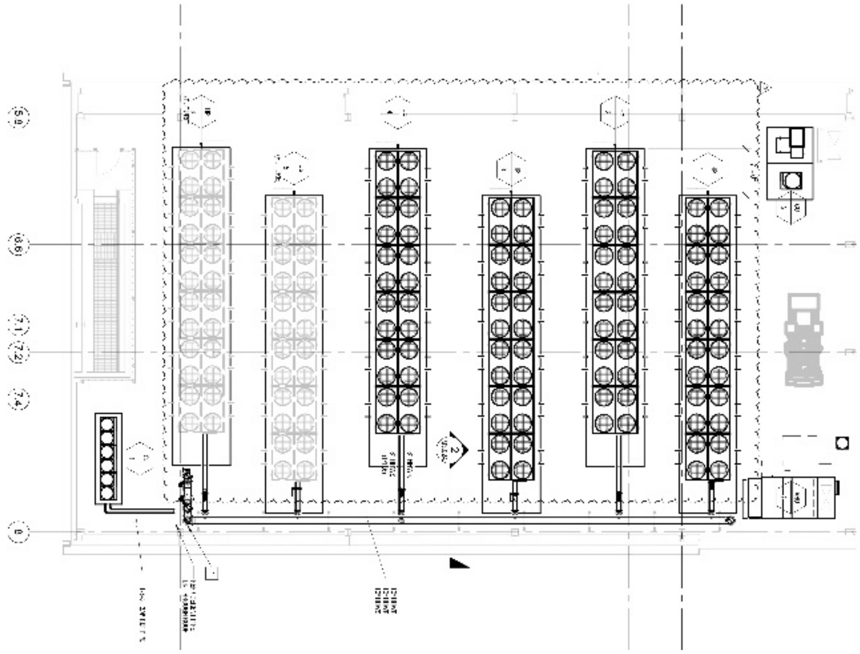
PIT INSTALLATION

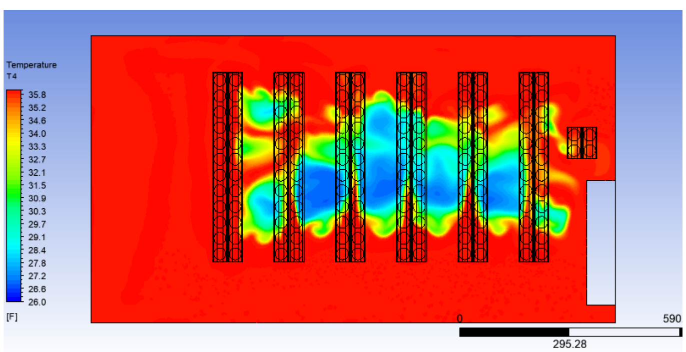
- Minimum 72" from walls
- Walls should not be taller than the chiller
- Best Practice: Raise the chiller to expose ≥ 75% of the air coil, include openings/louvers in walls

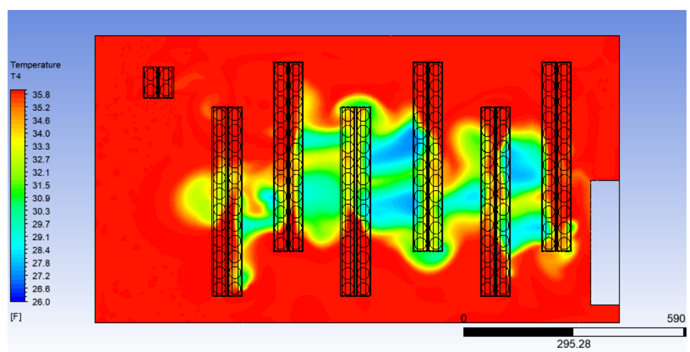
AIR-SOURCE CLEARANCES

MULTIPLE AIR-SOURCE LAYOUT

- Minimum air flow clearance from solid wall is 72”
- Minimum air flow clearance between banks is 84”
- For greater than 3 banks, a staggered layout is suggested to prevent cold air recirculation in heat mode.



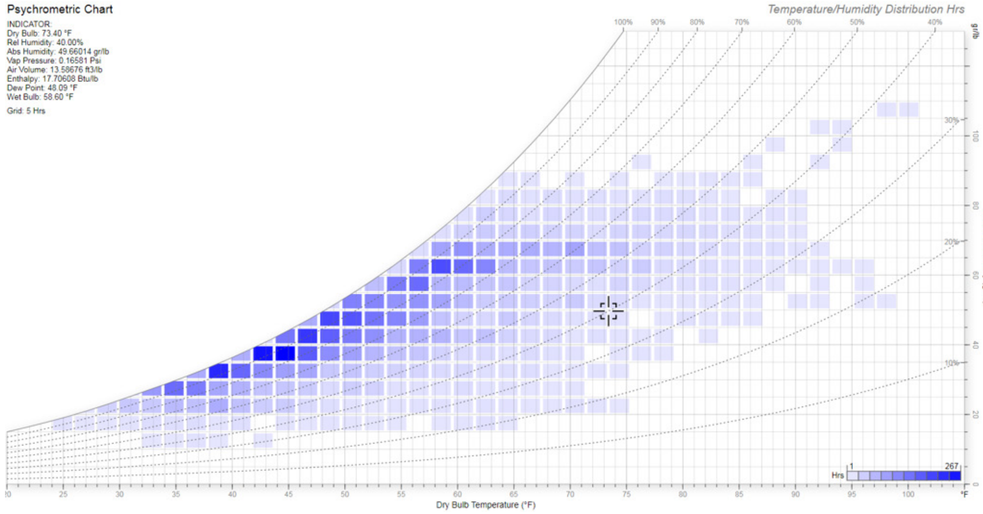




AIR-SOURCE UNIT HEATING

DEFROST OPERATION

- Ambient air above 90% RH and below 46°F are the worst conditions for frost forming on outdoor coils in heating mode operation.
- Moisture can accumulate on the condenser coil and freeze at other conditions.
- Consider city typical meteorological year weather data and the number of hours where frost may occur.



- Assume 18~24% Heating Derate at times of frequent defrost.
- A minimum of three modules is recommended by ClimaCool. During testing, systems performed better, provided better control when a minimum of 3 modules in a system were used.
- An extra module per heating bank is recommended When heating banks are sized for the exact heating design load, no additional capacity is reserved for defrost. As a result, additional capacity provides the required needed to during defrost formation ambient conditions.
- Minimum flows during heating and cooling need to be followed. As these chillers operate in heating and cooling, minimum flow rates through the chillers need to be adhered to, this includes watching the pressure drop across the strainers and making sure those stay clean on both the heating and cooling loop. Particularly since the cooling loop is used in the 4 pipe air cooled SHC chiller modules
- ClimaCool recommends minimum of 6 GPM per ton of cooling of water volume in the system. A heat pump system is meant to continuous heat and cool a system and move energy from one system to another, they operate best when changes to the system are done slowly, as a result, water volume is imperative to make sure the design will be successful
- Even during the heating system, the chilled water system must be available. Since the defrost cycle uses the chilled water loop during the defrost process both heating and cooling loops must be available.

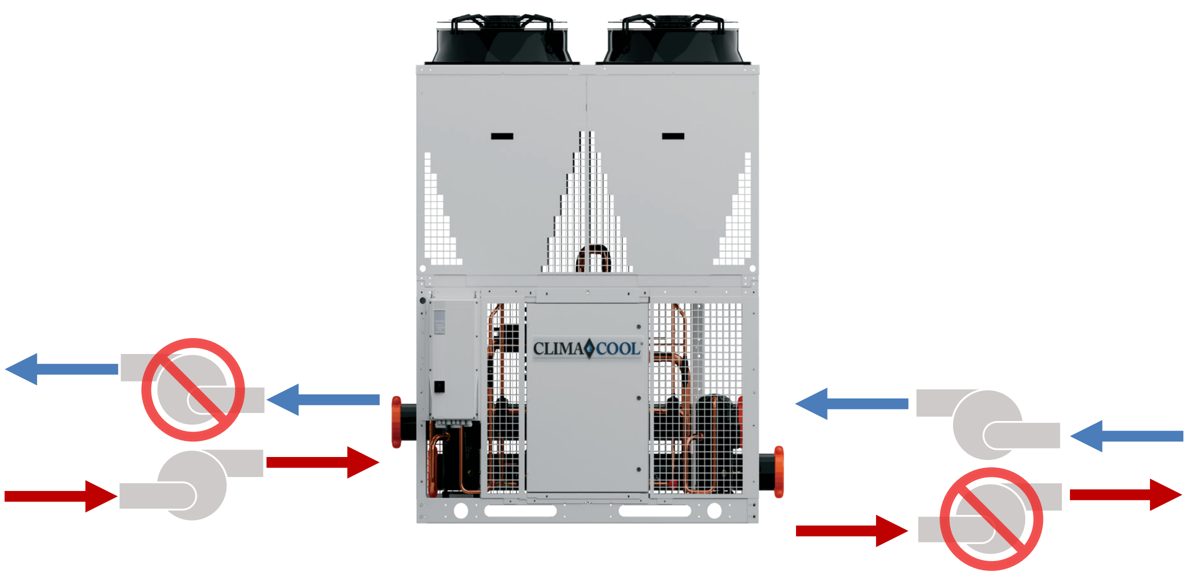
AIR-SOURCE HEAT PUMP

LOW AMBIENT HEATING

- Bank will cycle units into defrost mode one at a time.
  - Consider adding extra module per bank to allow for heating capacity during defrost.
- Modules in defrost will effectively be in cooling mode and introduce cold water to heating loop.
  - Increase fluid loop volume to buffer hot and cold swings as modules go into defrost. (6 gal/ton minimum)
- For SHC HP/HR Systems:
  - Defrost cycle uses the chilled water loop during the defrost, both heating and cooling loops must be available.
  - Cooling load must be present so that the chilled water loop does not get too cold.
  - Minimum flow rates during heating and cooling must be followed.
- Frequent defrost operation at low ambient temperatures will reduce over all leaving water temperatures.
  - Consider sizing heating coils for 5°F to 10°F lower hot water temperatures at extreme cold days.
- The maximum temperature difference between ambient air temperature and leaving hot water temperature is 95F.
  - For critical heating load applications supplementary and emergency heating sources should be included in design.

PUMP LOCATION

- Pumps must be a push-through design for best chiller control and loop pressurization.



AIR-SOURCE HEAT PUMP

LOW AMBIENT HEATING - FAQ

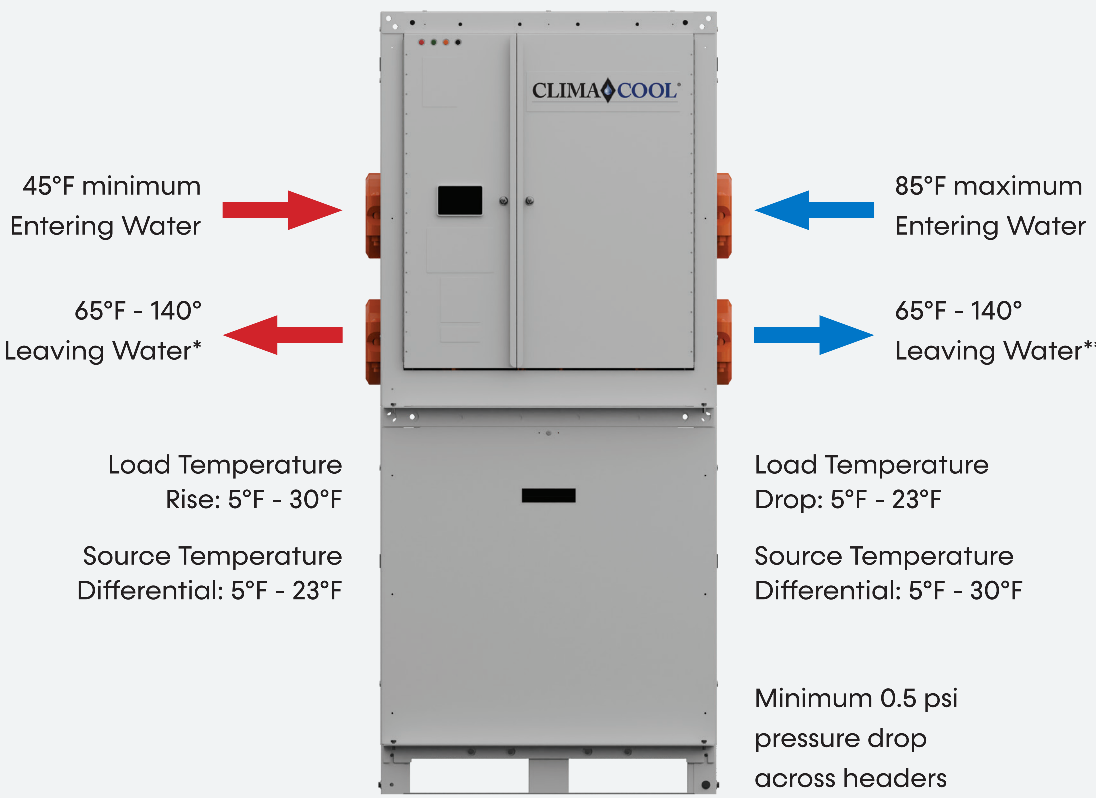
- Defrost cycle is approximately 6-8 minutes, while active defrost mode is 3-4-minute time period in "cooling mode."
  - The circuit must stop compressor, move 4-way valve from heat to cool mode, start compressor in cooling mode (active defrost), stop the compressor, move the 4-way valve back to heating mode, and start the compressor again in heating. This cycle takes approximately 6-8 minutes.
  - Typical time operating the compressor in cooling mode for active defrost is 3-4 minutes.
- Heat pulled from the heating loop over that period is approximately 4.5% of the heat produced. Example: For a 70-ton module in defrost, selected at a design weather condition capacity of 625 MBH,
  - Each module has 2 circuits, equally split. 625/2 = 312MBH each. 312MBH / 60minutes = 5.2MBM. Defrost for 3 to 4 minutes actively pulls 5.2MB/H to 15.6MB/H out of the loop during a reverse cycle defrost action.
  - Total unit 625 MB/H / 60 minutes = 10.4 MB/M. Defrost for 3 to 4 minutes actively pulls 10.4MB/H to 31.25MB/H out of the loop during a reverse cycle defrost action. Assuming both circuits defrost at the same time, or both defrost in an hour.
- Each chiller module has 2 refrigerant circuits, the module will defrost 1 circuit while the other circuit is still producing heat, unless the second circuit is within 80% of the frost accumulation timer, then they will both defrost.
- The CoolLogic controller will only allow 1 chiller module to defrost at a time.

WATER-SOURCE MODULAR CHILLERS

OPERATING PARAMETERS

WATER HEATING MODE

WATER COOLING MODE



115°F maximum difference between **leaving** chilled and hot water temperatures.

30°F minimum difference between **entering** chilled and hot water temperatures.

- Additional heat source may be needed. See manufacturer engineering data.
- Water temperatures below 40°F require glycol mixture for freeze protection.

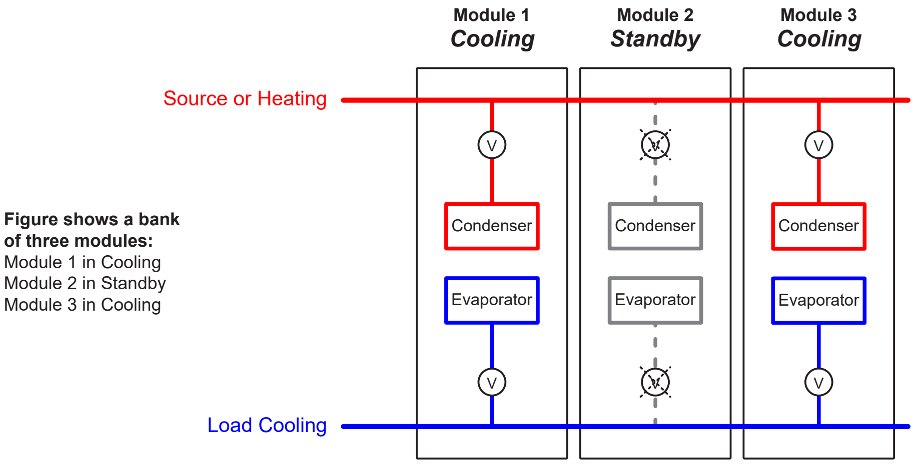
WATER-SOURCE MODULAR CHILLERS

CHILLERS (UWC)

The UWC (4-Pipe Cooling Only) modules reject heat to a geothermal well field or cooling tower (see Figure 4).
The UWC model is typically applied as a retrofit to hard-to-install centrifugal chillers or trim or pony chillers. Each refrigerant circuit includes an electronic expansion valve and an accumulator. Four (4) headers shall be provided – supply/return for the chilled water loop and supply/return for the source loop. Motorized isolation valves shall be provided with ¾-inch flush port connections – four (4) motorized proportional valves shall be provided, one on each header.

The whole bank is in cooling mode.

Figure 4: UWC, Cooling Only



* Simplified single line water circuit shown; V = motorized isolation and control valve

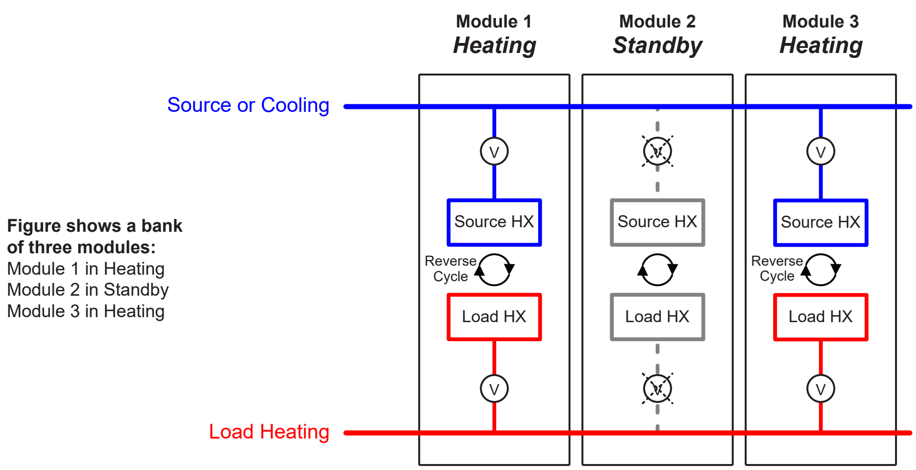
WATER-SOURCE MODULAR CHILLERS

HEAT PUMPS (UWT)

The UWT (4-Pipe Heat Pump) modules operate in either cooling or heating (see Figure 5). The load heat exchanger will provide chilled water to the load loop in cooling mode or hot water to the load loop in heating mode. The source heat exchanger will reject heat to the source in the cooling mode and absorb heat from the source in the heating mode. Each refrigerant circuit includes a reversing valve, an electronic expansion valve, and an accumulator. Four (4) headers shall be provided – supply/return for the load loop and supply/return for the source loop. Motorized isolation valves shall be provided with ¾-inch flush port connections – four (4) motorized proportional valves shall be provided, one on each header.

The whole bank is either in cooling or heating mode.

Figure 5: UWT, Heat Pump



* Simplified single line water circuit shown; V = motorized isolation and control valve

WATER-SOURCE MODULAR CHILLERS

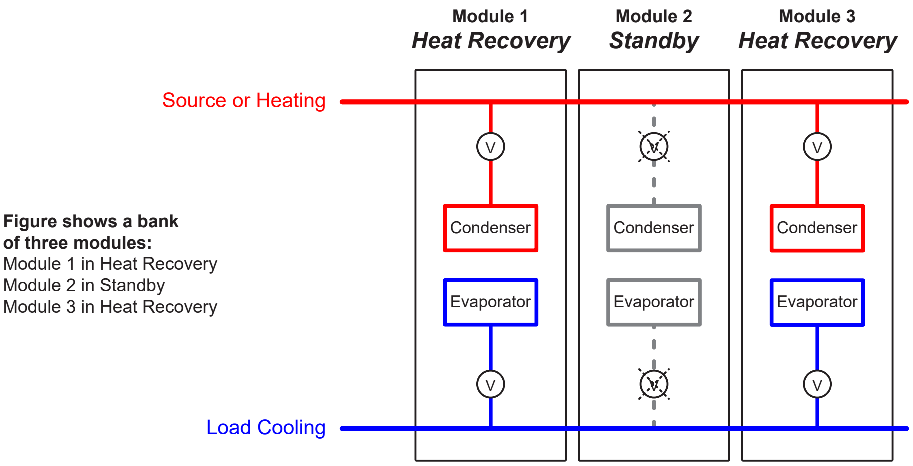
HEAT RECOVERY (UWH)

The UWH (4-Pipe Heat Recovery) modules simultaneously provide hot and chilled water (see Figure 6). The chilled and hot water setpoints are both used to determine the stages of compressors required. The first setpoint met will stage the system down or off as needed, sacrificing the opposite mode's setpoint.

The UWH is typically used for building efficiency upgrades dedicated to the constant base cooling & heating loads. Each refrigerant circuit includes an electronic expansion valve and an accumulator. Four (4) headers shall be provided – supply/return for the chilled water loop and supply/return for the hot water loop. Motorized isolation valves shall be provided with ¾-inch flush port connections – four (4) motorized proportional valves shall be provided, one on each header.

The whole bank is in heat recovery.

Figure 6: UWH, Heat Recovery



* Simplified single line water circuit shown; V = motorized isolation and control valve

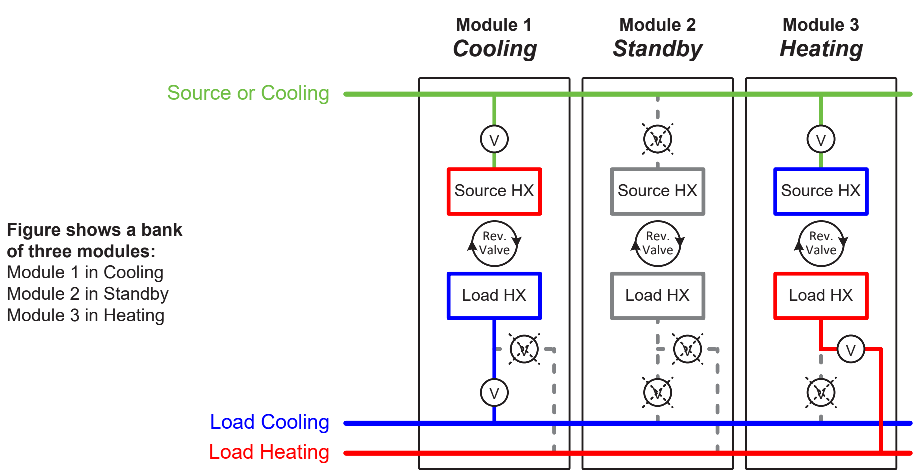
WATER-SOURCE MODULAR CHILLERS

SHC HEAT PUMPS (UWU)

The UWU (6-Pipe/SHC Heat Pump) modules have internal valves (see Figure 7). Each module has two modes of operation: heating or cooling. This is accomplished by using reversing valves to reverse the flow within the module refrigeration circuits. Both refrigerant circuits within each module must operate in the same heating or cooling mode. Each module may operate in either mode, heating or cooling, regardless of the position in the bank, provided header bypass kits are installed at the 3 chiller headers. In cooling mode, the chilled water is routed to the chilled water loop and the condenser water is routed to the source water header loop. In heating mode, the chilled water is rejected to the source water loop, and the hot water is routed to the hot water loop. An added benefit is the heat that is rejected to the source water loop from modules operating in cooling mode can be reclaimed by modules operating in heating mode, taking advantage of the refrigeration process.

Each refrigerant circuit includes a reversing valve, an electronic expansion valve, and an accumulator. The six-header module design enables the modular chiller bank to supply the required chilled and/or hot water and/or utilize the source water as a sink. Internal proportional motorized valves are provided for cooling, heating, and source, allowing for variable pumping and internal head pressure control.

Figure 7: UWU, SHC Heat Pump



* Simplified single line water circuit shown; V = motorized isolation and control valve

Heat pumps shall operate as a simultaneous heating and cooling bank utilizing six headers in each module. The bank control panel shall enable the bank to produce chilled and hot water. The six-header module design allows the operation of any module to provide hot or chilled water, equalizing run hours on all modules contained in the bank. Any module in the bank may be selected for cooling or heating operation at any time. In heating operation, the module's motorized valves to and from the hot water load header will open, and the motorized valves to and from the chilled water header will close. In cooling operation, the module's motorized valves to and from the chilled water load header will open, and the motorized valves to and from the hot water header will close.

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WATER-SOURCE MODULAR CHILLERS

UWU (6-Pipe/SHC Heat Pump) cont'd.

Figures 8 and 9 identify the modes of operation as they pertain to the water loop that the Load Heat Exchanger serves. The Load Heat Exchanger of each individual module in the bank can serve only one of the two load loops at a time. Having multiple modules in a chiller bank allows the two simultaneous modes of operation, heat mode and cool mode. It is important to note that the fluid pump location must be defined as a Push Through application at the chiller. This helps to keep all the loops at similar pressures at the chiller location.

Figure 8: Cooling Mode, SHC Simultaneous Heating and Cooling Heat Pump

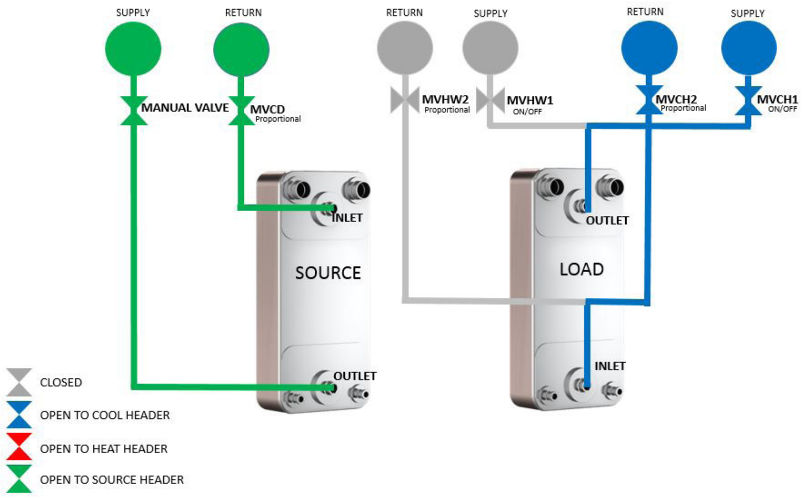
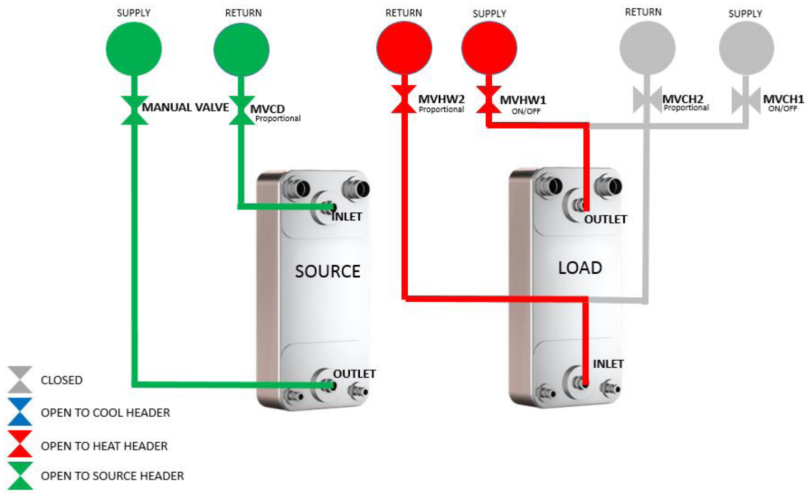


Figure 9: Heating Mode, SHC Simultaneous Heating and Cooling Heat Pump



ClimaCool recommends Push Through for the loop pumps. Failure to design the system in this manner will result in over-pressurization of the lowest pressure loop and a loss of pressure in the highest pressure loop.

WATER-SOURCE MODULAR CHILLERS

SHC HEAT RECOVERY (UWW)

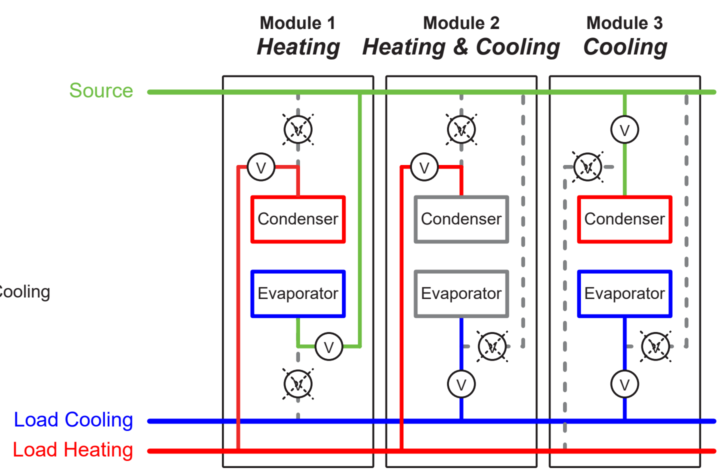
The UWW (6-Pipe/SHC Heat Recovery) modules operate as a bank of modules with three modes available: Heating Only, Cooling Only and Heat Recovery. These modes are accomplished by using motorized valves between the heat exchangers and the appropriate headers (see Figure 10).

In the Heating Only operation, the water that circulates through the condenser heat exchanger is routed to the heating water loop. At the same time, the chilled water from the evaporator heat exchanger is routed to the source loop and is used for no purpose other than to absorb heat for the refrigeration process.

In the Cooling Only operation, the water that circulates through the condenser heat exchanger is routed to the source loop. This source loop water is sent to a geothermal well field or a cooling tower for the heat to be rejected and not utilized in any process. The chilled water from the evaporator heat exchanger will be directed to the chilled water loop to meet the building's cooling demand.

Figure 10: UWW, SHC Heat Recovery

Figure shows a bank of three modules:
Module 1 in Heating
Module 2 in Heating & Cooling
Module 3 in Cooling



* Simplified single line water circuit shown; V = motorized isolation and control valve

In the Heat Recovery operation, the water that circulates through the condenser heat exchanger is routed to the building's hot water loop to be utilized for heating purposes instead of simply rejected and unused. Additionally, in the Heat Recovery Mode, the chilled water from the evaporator heat exchanger will be directed to the building's chilled water loop.

Like the standard heat recovery module, the first setpoint met will stage the system down or off, regardless of the opposite mode's setpoint. Each module in a chiller bank can be automatically or manually indexed into any of the available modes.

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WATER-SOURCE MODULAR CHILLERS

UWW (6-Pipe/SHC Heat Recovery) cont'd.

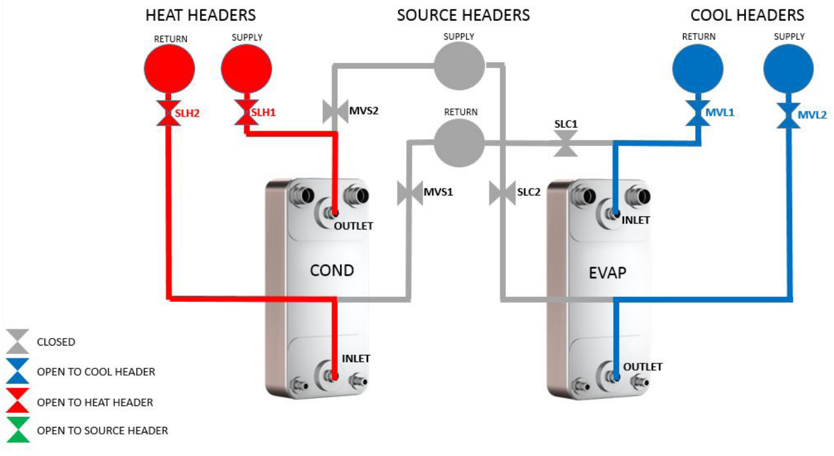
Figures 11, 12, and 13 identify the modes of operation that pertain to the water loop each heat exchanger serves. Each heat exchanger can serve up to two separate loops to provide the various modes of operation. Because there are two heat exchangers and three water loops, each heat exchanger can serve up to two water loops. This means water will be mixing from one loop to the next over time.

This loop mix does not occur while a module is in operation. The chiller module will shut down the compressors, close the currently used valve pair, and then open the new one. The closed valve pair traps the fluid (and pressure) inside the heat exchanger and will be transferred to the new water loop the heat exchanger will serve.

When designing the piping system, it is important to confirm that all three loops will have the same fluid type, i.e., glycol type and percentage, and similar fluid pressure at the chiller location within the piping system.

ClimaCool recommends push-through pumping for all three loops. Failure to design the system this way will result in over-pressuring the lowest pressure loop and losing pressure in the highest pressure loop.

Figure 11: Heat Recovery Mode, SHC Heat Recovery 6-Header Chiller Module



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WATER-SOURCE MODULAR CHILLERS

UWW (6-Pipe/SHC Heat Recovery) cont'd.

Figure 12: Cooling Mode, SHC Heat Recovery 6-Header Chiller Module

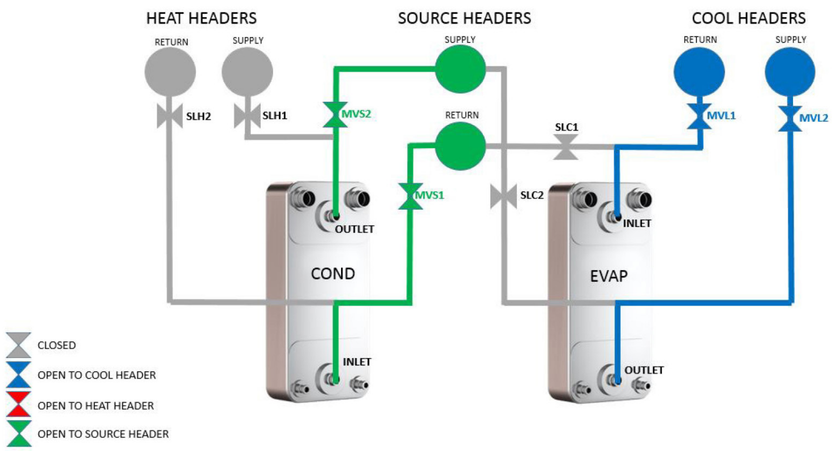
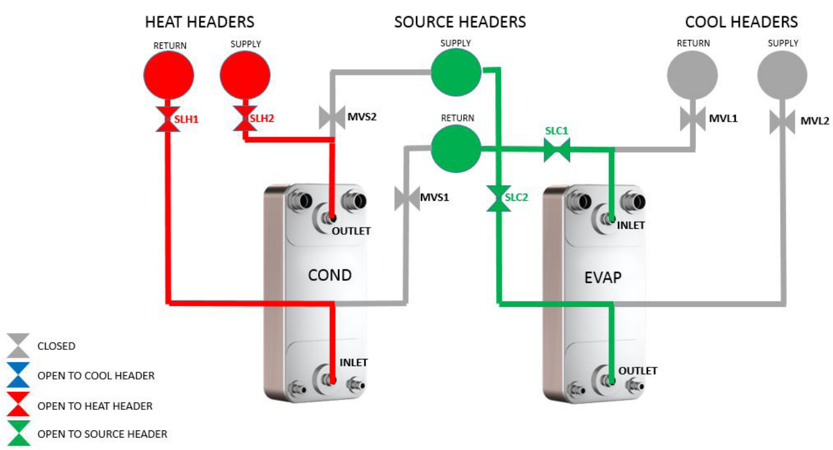


Figure 13: Heating Mode, SHC Heat Recovery 6-Header Chiller Module



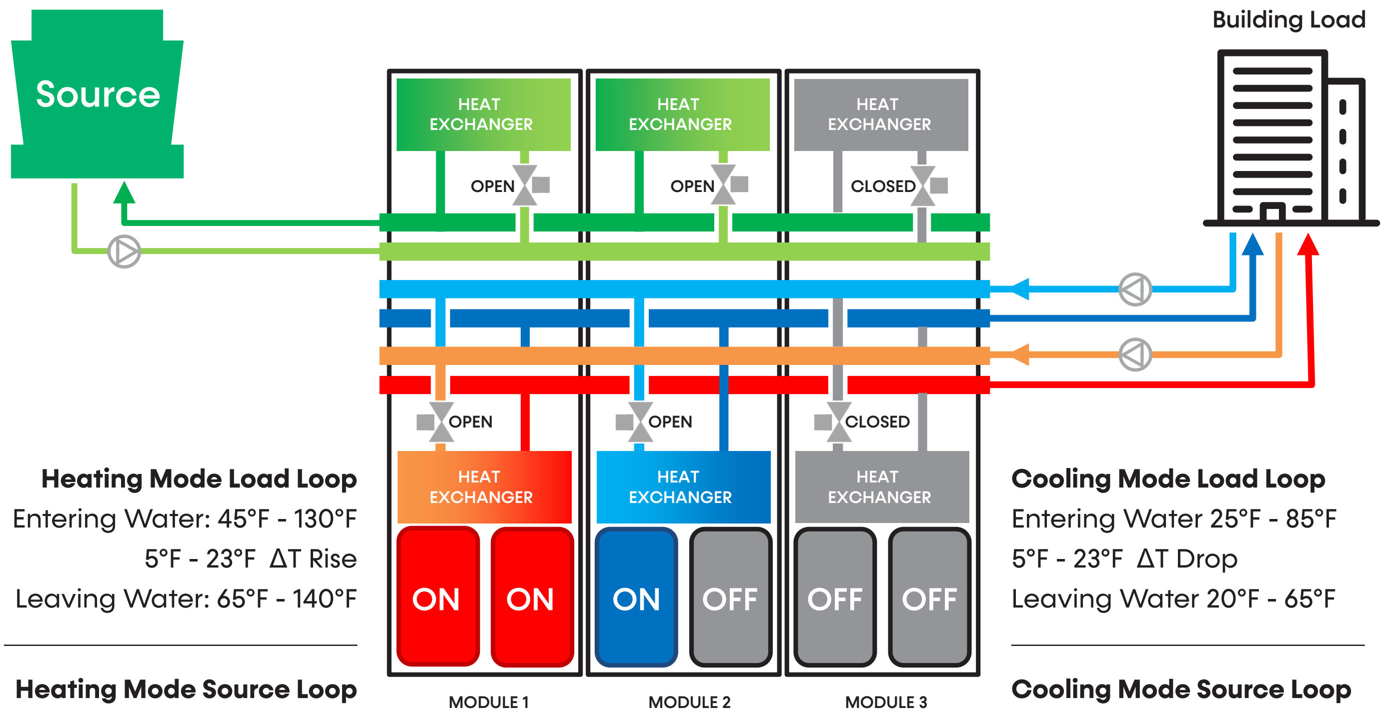
SIMULTANEOUS HEATING AND COOLING (SHC)

SIMULTANEOUS HEATING AND COOLING (SHC) SYSTEM

1. Pump Differential Pressure (DP) settings must be the same for multiple modes of operation (Heat, Cool, Heat-Recovery) for the Hot, Cold and Source water loops.

2. Pump for Hot, Cold, and Source water loops must remain active at all times of operation, regardless of module mode.

3. In Mixed Mode operation, Source water must be within both Heat and Cool mode temperature parameters.



Heating Mode Load Loop
Entering Water: 45°F - 130°F
5°F - 23°F ΔT Rise
Leaving Water: 65°F - 140°F

Heating Mode Source Loop
Entering Water: 25°F - 93°F
5°F - 23°F ΔT Drop
Leaving Water: 20°F - 70°F

Cooling Mode Load Loop
Entering Water 25°F - 85°F
5°F - 23°F ΔT Drop
Leaving Water 20°F - 65°F

Cooling Mode Source Loop
Entering Water: 45°F - 130°F
5°F - 30°F ΔT Rise
Leaving Water: 65°F - 140°F

- For SHC-HR units, Source, Heat and Cool Water loops will mix.
- For SHC-HP units, Source loop will be isolated. Heat and Cool Water loops will mix.
- For more information on operating temperatures, see ClimaCool Selection Software or Installation Manual.

SIMULTANEOUS HEATING AND COOLING (SHC)

SIMULTANEOUS HEATING AND COOLING (SHC) HEAT PUMP

Figure 14: Example of Simultaneous Heating and Cooling (SHC) Module Mode Staging

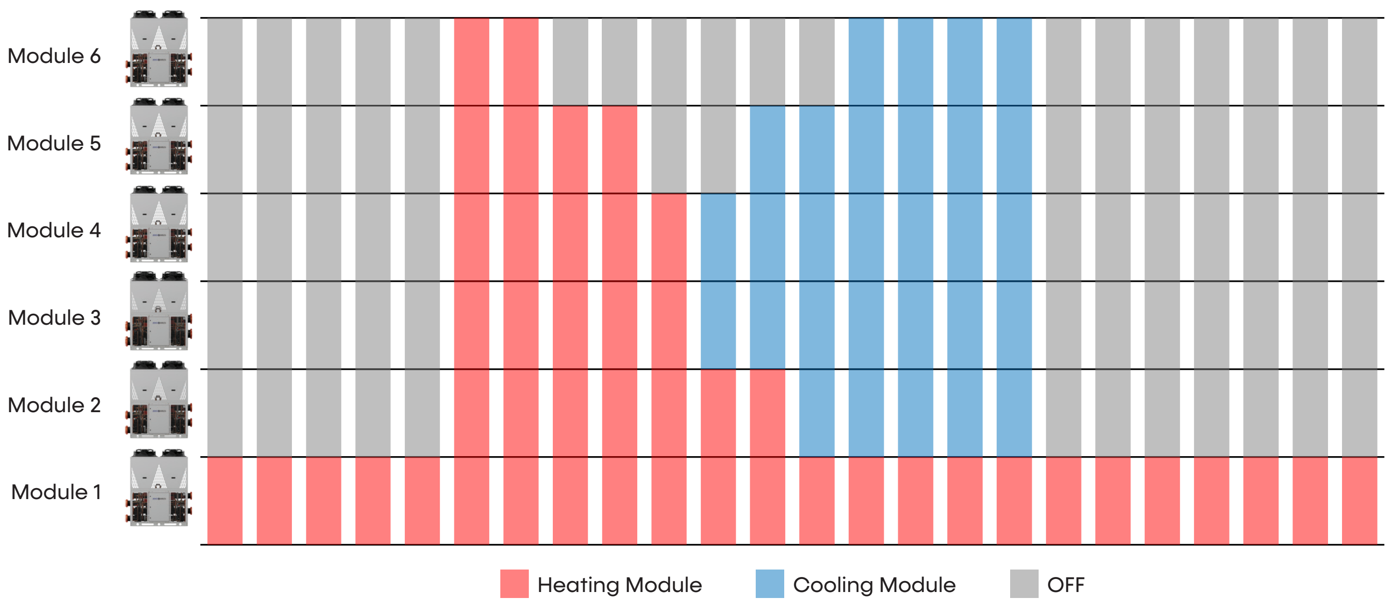


Figure 14 shows a 6-module SHC heat pump bank operating throughout the day. Module 1 stays in heating to meet the base heating need throughout the day. Modules 2-6 stage on/off and switch modes as the demand changes. During peak demand, all 6 modules are in use.

SIMULTANEOUS HEATING AND COOLING (SHC)

SIMULTANEOUS HEATING AND COOLING (SHC) HEAT RECOVERY

Figure 15: Example of Simultaneous Heating and Cooling (SHC) Module Mode Staging

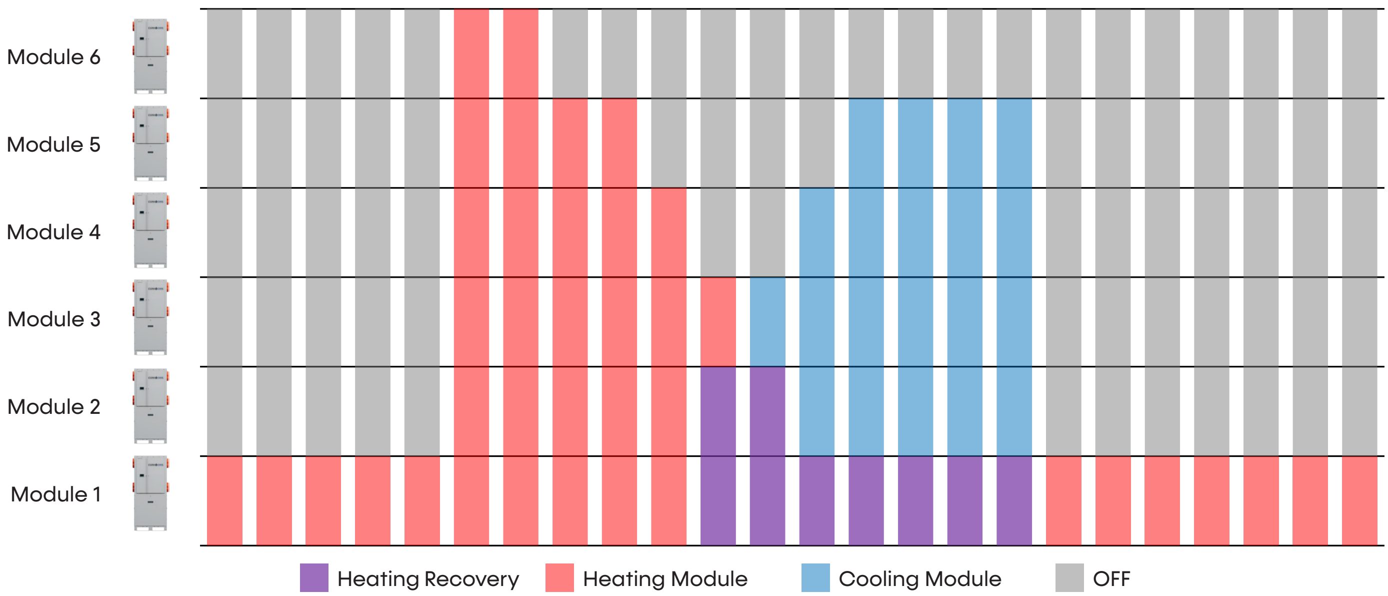
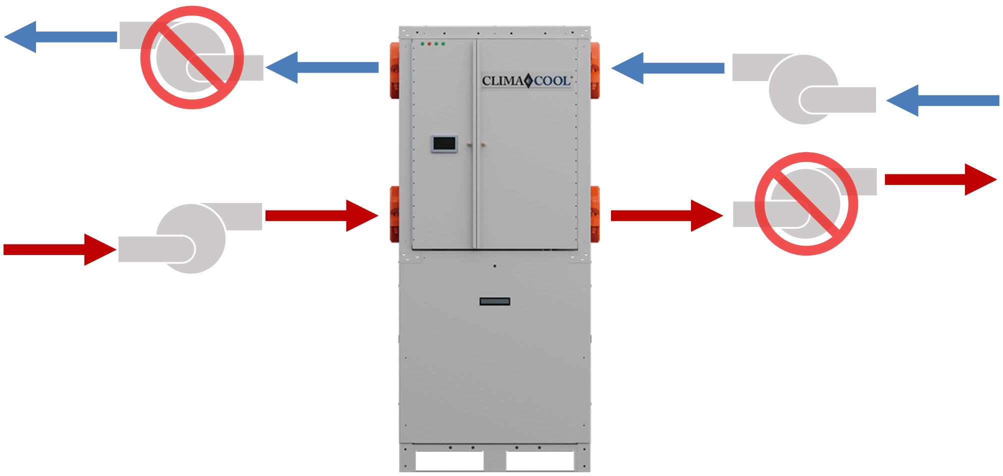


Figure 15 shows a 6-module SHC Heat Recovery bank operating throughout the day. The bank will stage up to all 6 modules during heating-only operating. As the cooling demand grows, modules switch from heating to heat recovery. As the day progresses, the cooling demand grows and the heating demand decreases. Module 1 operates in heat recovery mode at this time. At peak cooling demand, 5 of the 6 modules are in use.

PUMP LOCATION

- Pumps must be a push-through design for best chiller control and loop pressurization.



SIMULTANEOUS HEATING AND COOLING (SHC)

SIMULTANEOUS HEATING AND COOLING (SHC) SYSTEM

A Possible Strategy for Source Water Inlet Temperature Control:

- Cooling Mode Operation requires Minimum Source Entering Water Temperature of 35°F+.
- Hot Water Operation has a Maximum Source Entering Water Temperature of 85°F.
  - Minimum Source Leaving Water Temperature Temp low trip point is 40°F.
- Source Water Setpoint Reset would likely be based on Chiller Mode:
  - Heating Mode Only = 45°F Source Entering Water Temperature
  - Mixed Heat/Cool Mode = 65°F Source Entering Water Temperature
  - Cooling Mode Only = 85°F Source Entering Water Temperature

SIMULTANEOUS HEAT RECOVERY VS. HEAT PUMP

Heat Recovery System

- Typically used in laboratory, healthcare, and process applications.
- There are base simultaneous heating and cooling loads or thermal storage.
- Independent module modes of operation: Heat Recovery, Heat or Cool.
- Source, Heating or Cooling loops mix over time during mode change.

Heat Pump System

- Typically used in K-12, office, and comfort cooling and heating applications.
- There is no or low simultaneous heating and cooling load.
- Independent module modes of operation: Heat or Cool.
- Source loop is isolated and does not mix with Heating or Cooling loop. Some mixing of Heating and Cooling loops occur during mode change.

UW(C/H/T/U/W)S - HEAT REJECTION INTO MECHANICAL ROOM	
Model Size	**Heat Rejection into Mechanical Room**
UW(C/H/T/U/W)S30	850BTUH
UW(C/H/T/U/W)S50	1350BTUH
UW(C/H/T/U/W)S70	1650BTUH
UW(C/H/T/U/W)S80	1850BTUH

- See ClimaCool Selection Software or Installation Manual for more information on operating temperatures.
- For SHC-HR units, Source, Heat and Cool water loops will mix.
- For SHC-HP units, Source, loop will be isolated. Heat and Cool water loops will mix.

MODULAR CHILLER SYSTEMS DESIGN

For Variable Flow Chilled Water, Hot Water and Simultaneous Heating & Cooling Systems

MODULAR CHILLER SIZING

When selecting module chiller sizes, incremental capacity steps should be considered to match with building load profile.

Example: If the total load is equal to 210 tons, the module sizes can be selected in one of the following ways:

- Three 70-ton modules for a total of 6 capacity steps.
- Seven 30-ton modules for a total of 14 capacity steps.

If seven 30-ton modules take up too much space, another consideration would be to utilize the three 70-ton modules and outfit each module with a variable frequency drive (VFD) on the lead compressors.

This module can be set up as a Trim Chiller that will be first on and last off. Larger tonnage modules (50, 60, 70, and 80 tons) are best applied with VFDs when smaller capacity steps are required. The minimum speed for a compressor with VFD is 45 Hz (or 75% capacity). VFDs can also be applied to smaller tonnage modules (20 and 30 tons) that require be selected to apply the VFD to function as a trim chiller that will be first on and last off.

To attain incremental capacity steps between compressors using VFDs, it is unnecessary to outfit all modules with VFD-driven compressors unless equalized runtime is a concern. Contact factory for recommendations on the best application of variable capacity compressors for a specific project.

WATER SYSTEM DESIGN

All ClimaCool Modular Chillers will have two independent R-454B refrigeration circuits in each individual module. Both of these refrigeration circuits will be served by common water flow.

In a typical water-cooled application with nominal water flows of 2.4 gpm/ton through the evaporator BPHX and 3.0 gpm/ton through the condenser BPHX, the delta temperature entering and leaving both BPHX's will be 10°F with both compressors running and 5°F with one compressor running. The operation limitations found in the respective product's Installation, Operation & Maintenance Manual (IOM) will list the minimum and maximum delta temperatures along with the minimum and maximum flow rates, which will correspond to approximately a minimum ΔT of 5°F and a maximum ΔT of 23°F for the evaporator and a minimum ΔT of 5°F and a maximum ΔT of 30°F for the condenser.

In addition to water flow rate in gallon per minute as detailed above, there is also a minimum requirement of total number of system gallons in each water loop for adequate thermal mass to prevent short cycling. This requirement is six gallons of fluid per ton of refrigeration. For example, a bank of three 50-ton modules will require a minimum loop volume in each water loop of 3 x 50 x 6 = 900 gallons of total system fluid.

Modular Chillers use brazed-plate heat exchangers. To ensure their longevity, 40-mesh minimum first pass water strainers must be installed and maintained on each water loop.

Water treatment should be appropriate for brazed-plate heat exchangers. Please see equipment IOM for water parameter details. Each chiller bank has a safety sensor to avoid freezing heat exchangers. This differential pressure sensor is field installed between the supply and return water pipe. This sensor is not to be used for pump control. The Building Automation Systems (BAS) should use a separate means of measuring flow to control system pumping.

MODULAR CHILLER SYSTEMS DESIGN

MINIMUM WATER LOOP VOLUME

- A minimum of 6 gallons per nominal system ton is required to maintain proper system thermal intertia
  - Requirement applies to cooling, heating and source water loops.
    Example: For 150-ton bank : (150 tons * 6 gallons/ton) = 900 gallons per water loop.
  - For some applications, even more water volume may be recommended.
- This is to avoid short cycling of compressors in the chiller/heater system, as well as prevent nuisance alarms.
- Increased water volume can reduce effects of defrost cycles on heating loop water temperature.
- If this volume is not provided by system piping, a buffer tank should be added.

PROPER WATER FLOW

Systems require proper water flow. Consequences of low water flow include:

- Low suction pressure or high head pressure
- Nuisance low flow alarms
- Complete chiller shutdown
- Damaged heat exchangers

Possible causes of low water flow include:

- Poor water treatment
- Dirty strainers
- Undersized pumps
- Pump VFD not programmed correctly
- Recommended pump VFD load/unload speed: 60Hz to 30Hz over three minutes
- Lack of chiller header bypass and/or load side bypass valves

Recommended pump start-up and shutdown timing:

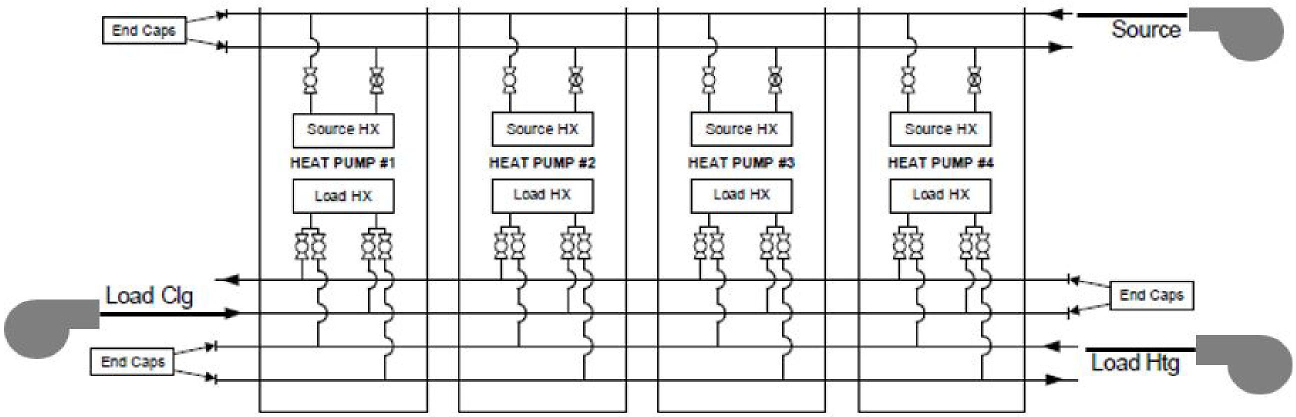
- On start-up, start pump 2-3 minutes before starting chiller
- On shutdown, maintain pump flow for an additional 2-3 minutes

MODULAR CHILLER SYSTEMS DESIGN

SHC BANK AND PUMP LAYOUT

A Push Through water pump arrangement is recommended. Pump arrangement must be the same for all water loops. Both the cooling and heating water loops should have the same relative loop pressures during mode change as they share a common heat exchanger. Equalization circuits between heating and cooling loops may be needed.

Figure 16: Cooling Mode, Simultaneous Heating (SHC) and Cooling Heat Pump



CHILLER HEADER BYPASS VALVES

The Header Bypass Valves are 2-position and are only open when all the module's water valves are closed to that respective loop.

Their two purposes are to prevent pump "dead-heading" when module water valves are closed and to provide a single module's worth of water flow across the water temperature sensors for load monitoring.

The operation of each header bypass pertains only to the loop on which it is installed. Taken on a loop by loop basis, the CoolLogic Touch Control System monitors all the motorized valve end switches within each of the modules that connect to that loop for that mode of operation.

Example: The Load Cooling Loop has motorized valves connected to the load heat exchangers.

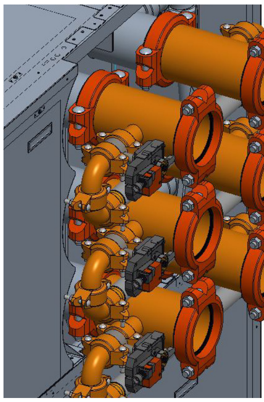
When no module has motorized valves open to the Load Cooling Loop, all those motorized end switches will be electrically 'open', showing a closed status in the BACview® interface. The CoolLogic Touch Control System recognizes this and signals the header bypass valve to open. Once the first module is indexed to cooling mode and both motorized valves mechanically open (end switches electrically 'close'); the header bypass valve is signaled to mechanically close.

Modules can also be assigned as a fixed Smart Bypass for load and source flow, however, this limits the number of modules remaining for that duty. Smart Bypass is only available for standard equipment. SHC banks must use an external bypass.

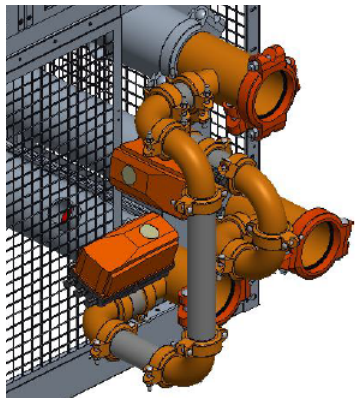
MODULAR CHILLER SYSTEMS DESIGN

CHILLER HEADER BYPASS VALVE KITS

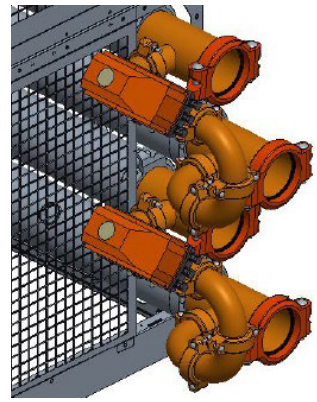
Factory supplied, and field installed chiller header bypass valve kits



Water-Source

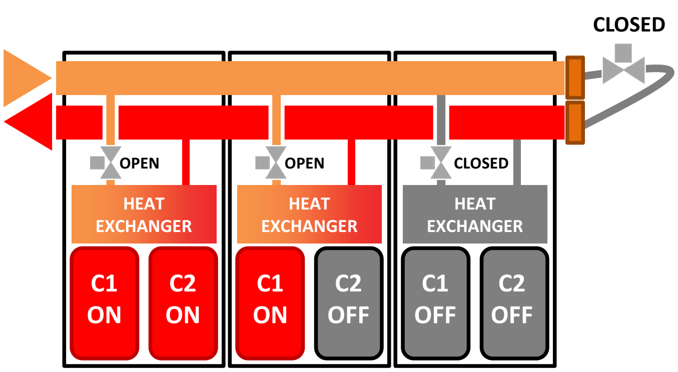


Air-Source - 50/60T

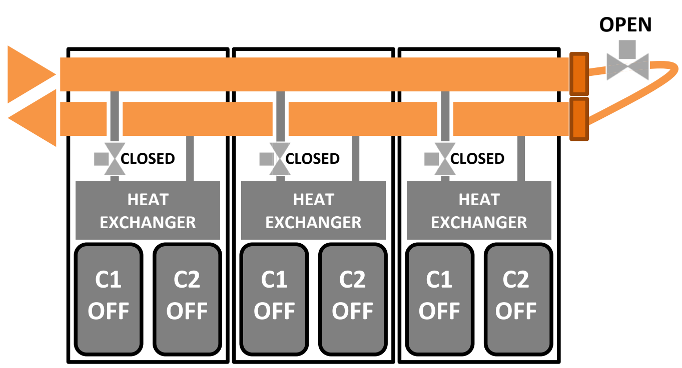


Air-Source - 20/30T

- Prevents pump deadheading when no internal module valves are open.
- Allows chiller leaving water temperature sensor to monitor loop water temperature passing the chiller.
- Reduces wear on module heat exchangers when they are not operating.
- Valve is controlled by chiller module CoolLogic controller.
- Valve is always open when modules are not in operation.
- Valve is adjusted at commissioning to match pressure drop of one module.



Bank with modules ON and header bypass CLOSED



Bank with all modules OFF and header bypass OPEN

MODULAR CHILLER SYSTEMS DESIGN

HEADER BYPASS KIT - SAME END DIRECT RETURN

- Important for Temperature Sensors and Differential Pressure Sensors (flow indication) to be 36 - 60 inches from end of chiller bank for proper mixing of water, especially for leaving water temperature sensor.
- Always position Temperature Sensors and Differential Pressure Sensors to be upstream of Header Bypass.

HEADER BYPASS KIT - OPPOSITE END DIRECT RETURN

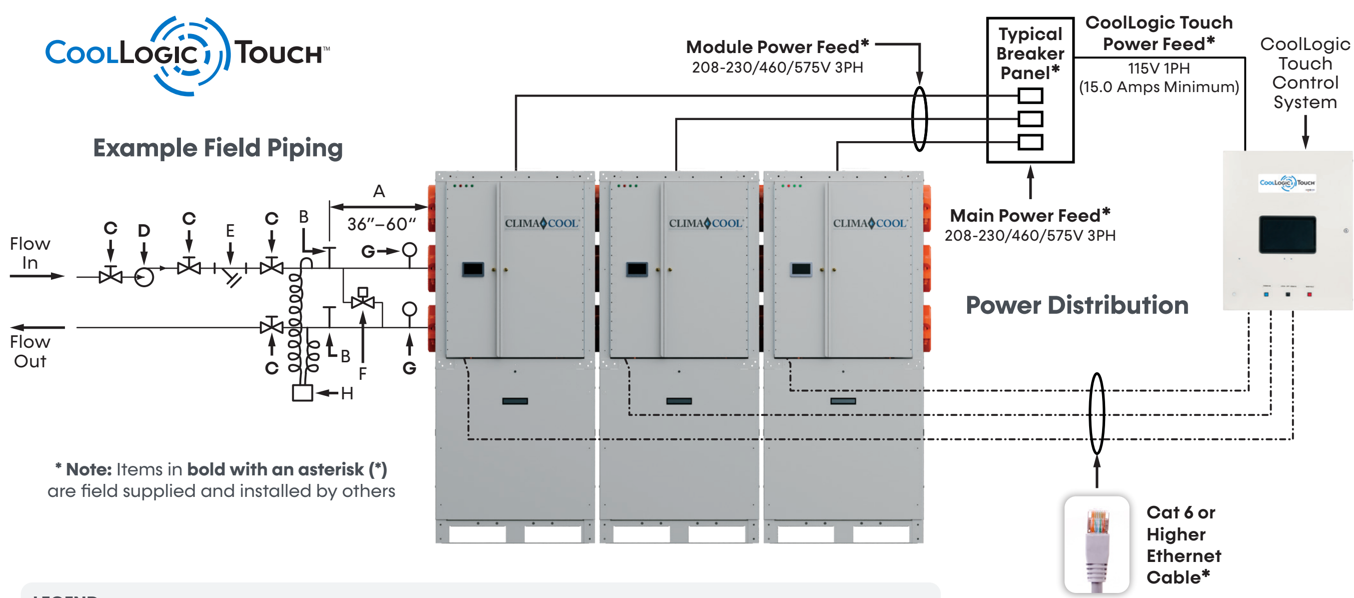
- Important for Temperature Sensors and Differential Pressure Sensors (flow indication) to be 36 - 60 inches from end of chiller bank for proper mixing of water, especially for leaving water temperature sensor.
- Always position Temperature Sensors and Differential Pressure Sensors to be upstream of Header Bypass.

MODULAR CHILLER SYSTEMS DESIGN

BANK FIELD PIPING AND WIRING OVERVIEW

ClimaCool Supplied, Shipped Loose, and Field Installed by Others:

- CoolLogic Touch Control System Panel (1 per bank)
- Pressure Differential (DP) Flow Proving Sensors, wired to CoolLogic Touch Control System Panel (1 per water loop) (Not for pump control)
- Temperature Sensors, wired to CoolLogic Touch Control System (1 set per water loop)
- Bank Header Bypass Valve Kit, wired to CoolLogic Touch Control System (1 per water loop)
- 40-Mesh Strainer (1 per water loop minimum)
- End Header Caps & Grooved Coupling (1 set per water loop)



LEGEND

A. Sensor Location (Field Installed)
B. Temp Sensor Well(s)
C. Isolation Valve(s)*
D. Pump*
E. Strainer(s)
F. Header Bypass Valve
G. Pressure Taps with Shut-Off Valves & Gauges (Optional)*
H. Pressure Differential Flow Sensor

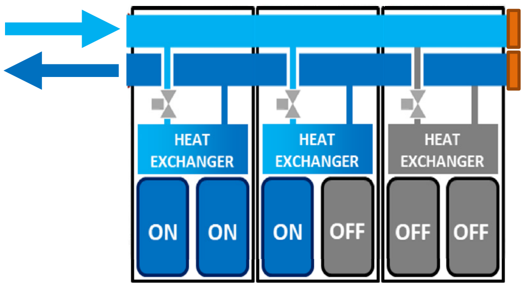
Notes:

1. Locate DP sensor between the strainer and the entering side of the chiller as well as before the first water take off on the leaving side of the chiller.
2. Breaker panel represents field power supply and is to be installed by others. Power disconnects/fusing not included as part of Climacool Modular Chiller System.
3. All water piping and power & control wiring by others.
4. Field communication connections require parallel runs from the module to the bank controller.
5. Water Pumps, isolation/shut-off valves, gauges and pressure taps, and any field piping insulation by others.

MODULAR CHILLER SYSTEMS DESIGN

INLET AND OUTLET PIPING CONNECTIONS

- Either end of the module bank can be used as an inlet or outlet pipe connection.



End Header Caps

MODULAR CHILLER SYSTEMS DESIGN

FREEZE PROTECTION - BANK LEVEL

The CoolLogic Touch Control System has temperature sensor inputs in each entering and leaving loop connected to the bank of modules. They are also used for high or low entering and leaving temperature safeties. The CoolLogic Touch Control System also has differential pressure transducer (DPT) inputs for each water loop. The sole purpose of the DPT is for low water flow protection for each loop, and can also be used by the technician or operator to monitor the chiller header differential pressures viewable at the BACview interface.

FREEZE PROTECTION – MODULE LEVEL

Each chiller module has independent freeze protection in the form of a leaving water temperature sensor at the heat exchanger, refrigerant low-side pressure transducer and refrigerant suction temperature. Each of these trips points are defaulted at values for use with straight water. The default leaving water temperature trip point at the module heat exchanger is 40°F, and the ambient trip point for all air-source units is 36°F.

GLYCOL USAGE

If glycol is used in a specific loop and these settings require adjustment, care must be taken to first confirm the type and percentage of glycol used in the loop.

ClimaCool recommends the module freeze temperature setting be adjusted no less than 8°F above the actual freeze point of the solution. The coincidental refrigerant low pressure and temperature trip points will also require adjustment in accordance with this value using a 5°F to 6°F approach temperature. For example, 30% propylene glycol has been confirmed to be present in a chilled water loop. The freeze point of this solution is 9°F. So the module leaving water freeze point should be set to 17°F, (9°F + 8°F = 17°F).

Using the approach of 5°F the refrigerant temperature at this leaving water temperature is 12°F. Using a pressure temperature chart, the coincidental refrigerant pressure is approximately 65 psig. The low suction temperature trip point should also be adjusted to the minimum superheat above the adjusted saturated suction temperature. In the example above, the saturated temperature was 12°F + 6°F minimum superheat is an 18°F low suction temperature trip point. These numerous safeties provide added layers of protection from freeze failures. Even with layers of protective alarms, repeated resetting of alarms without correcting the root cause can eventually result in equipment failure.

AIR-SOURCE INSTALLATION CONSIDERATIONS

Air-Source chillers require adequate airflow and airflow clearances to operate correctly. Minimum airflow clearances should always be met and never shared between multiple banks. To minimize air recirculation, multiple banks should be staggered instead of parallel, with the middle banks spread further than the minimum 84” required. If banks need to be installed near solid walls, a 6’ minimum clearance should be met, and the wall should not be taller than the top of the units. ClimaCool Air-Source Modular Chillers are designed to be installed outdoors without any ductwork.

AIR-SOURCE DEFROST CONSIDERATIONS

In most regions, outdoor packaged heat pump chillers experience frost build-up on the coils at some point, requiring a defrost mode. When in defrost mode, the unit produces chilled water in lieu of the required load hot water. Therefore, the equipment experiences a de-rate in heating performance. For a single unit, this de-rate is about 26%. This de-rate can be minimized or eliminated by adding redundant units to the bank. The number of redundant units depends on the building’s heating load and specific weather conditions.

MODULAR CHILLER SYSTEMS DESIGN

COOLLOGIC TOUCH CONTROL SYSTEM

The CoolLogic Touch Control System includes an enclosure, control transformer, surge protection, convenience outlet, three-position selector switch, power and fault indication, microprocessor controller, and BACnet BAS interface. It is provided with all multiple unit banks to stage on or off units and compressors to match the required load in the building. It is shipped loose as a separate panel and field installed and wired to each unit in the bank.

MODULE AND COMPRESSOR ROTATION

ClimaCool employs two methods of rotation operation: rotation of the lead module and rotation of the lead compressor within a module. Rotation of the lead module method is done every week. Each module's lead compressor run hours are polled weekly to determine which compressor has the lowest run hours. That module is selected to operate first in line, followed by the next module with the second lowest lead compressor run hours. The lead-lag rotation of the lead compressor within a module is done monthly. The lead compressor switches to the opposite compressor on the first of every month. As the module stages up, it will follow the method of starting the lead compressor in a module with the lowest run hours. As the module stages down, it will stage off the compressor with the highest run hours first, then the other compressor. The purpose is for compressor runtime equalization.

REMOTE SETPOINT ADJUST

The chiller bank systems can be configured to accept a hardwired 2-10 VDC or 4-20 mA signal that can proportionally change the water temperature setpoints based on any criteria determined by others providing the signal. When there are also associated Building Automation System (BAS) points, the voltage or current valves can be written to those points to accomplish the same result. The remote temperature reset menu must be configured using the CoolLogic Touch HMI before it becomes available. Configure the option from "NONE" to "REMOTE (COOL OR HEAT) TARGET," set the minimum and maximum temperature range, and configure the signal type to be used.

DEMAND LIMIT

Demand limiting is used to set a bank's maximum capacity. The module controller limits the number of modules that will run so that the limit is not exceeded.

For example, a four-module bank's demand limiting is set to 80% capacity between 2:00 p.m. and 8:00 p.m., when electrical rates surge. The bank will run a maximum of three modules (for a 75% capacity limit) during these hours.

TRIM CHILLER

Another advantage of the Cooling Only non-SHC Modular Chiller is to mix and match the tonnage sizes and apply a concept called Trim Chilling or Trim Heating. A module of a smaller size than the others in a bank can be designated as a Trim Module so that it is always the first on, last off. During light loads, this is an advantage to use a smaller tonnage compressor circuit which will promote longer run times and minimize short cycling. This concept should also be applied for modules with VFD controlled compressors. All SHC banks require a minimum of two equally sized units for maximum flexibility.

MODULAR CHILLER SYSTEMS DESIGN

AUTO STAND ALONE (ASA)

Auto Stand Alone allows the chiller to operate in the event that the CoolLogic Touch has lost communication. ASA switches the chiller into manual mode, automatically keeping the chiller online until a replacement CoolLogic Touch can be provided. Each module will continue to run (or not run) in its last known mode.

For example, a bank of four SHC heat pumps is running one module in heating, two modules in cooling, and one module in standby when communication with the CoolLogic Touch is lost. ASA will engage one module in heating, two in cooling, and one in standby, regardless of load changes

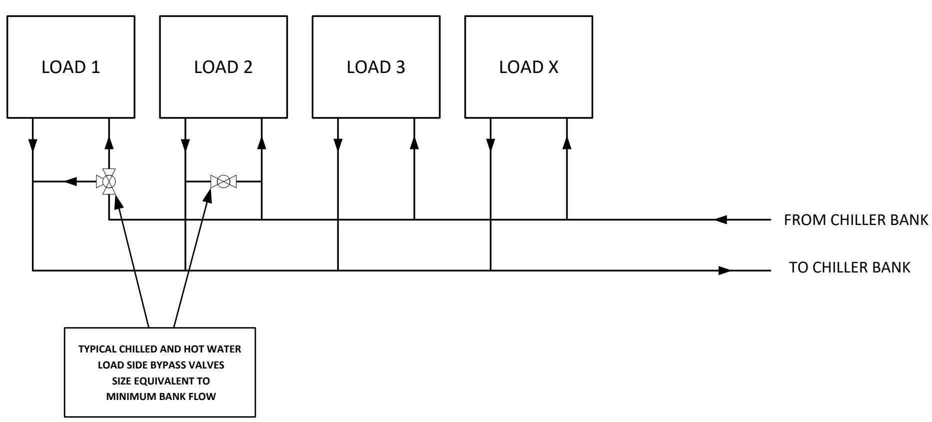
CONSTANT VOLUME CONSIDERATIONS

Constant volume is available in cooling mode only for all applications. All valves will be 100% open and will not modulate to account for changes in flow.

VARIABLE FLOW LOAD SIDE BYPASS

A System Side (load side) Bypass Valve is required for the chilled, heat, and source loops with variable pumping and all load side 2-way valves. These bypasses are best sized to accommodate the minimum chiller flow at maximum chiller load of the entire chiller bank. There can be short durations when the building load diminishes quickly, closing 2-way valves, causing the variable speed pump to ramp down before the chiller senses the load change and has an opportunity to stage down. Without a system side bypass to monitor the chiller header DP and modulate open as the chiller header DP begins to fall below the submitted value, nuisance loss of flow and low temperature/pressure alarms can occur. It is important to install 3-way valves or bypass valves at the load side of the system to keep flow above the minimum rate when these loads satisfy. Use of bypass valves at the far end of the system will also promote keeping the overall active loop volume high. The load side bypass valves are generally open when the load control valve is closed and could also operate in reverse proportion to the control valve. This is critical for maintaining proper flow at the load side of the system (see Figure 17).

Figure 17: Typical Load Bypass Valve Arrangement



MODULAR CHILLER SYSTEMS DESIGN

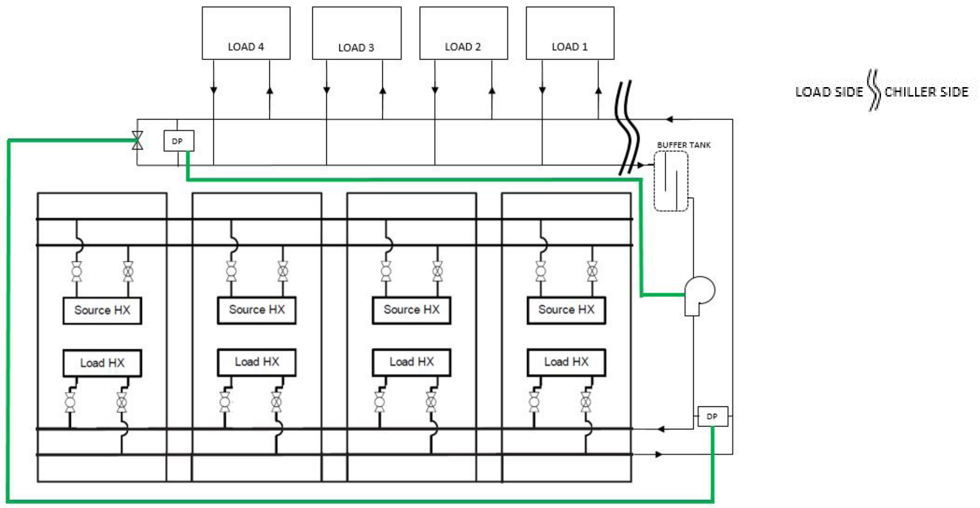
STAGED VARIABLE PRIMARY PUMP SYSTEMS (PUMP CONTROL)

When using motorized valves on the chiller modules, the chiller bank requires a staged flow control scheme as the flow requirement changes based on the number of modules in operation. This can be accomplished by utilizing variable frequency drives to control pump speed and maintain the target differential pressure across the headers connected to the chiller bank. This target ΔP will be the same regardless of the number of modules in operation. If the pump speed is controlled to a ΔP at the load side of the system, as the load side valves begin to satisfy and modulate closed, the pumps respond by delivering a lesser flow to the chiller bank. When the chiller bank senses this drop in flow, the modules may have not yet staged down and could still be open in a temperature pull down situation. Loss of flow alarms, low or high water temp alarms and even low or high refrigerant pressure alarms can result.

When the system pump is controlled by the load side flow requirement, this single bypass valve can be controlled to maintain the proper differential pressure across the chiller bank. This will help ensure adequate flow at the chiller headers even as the loads stage down (internal chiller control valves close).

As the building system DP falls, the pump speed increases supplying more fluid flow to the building. As the building system DP rises, the pump speed decreases providing less fluid flow to the building. Meanwhile, the building system bypass valve toward the end of the loop monitors field supplied and installed DP sensors at the chiller. As the chiller

Figure 18: Pump Control From Load Side (Representative of One Loop)



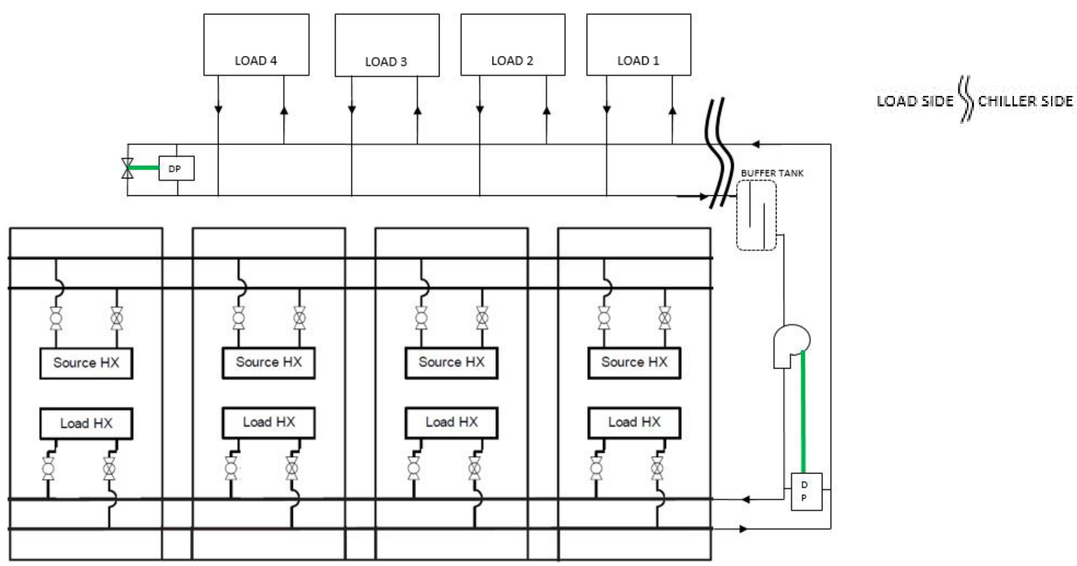
MODULAR CHILLER SYSTEMS DESIGN

DP falls (due to load side valves closing and the pump speed decreasing), this bypass valve will proportionally open maintaining the DP at the chiller. The act of the bypass valve opening proportionally, allows the pump speed to increase supporting the flow needs of the chiller (see Figure 18).

The pump speed will increase or decrease to maintain the submitted DP value across the chiller header. As chiller module internal valves open, the chiller header DP will fall. This will cause the pump speed to increase to maintain DP at the chiller header each time a new module opens its internal valves. Conversely, as the chiller modules satisfy and their internal valves close; the DP sensor will sense this increase in DP and the pump speed will decrease. Meanwhile, the building system DP set point will be maintained by the system bypass valve, proportionally opening when the system DP is high (when some load valves are closed) and proportionally closing when the System DP is low (as the load side valves are opening). When the load side valves are open (system bypass should be closed), this introduces additional load to the chiller, causing it to stage up to meet this increased load demand (see Figure 19).

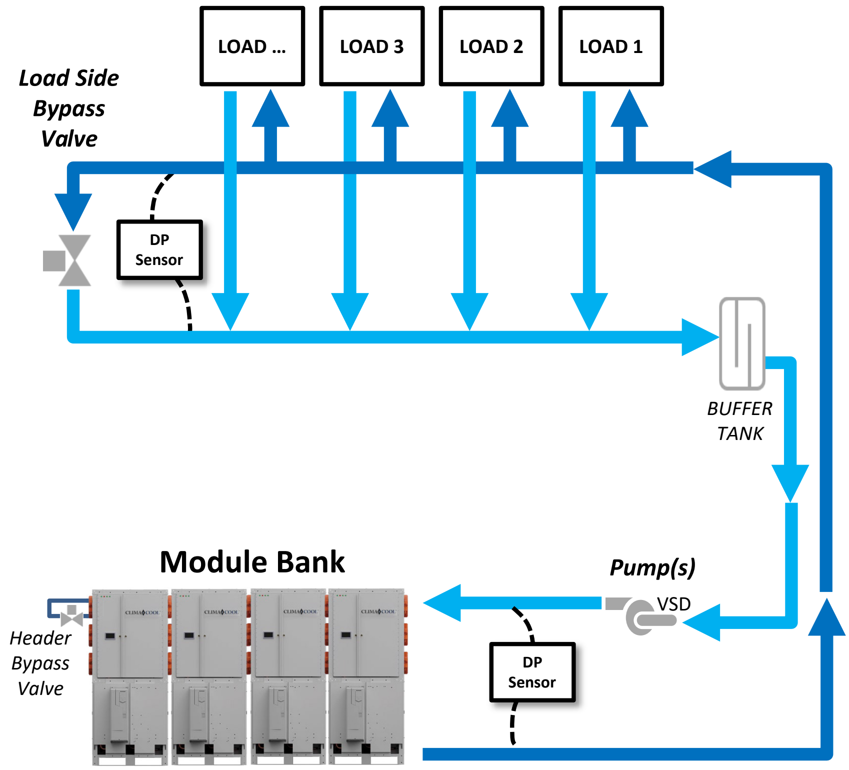
Whichever method used, the system water flows must be controlled to keep a constant chiller header differential pressure and the DP to each active loop above the minimum flow trip point at all times or the above nuisance alarms will occur. The response time of the method used is also critical to prevent nuisance alarms.

Figure 19: Pump Control From Chiller Header (Representative of One Loop)



VARIABLE PRIMARY FLOW CONTROL

- For banks with greater than two modules, motorized water valves and variable primary flow pumping are required as the flow requirement changes based on the number of modules in operation.
  - Pumps should be controlled by differential pressure set point.
  - Refer to ASHRAE 90.1 Section 6.5.4.2 for location of pump speed control DP sensor.
  - Use high quality differential pressure sensor and wired directly to valve actuator.
- A Load Side bypass valve is required to manage transient flows and allow chillers to respond to shifts in load.
  - For more stable control and to reduce chiller cycling locate the load side bypass valve further from the chiller.
  - The Load Side Bypass Valve should not be confused with the Header Bypass Valve.
  - Select bypass valve with linear flow characteristics. Ball, Globe, and Pressure Dependent valves are all suitable. Do not use a Butterfly valve.
  - Size load side bypass to maintain the minimum flow rate of the module bank as load coil flow decreases.
- Slow-acting valves on load coils (not shown) and staggering of load coil start-stop times give load side bypass valve and chiller time to respond.



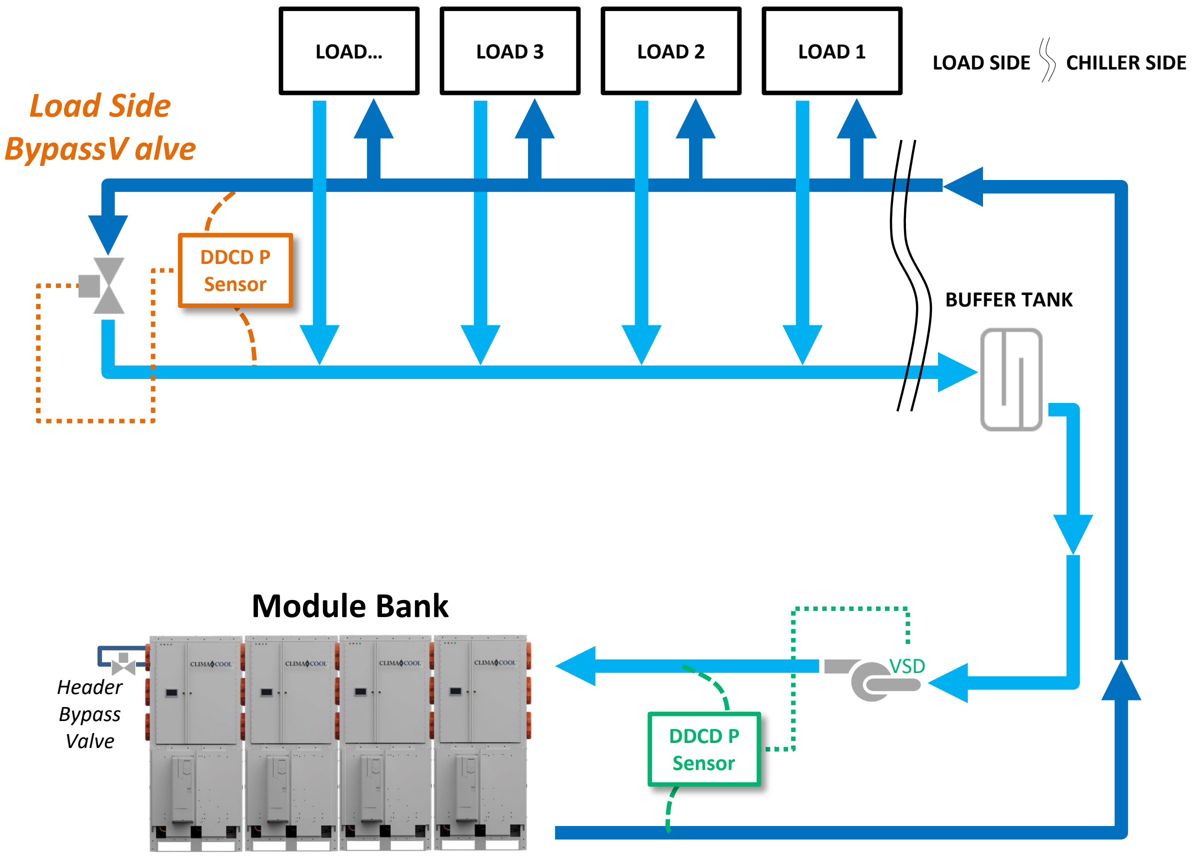
VARIABLE PRIMARY FLOW CONTROL

- When using motorized valves on the chiller modules, the chiller bank requires a variable flow arrangement as the flow requirement changes based on the number of modules in operation. This can be accomplished by utilizing variable frequency drives to control pump speed and maintain the target delta pressure at the headers connected to the chiller bank.
- This target **ΔP** will be the same regardless of the number of modules in operation. If the pump speed is controlled to a **ΔP** at the load side of the system, as the load side valves begin to satisfy and modulate closed, the pumps respond by delivering a lesser flow to the chiller bank. When the chiller bank sees this drop in flow, the modules may have not yet staged down and could still be "open" in a temperature pull-down situation, loss of flow alarms, low or high-water temp alarms and even low or high refrigerant pressure alarms can result.
- In addition, it is important to install 3-way or bypass valves at the load side of the system to keep flow above the minimum rate when these loads are satisfied. Using bypass valves at the far end of the system will also promote keeping the overall active loop volume high.
- The load-side bypass valves are generally open when the load control valve is closed and could also operate in reverse proportion to the control valve. This is critical for in maintaining proper flow at the load side of the system.
- If a single system side bypass valve is used, it should be sized to bypass the minimum water flow at the maximum chiller load. When the load-side flow requirement controls the system pump, this single bypass valve can be controlled to maintain the proper differential pressure across the chiller bank. This will help ensure adequate flow at the chiller headers even as the loads stage down (internal chiller control valves close).
- Whichever method used, the system water flows must be controlled to keep the flow to each active loop above the minimum flow trip point at all times, or the above nuisance alarms will occur. The response time of the method used is also critical to prevent nuisance alarms.

VARIABLE PRIMARY FLOW CONTROL

Variable Primary Pump Control from Chiller Header Differential Pressure (DP) set point

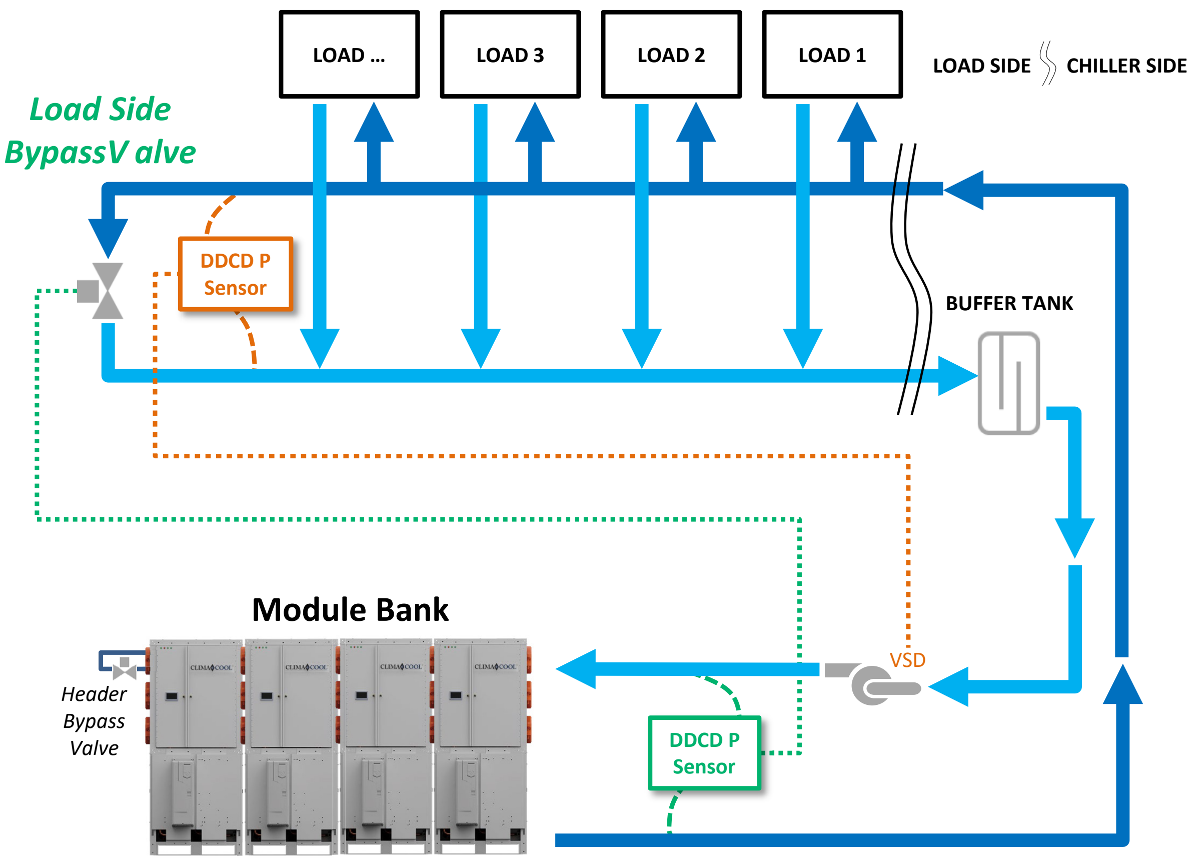
- As chiller modules start and open interval valves, Chiller Header DP falls and pump speed increases.
- As chiller modules satisfy and internal valves close, Chiller Header DP rises and Pump speed decreases.
- Building Load DP set point will be maintained by Load Side Bypass Valve. Proportionally opening when the building load side DP is high (as load valves close).
- Proportionally closing when the building load DP is low (as load side valves open).
- When the load side valves are open, bypass valve should be closed causing chiller to stage up to meet increased load demand.
- **This method is recommended for pump speed control as it monitors the bank directly.**



VARIABLE PRIMARY FLOW CONTROL

Variable Primary Pump Control from Load Side Differential Pressure (DP) Set Point.

- As the load sources open valves, the Building Load DP falls, Pump speed increases, supplying more flow to the building.
- As the load sources close valves, the Building Load DP rises, Pump speed decreases, providing less flow to the building.
- The Load Side Bypass Valve (near the end of the loop) monitors field supplied and installed Chiller Header DP Sensor.
- As the chiller DP falls (due to load side valves closing and the pump speed decreasing), this bypass valve will proportionally open to maintain the DP at the chiller.

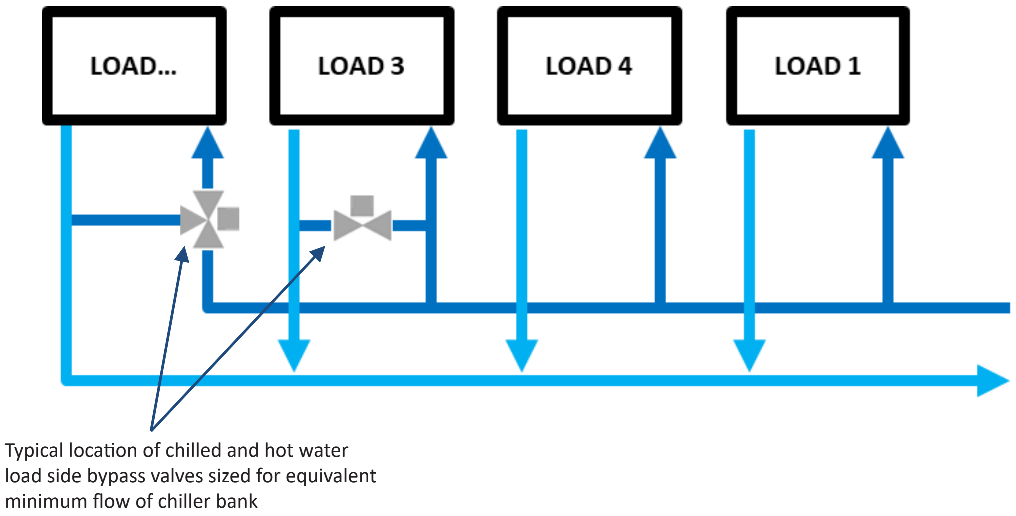


Note: If the chiller bank sees a drop in flow, the modules may not yet have staged down and could still be "open" in a temperature pull down situation. Loss of flow alarms, low or high water temp alarms and even low or high refrigerant pressure alarms can result.

VARIABLE PRIMARY FLOW - LOAD SIDE BYPASS VALVE

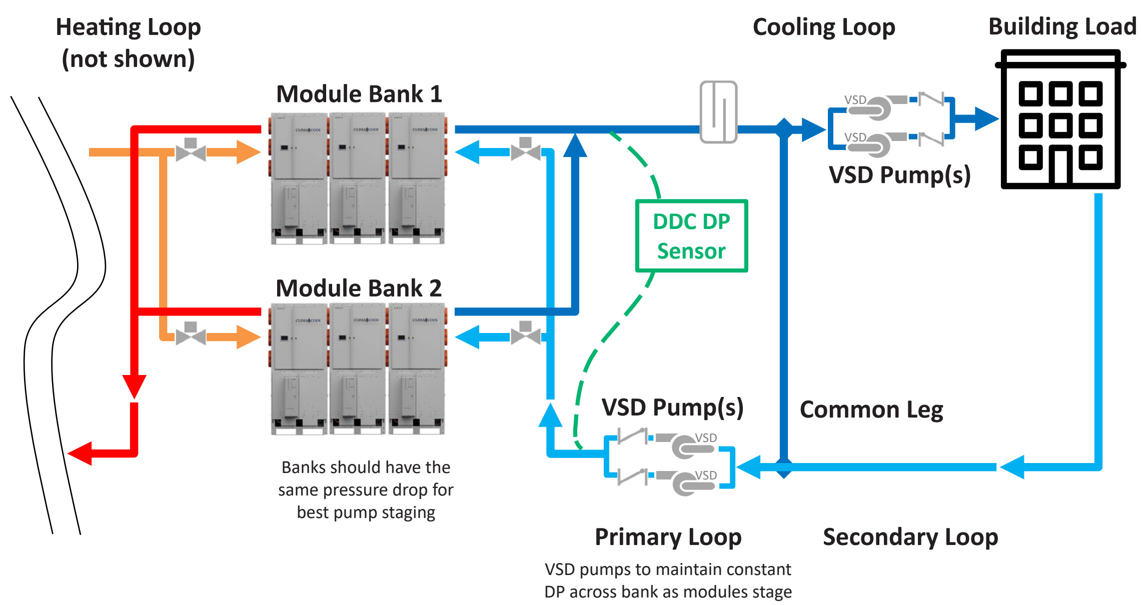
A System Side (Load Side) Bypass Valve is required for the chilled water, hot water, and source water loops with variable pumping and 2-way control valves on loads.

- Field piping with a 2-way valve to provide a bypass across the larger system loads when the load side valves close (2-way bypass valve should be ball, globe, or pressure-independent valve).
- Utilize several 3-way control valves on the largest loads, farthest from the chiller bank.
- Without a Load Side Bypass, nuisance loss-of-flow, low-temperature and low-pressure alarms can occur.

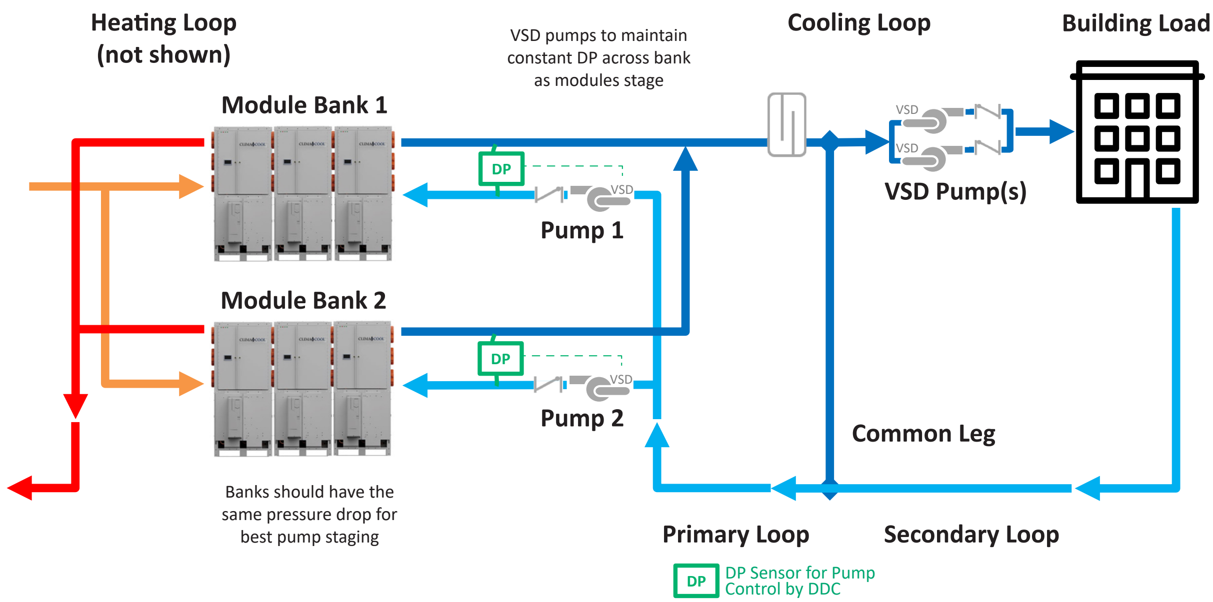


VARIABLE PRIMARY / VARIABLE SECONDARY FLOW

- Banks should have the same pressure drop for best pump staging

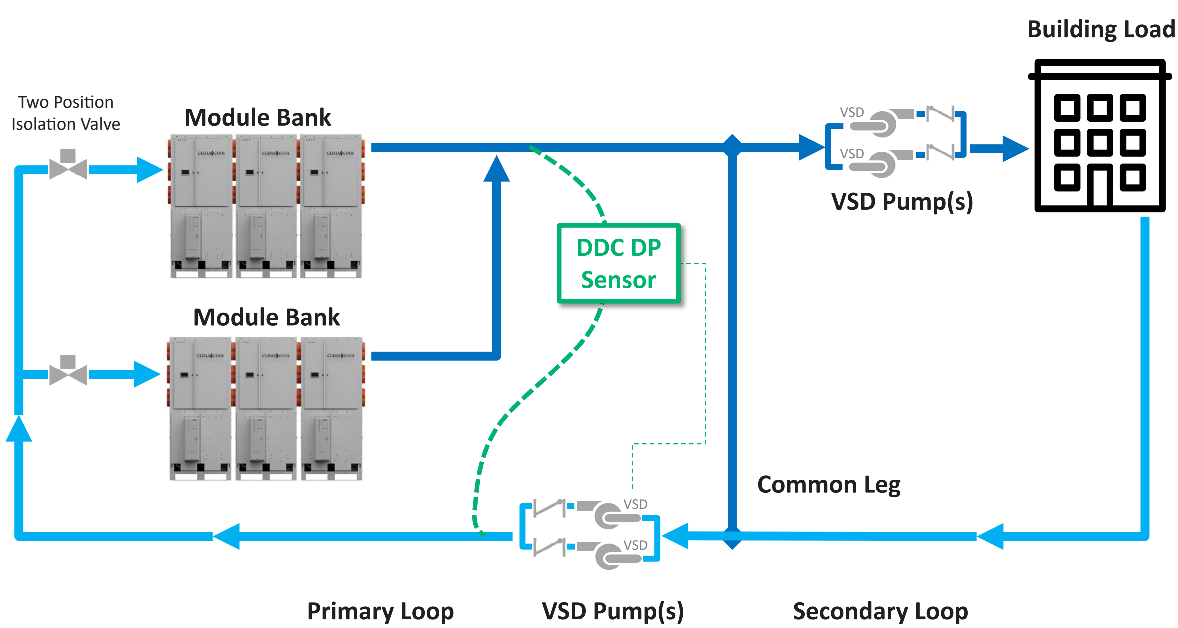


VARIABLE PRIMARY / VARIABLE SECONDARY FLOW

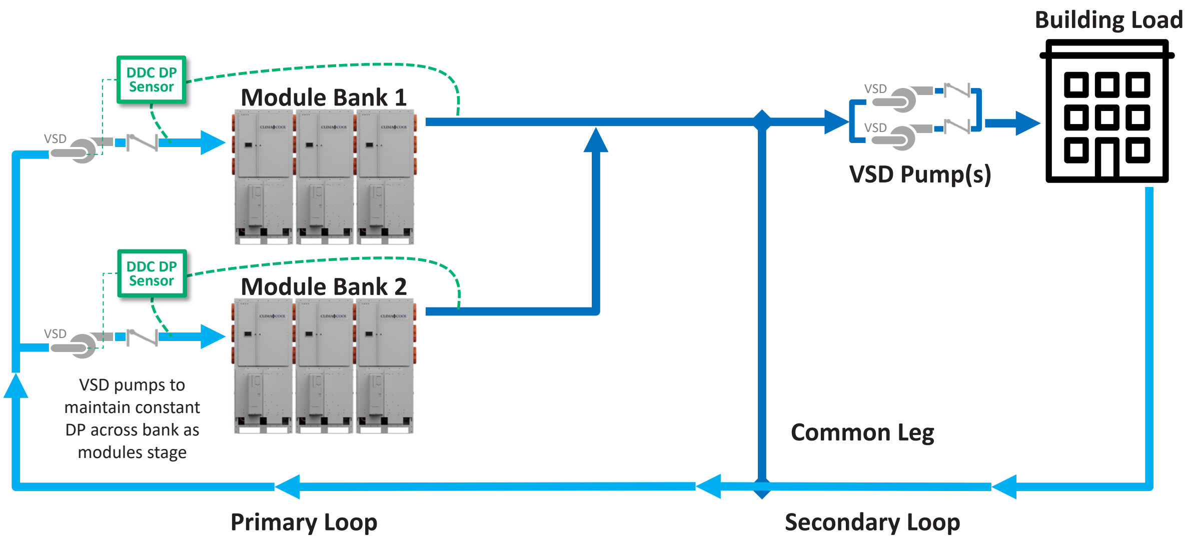


VARIABLE PRIMARY / VARIABLE SECONDARY FLOW

- Banks should have the same pressure drop for best pump staging

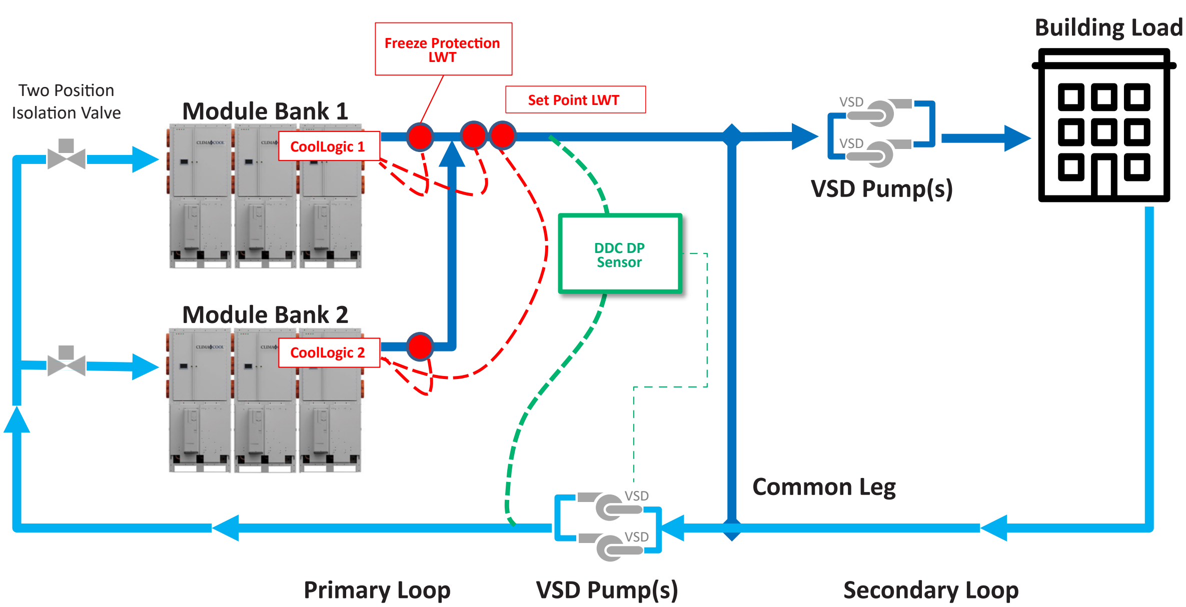


VARIABLE PRIMARY / VARIABLE SECONDARY FLOW



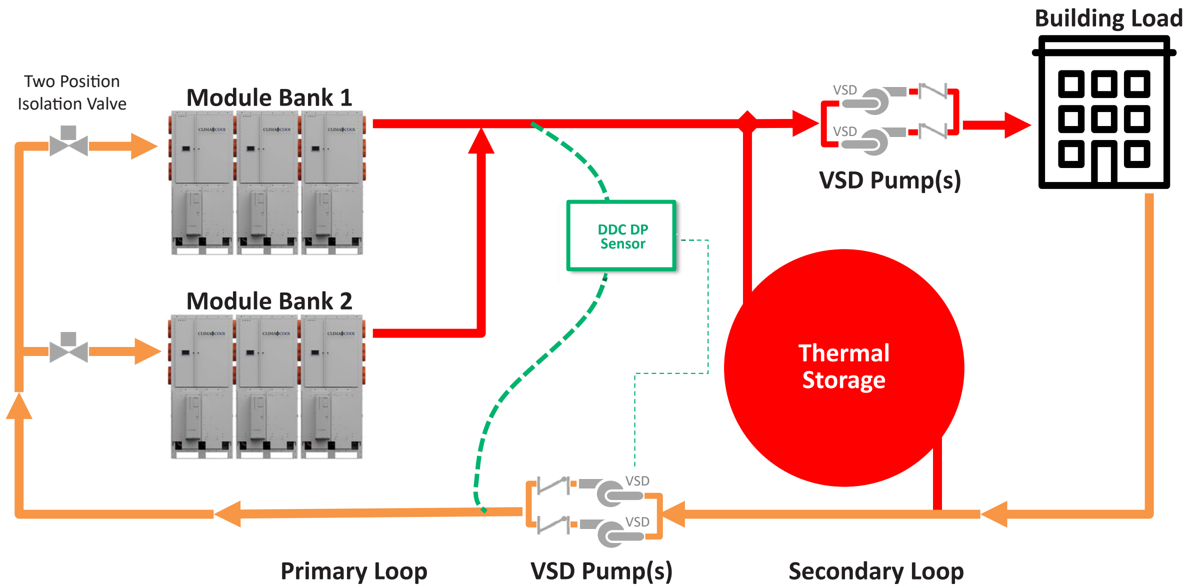
VARIABLE PRIMARY / VARIABLE SECONDARY FLOW

- Banks should have the same pressure drop for best pump staging



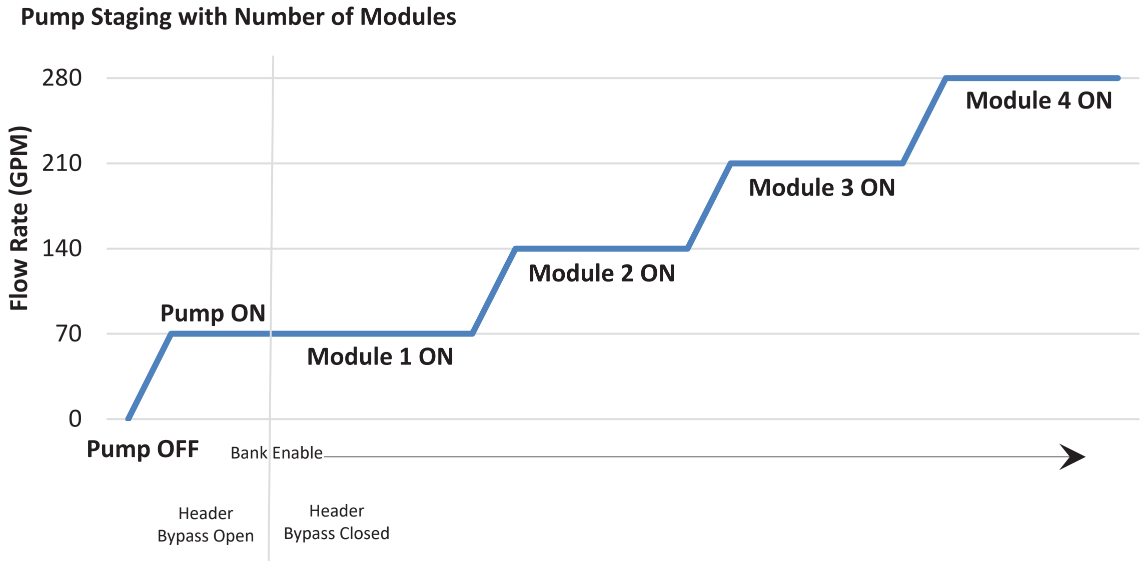
VARIABLE PRIMARY / VARIABLE SECONDARY FLOW WITH TES

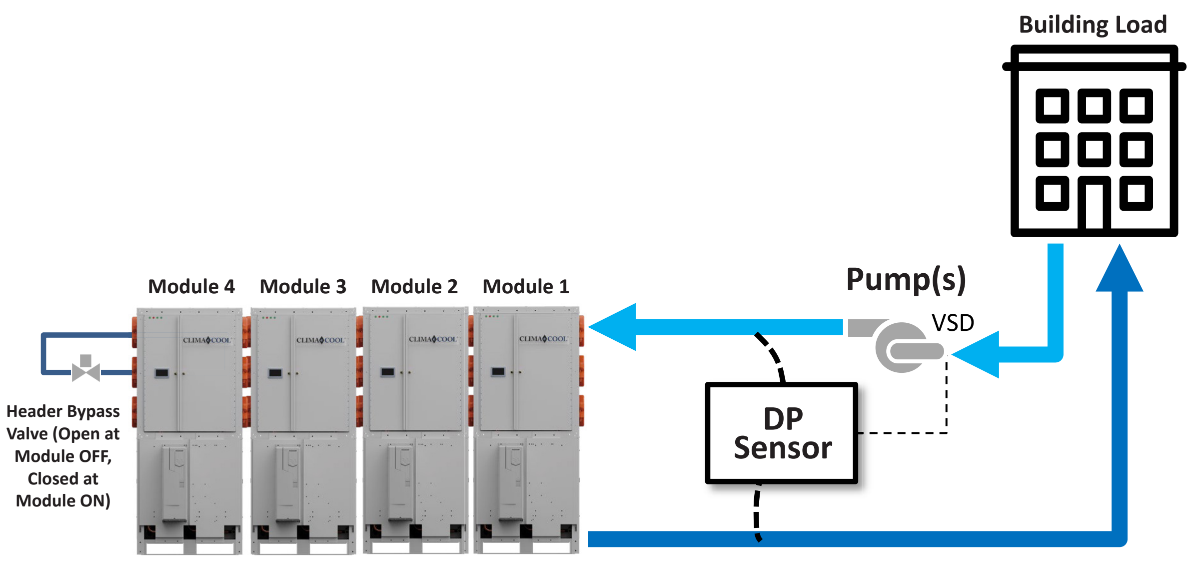
- Banks should have the same pressure drop for best pump staging



MODULAR CHILLERS REQUIRE STAGED PRIMARY FLOW

- Modules are piped in parallel with a common factory water piping header.
- As modules are turned ON or OFF with load, the primary flow will need to change.
- Pumps must be started by building controls system before enabling module bank.
- Water pumps will need VSD, and control water flow based on Differential Pressure (DP) to compensate for the number of modules operating (Differential Pressure Sensor Field supplied).





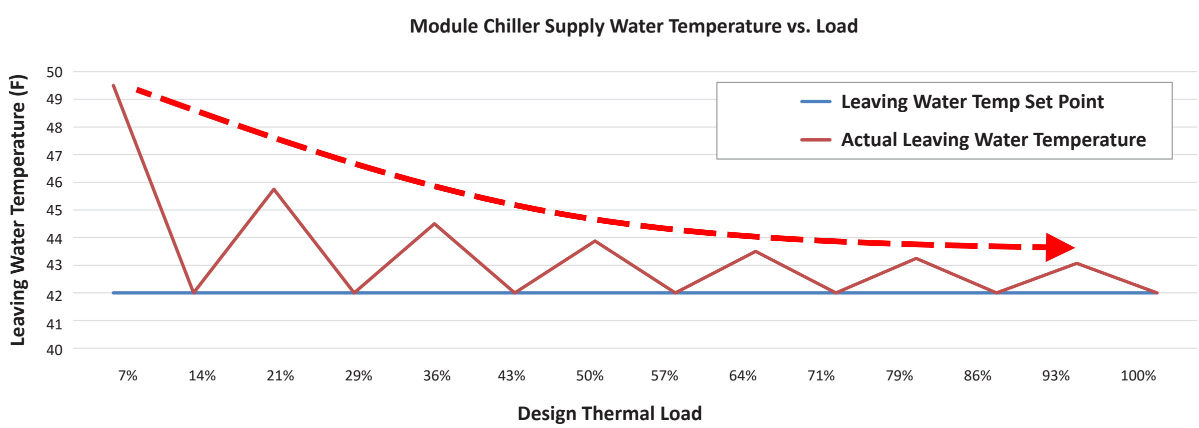
MULTIPLE CHILLER BANK APPLICATION

- Chiller Piping
  - Suggest common Return Water and Supply Water headers shared by all banks be piped in counterflow
  - To reduce bank down time during cleaning, it is recommended to have redundant strainers on return water piping (40 mesh minimum).
- Common or Decoupling Water Circuit
  - Sized for water minimum flow of a single bank
- Minimum Fluid Loop Volume
  - Minimum of 6 gallons/ton fluid loop volume for cooling, heating, and source water loop.
- Chiller Bank Control
  - BMS/DDC to monitor water loop temperatures and stage chiller banks ON and OFF (not by ClimaCool)
  - BMS/DDC to monitor chiller compressors' status in each bank (via BACnet) and stage additional banks based on the number of compressors running.
    - We suggest that the BMS enable the first bank and watch the status of compressors. Once the bank is 100% active, then enable the next bank.

UNDERSTANDING MODULAR CHILLER LWT TEMP CONTROL

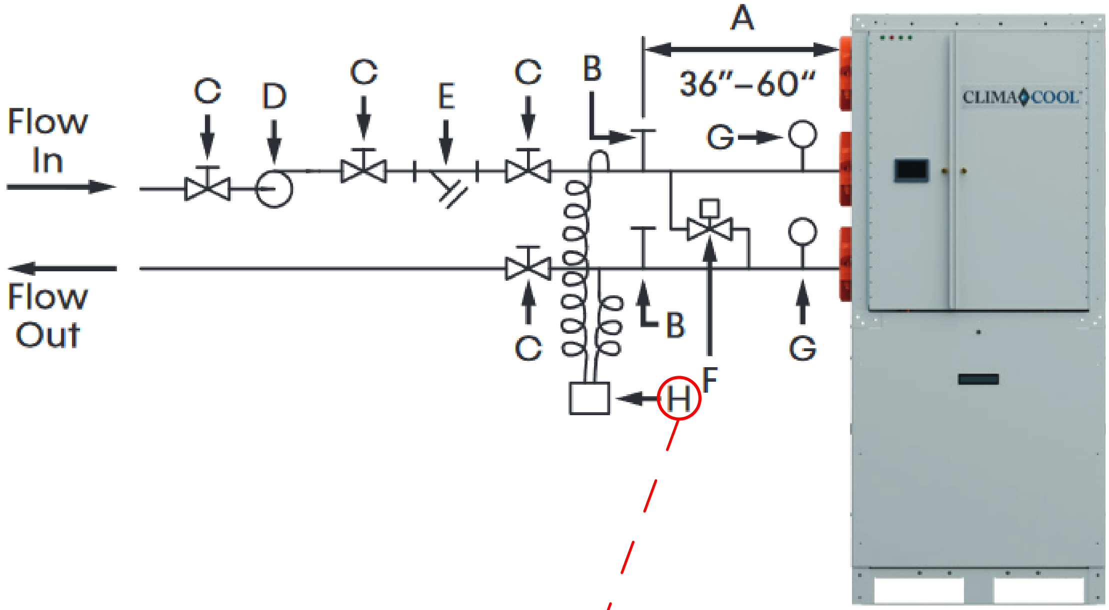
- At Design Load, Bank will operate at design flow rate and have very accurate leaving water temperature.
- At Low Load, Bank will operate under design flow rate and have less control of leaving water temperature.

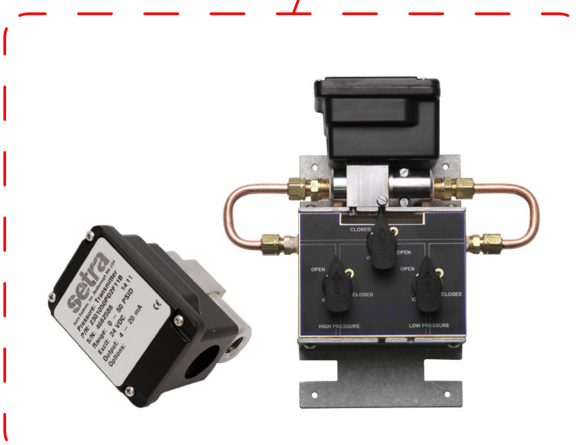
Example: 7 Module Bank with a 42°F Set Point and 15°F Design Temperature Drop and Constant Return Temp.



FACTORY PRESSURE DIFFERENTIAL FLOW SENSOR

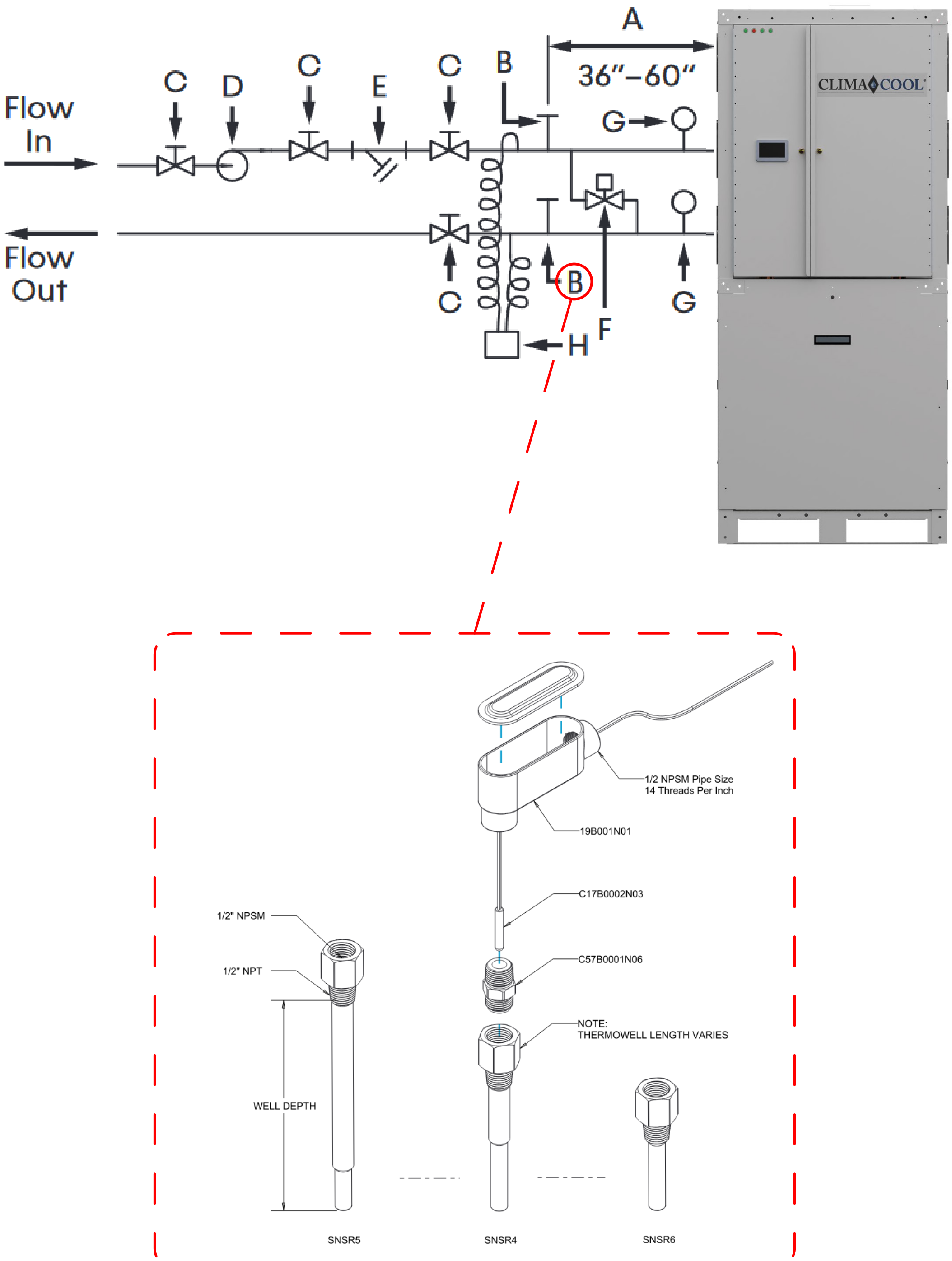
- Flow sensor for proof of water flow only
- Not to be used for water pump control





FACTORY WATER TEMPERATURE SENSORS

- 2 sensors measure return and supply water temperature
  - Install 36-60" from the bank

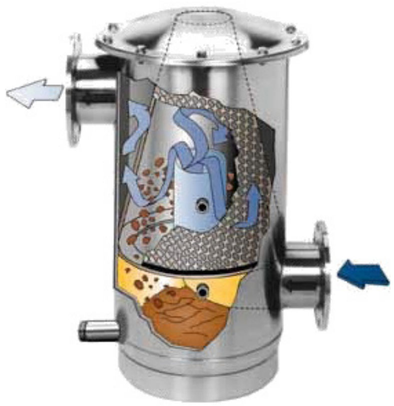


FACTORY WATER STRAINERS

- All water loops should be closed to environment and kept free of contaminants.
  - Use external, secondary heat exchangers for applications requiring open-loop, once-through, or potable water sources.

Water Quality Requirements	
Water Containing	**Concentration**
Ammonia	Less than 2.0 mg/l
$CaCO_3$ Alkalinity	30 - 500 mg/l
$CaCO_3$ Hardness	30 - 500 mg/l
Chlorides	Less than 200 mg/l
Dissolved Solids	Less than 1000 mg/l
Iron	Less than 5.0 mg/l
Manganese	Less than 0.4 mg/l
Nitrate	Less than 100 mg/l
pH	7.0 - 9.0
Sulphate	Less than 200 mg/l

- Mesh 40 Strainer required
  - **Y(Wye) Strainer** recommended for the cooling and heating water loop
  - **Basket Strainer** recommended for the source/condenser water loop
  - **Stainless Steel Strainer** with Auto-Flush recommended for older or dirty water loops



Note: Consider redundant strainers with isolation valves on loops to reduce bank downtime while cleaning

ACCESSORY POWER DISTRIBUTION PANEL

- Bank Power Distribution Panel (PDP) is available for indoor or outdoor environments. Available in 5KA and 65KA SCCR rating and includes:
  - Main disconnect shutoff with lock out tag out (LOTO) capabilities.
  - Circuit Breakers for individual branch circuit protection.
  - Single phase 120v transformer for CoolLogic controller and bank phase loss monitor.
- Field installed and wired for UCW/H Water Source Units
- Option for factory mounted and wired on UCA air-source units with factory skids

Example: 65KA SCCR PDP

UW FACTORY VFD OPTION

Single VFD option for compressor load control

LONG TERM STORAGE - RECOMMENDED PROCEDURES

AIR-SOURCE UNITS - UNINSTALLED, IN STORAGE

- Inspect unit for damage or oil leaks, document condition of equipment, include photos
- Seal header openings to prevent bugs, critters etc. from taking up residence in the piping
- Quarterly third party inspection
  - Clean debris from unit as necessary
  - Ensure fans are spinning freely
  - Open all electrical compartments to check for any infestation/damage to wiring/components
  - Send photos to ClimaCool upon completion of quarterly inspection
- Full unit startup by CCC when chiller is finally commissioned (if not already included, it will be added)

AIR-SOURCE UNITS - PIPED, POWERED, NOT OPERATED

- Inspect unit for damage or oil leaks, document condition of equipment, include photos
- Shut down chiller and disable operation
- Completely drain chiller of all fluid
- If the likelihood of sub-freezing temperatures exists, add glycol to HX
- Quarterly third party inspection
  - Clean debris from unit as necessary
  - Ensure fans are spinning freely
  - Open all electrical compartments to check for any infestation/damage to wiring/components
  - Send photos to ClimaCool upon completion of quarterly inspection
- Full unit startup by CCC when chiller is finally commissioned (if not already included, it will be added)

CONTACT REPRESENTATIVE

Contact your local ClimaCool representative or visit our website at www.climacoolcorp.com to find out more about the heating and cooling solutions that may fit your application needs.

A NIBE GROUP MEMBER

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