

Application Note 2044: CAHV AIR to WATER HEAT PUMP Product Introduction & Application Overview

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INTRODUCTION:

This document is a general application guide for the CAHV AIR TO WATER HEAT PUMP. This document is to serve as a supplement to the technical data already contained within the Mitsubishi Electric CITY MULTI® engineering manuals, submittal sheets, and other service, operation, and installation manuals.

This document will cover the product introduction and general application of the following products:

CAHV: CAHV-R136YAU(-BS)
CAHV-R136TAU(-BS)

WHAT IS CAHV?

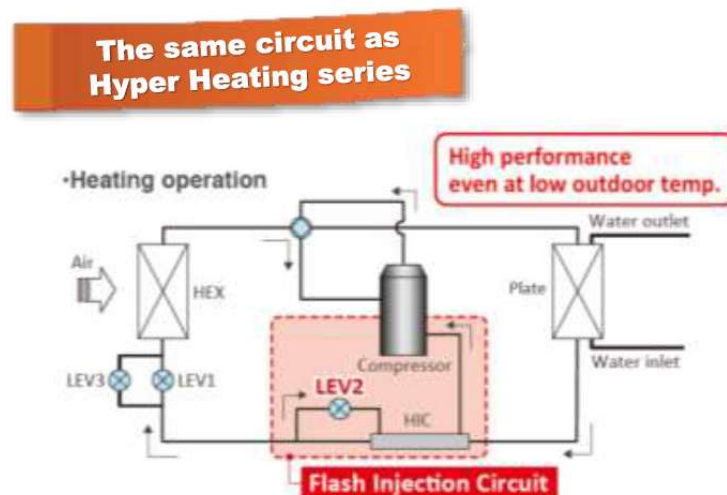
The CAHV is a modular air source hot water heat pump specifically for low delta T closed loop hydronic heating water systems.

- Nominal 40KW heating output (136,480 btu/hr)
- Efficiency Priority & Capacity Priority Modes (>40KW).
- Low GWP Refrigerant (R454C) with GWP of 148
- COP of 2.85 @ 44.6F DB, 113F Outlet Water Temp
- COP's over 4.0 @ Water Outlet Temp of 77F
- Supplies High Temp Hot water (up to 165°F)
- Operable at low outdoor temp (-13°F)
- Staging capability with modules up to 16 in single system with factory standard controls, including auto rotation and lead/lag functionality.
- Direct drive staging and capacity control by BMS



The CAHV is a dedicated inverter driven air source heat pump system that may be employed as a sole source heat pump water heater, depending on climate, or in conjunction with other supplemental hot water heaters.

The CAHV also utilizes flash injection technology on the compressor, similar to the City Multi Hyper Heating product, to allow for higher sustained high-speed operation at lower ambient conditions to maintain higher output capacity.



UNIT FOOTPRINT AND MAJOR COMPONENTS

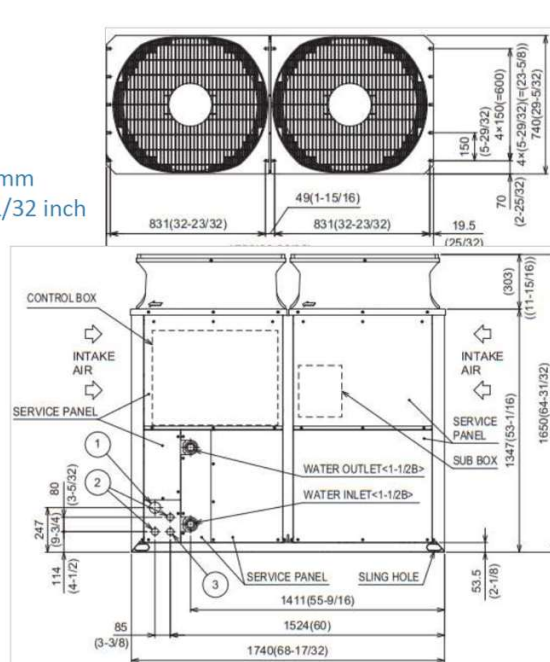
The unit is constructed of a sheet metal chassis with mounting feet like other conventual City Multi equipment. Major components include an air to refrigerant evaporator, direct commutated fan, direct commutated compressor, and integral refrigerant to water heat exchanger (HX).

Please note the piping connection to refrigerant to water HX are 1-1/2" grooved.

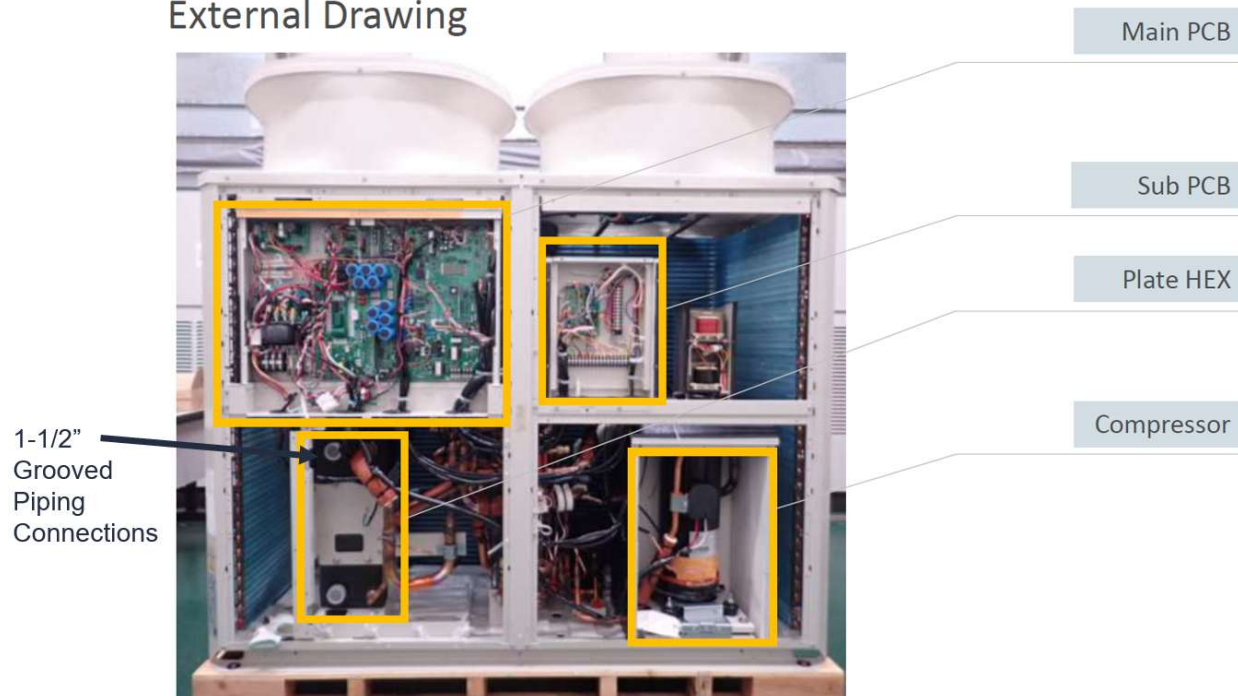
External Drawing



For more information, please refer to manuals.



External Drawing

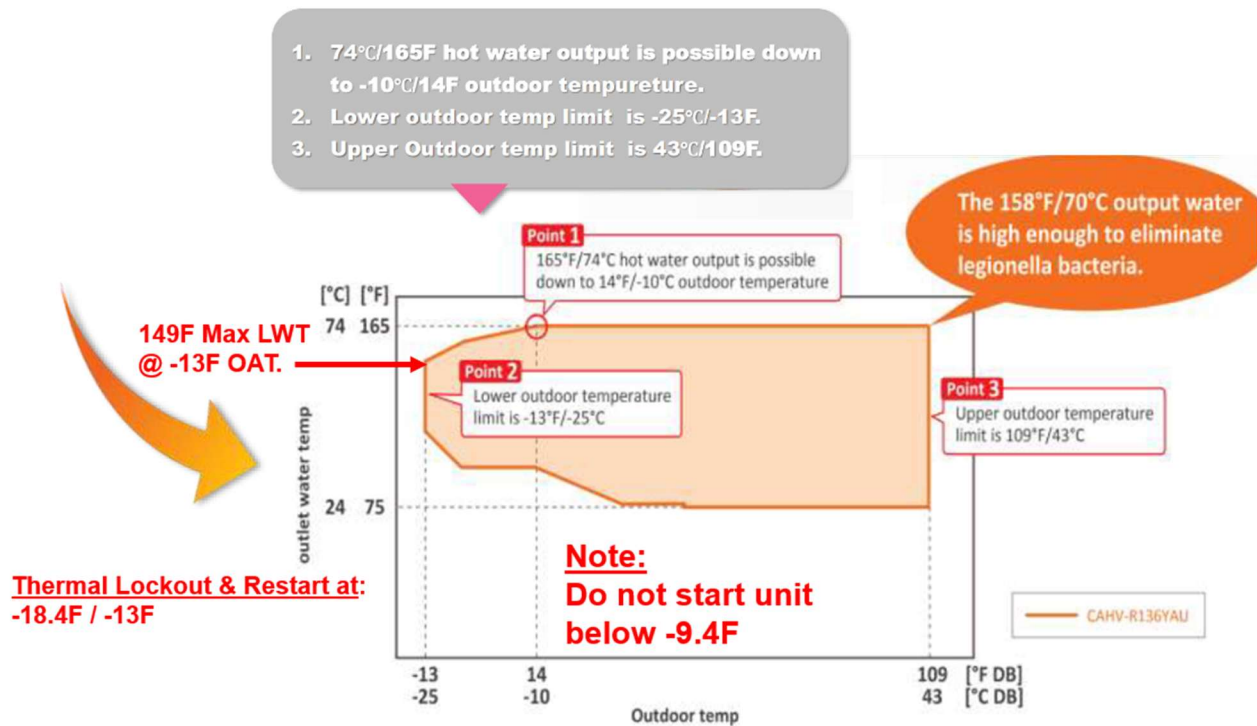




GENERAL SYSTEM APPLICATION & RATING DATA

Operating Temperature Range & Thermal Lockout

The CAHV is intended for low delta T heating hot water applications and can produce target outlet water temperatures shown below, within the guaranteed published ambient temperature range. Designs in colder climates operating close to the minimum guaranteed range should consider backup / supplemental heat to cover extreme operating periods and/or thermal lockout events.



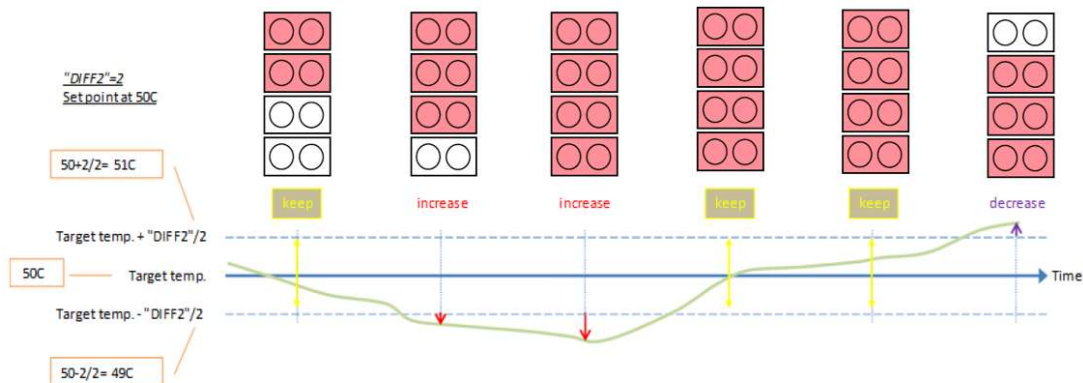
Standard Controls & System Size (Number of Modules)

The CAHV can operate individually as a single unit or as a larger group of units up to 16 modules. When operating with more than 1 CAHV in a system, with the standard controls offering, a remote temperature sensor accessory (by Manf.) is required.

The CAHV will thermoregulate and stage modules in order to achieve either discharge water temperature (common) or return water temperature (common) from the entire bank of connected CAHV units (up to 16 max).



- In case multiple unit system, water temp control is based on TW-TH16-E.
- CAHV software enables the multiple unit control (Up to 16 units)
- No additional control box is required to do this
- **Main unit** decide target outlet temp. of each subunit and number of unit to operate to achieve the target outlet temp.
- **Each unit** increases or decreases the compressor frequency based on the difference between the preset and the current water temperatures.



- THERMO ON/OFF differential is 2C (preset)... 0 - 8.0 C (Range) **3.6F - 14.4F Differential**
- The number of units to be in operation will be determined by the main unit to maintain the proper operating frequency of each unit.
- Unit with longer operating hours will STOP first
- Unit with shorter operating hours will START fist

Standard control includes the use of a manufacturer provided remote controller – PAR-W31MAA:

Remote Controller

Individual remote controller

•PAR-W31MAA

PAR-W31MAA offers an easy-to-see full-dot and backlit LCD display. Basic operations, such as ON/OFF, mode switching, water temperature setting and schedule setting, can be performed. Up to 16 units can be controlled with one remote controller.



Major functions

Operation/ setting	ON/OFF
	Hot water/Heating/HeatingECO/Anti-freeze
	Snow/regular
	Demand
Display	Scheduled operation (daily/weekly)
	Operation mode
	Current water temperature
	Error code

The CAHV is M-net connectable to standard City Multi central controllers as well with the basic functionality illustrated below:

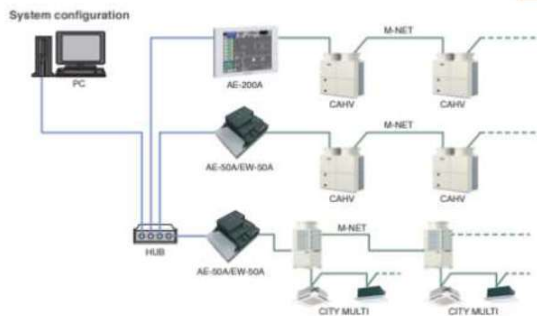
Centralized remote controller

•AE-200A / AE-50A / EW-50A

The CAHV-R136YAU(-BS) is connectable to the AE-200E that centrally controls up to 50 units or 50 systems connected via M-NET.

Major functions

Operation/ setting	ON/OFF
	Hot water/Heating/HeatingECO/Anti-freeze
	Snow/regular
	Scheduled operation (daily/weekly/annual)
Display	Operation mode
	Current water temperature
	Error code

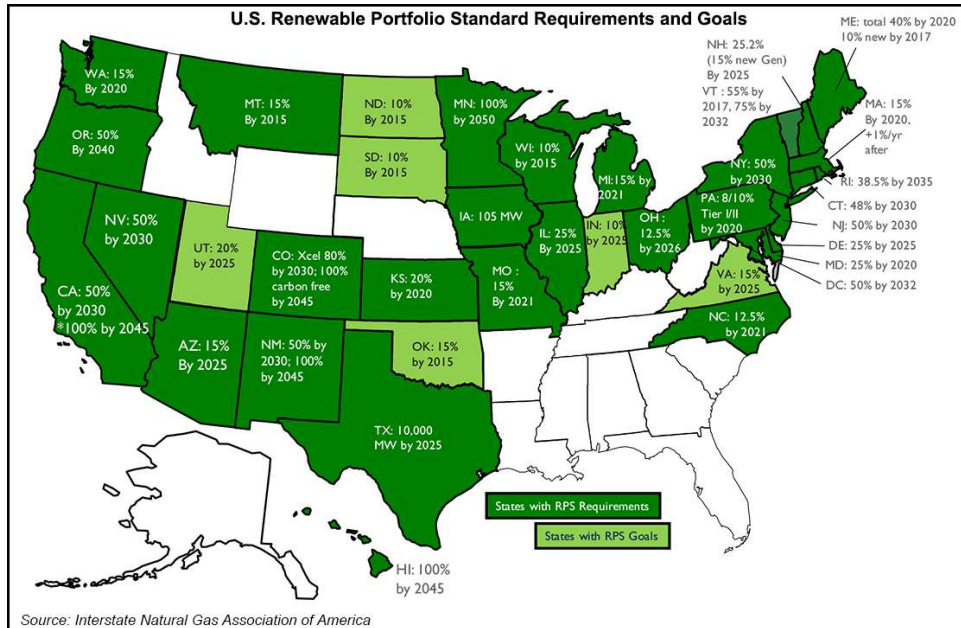


AE-C400A/EW-C50A and AE-200A/AE-50A/EW-50A cannot be in the same system.

Market Drivers

Many states have begun to push towards electrification with increased renewables, smart grid technology and a shift away from coal fired generation in pursuit of renewable technology blended with cleaner peaking plant strategies. In this effort the goal to shift fossil fuel away from end user and implement heat pump technology, for not only building heating needs, but also other process heating needs will become increasingly important. This also lends towards grid stability and energy independence.

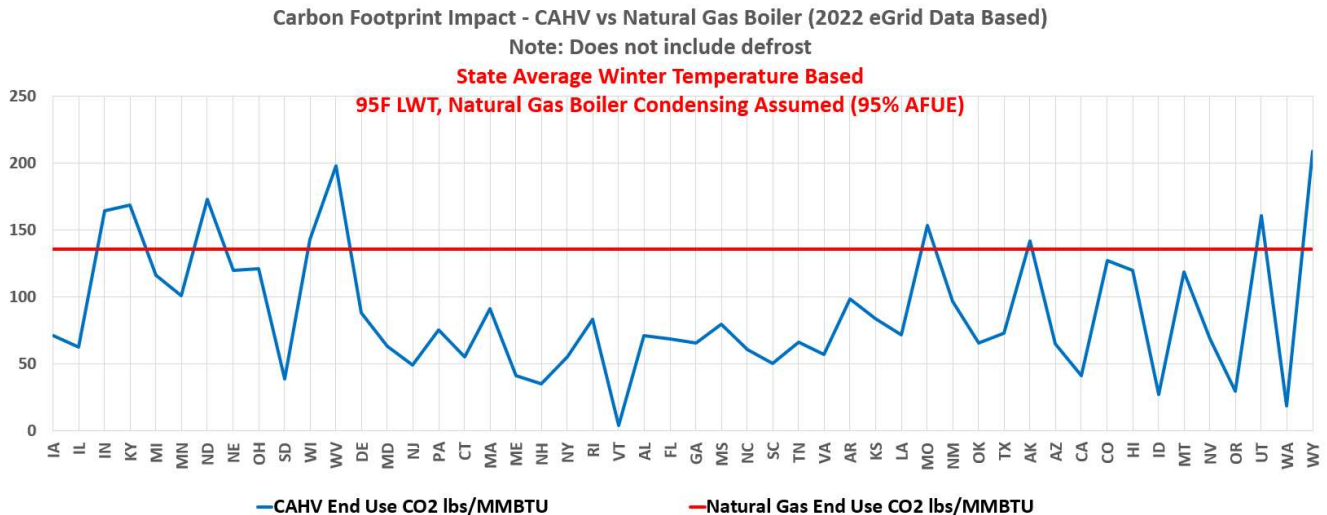
Rural areas where natural gas is not available and predominant heating sources are electric, propane, or fuel oil introduce operating cost savings as well.



Up front cost and maintenance cost saving can also be realized against conventional fuel burning equipment. Depending on climate, opportunities exist to remove fuel burning appliances at site for heating hot water production, reducing need for gas service or fuel delivery and storage cost, and other costly maintenance items associated with fuel burning equipment.

	Boiler	Electric water heaters	Heat pump
Mechanism	Makes hot water by burning gas and oil	Makes hot water by directly heating the supply water in the hot water tank by energizing the heater	Makes hot water by using the heat absorbed from the atmosphere
Safety	★★ Care must be taken for fire and exhaust.	★★★ Safe because only electricity is used and no fire is used.	★★★ Safe because only electricity is used and no fire is used.
Energy efficient	★★ Frequent starting and stopping of boilers due to fluctuations in the load result in an increase in fuel consumption.	★★ Uses a heater to heat, so the energy saving performance is not good.	★★★ Generates hot water using heat pump method, so about 3 to 4 times the input power can be obtained.
Maintenance	★★ Since combustion is involved, maintenance and inspection and assignment of managers are required.	★★★ Easy maintenance because the system uses electricity. The system can be monitored and operated remotely.	★★★ Easy maintenance because the system uses electricity. The system can be monitored and operated remotely.
Equipment cost	★★ Capacity of electrical equipment is small, and power receiving and transforming facility size can be reduced.	★★★ Easy installation and reduced initial cost.	★★ Requires a hot water storage tank and a large capacity electrical facility.
CO₂ emissions	★ CO ₂ and NO _x emissions are high due to the use of gases and oils.	★★ Although there is no emission of CO ₂ or NO _x at the installation site, it is inefficient.	★★★ Heat pumps enable efficient operation, reducing emissions of CO ₂ and NO _x .

Carbon footprint reductions can be maximized with this product in applications with lower water heating temperatures as well. This is especially important for industrial lower temperature heating applications and especially in more mild climates where COP is maximized. This is illustrated below for 95 LWT based on average winter heating temperatures using eGrid emission data.



Capacity & COP Data

The CAHV capacity and efficiency will vary with ambient temperature, ambient humidity, flow rate, defrost, and outlet water temperature. The published data books will provide detailed rating charts to determine net output capacity and power input. From this, resulting efficiency under varying conditions can be determined.

The official selection software should always be utilized in any design to determine final output capabilities at the project specific design conditions.

The CAHV is also capable of operating in two different modes, exchanging higher peak capacity output for operating efficiency.

The two modes offered are:

- Efficiency Priority – 40 KW max output capacity.
- Capacity Priority – Capacity output above 40KW is achievable at higher ambient temperatures.

An example of a typical Data Book Chart showing capacity and power correction (Maximum Capacity Mode) is illustrated below and resulting COP.



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Below – Data Book Capacity Chart Example – Capacity Priority Mode:

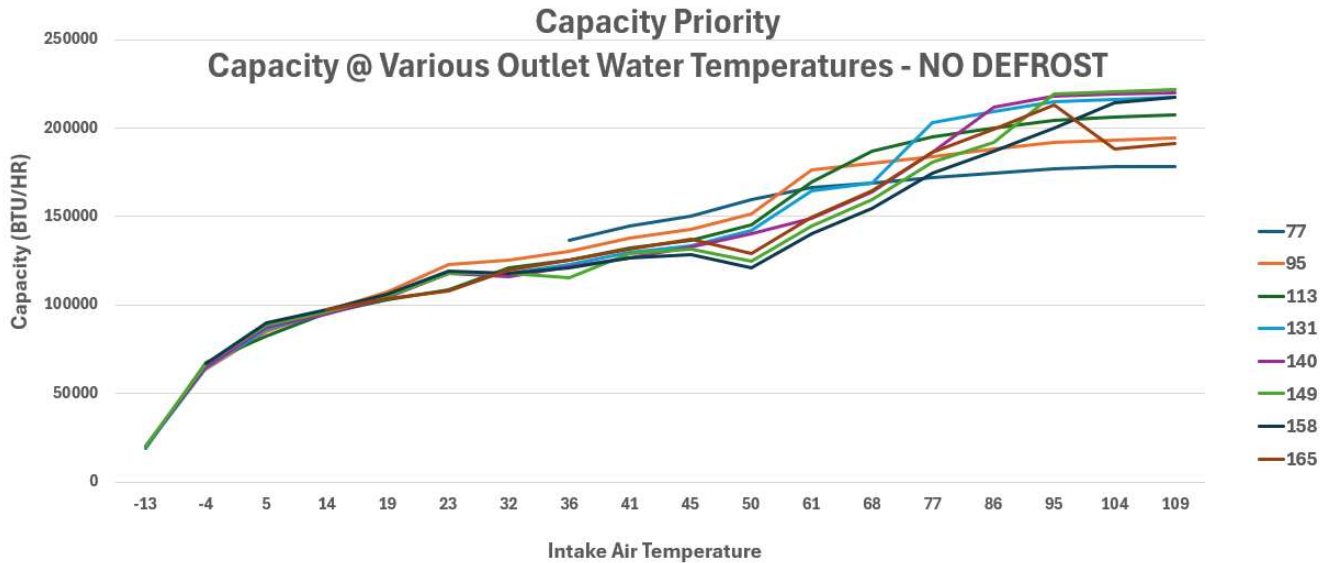
		Intake air temp. °F																	
		-13	-4	5	14	19	23	32	36	41	45	50	61	68	77	86	95	104	109
Outlet water temp. °F	77	—	—	—	—	—	—	—	136,890	144,980	150,280	159,500	166,700	169,020	171,890	174,730	177,300	178,110	178,450
	95	—	63,750	85,190	96,820	107,370	123,110	125,440	130,570	137,900	142,770	151,520	176,160	180,290	183,840	188,000	191,890	193,410	194,670
	113	19,350	67,420	82,610	95,530	103,290	108,460	121,140	125,530	132,100	136,480	145,130	169,430	186,780	195,260	200,140	204,600	206,060	207,310
	131	19,630	64,290	86,070	95,500	104,630	118,220	117,650	122,630	129,570	133,810	142,140	164,360	168,970	203,060	209,660	214,790	216,130	217,270
	140	20,070	65,220	87,310	94,950	104,050	117,810	116,330	121,990	126,960	132,670	140,570	148,900	164,270	186,270	212,140	217,940	219,190	220,260
	149	20,410	66,690	88,970	96,260	104,910	118,180	117,850	115,560	129,090	131,350	124,540	144,790	159,530	180,990	191,730	219,210	220,570	221,580
	158	—	67,080	90,010	97,720	106,100	119,180	117,830	120,970	126,820	128,650	121,170	140,420	154,480	174,790	187,180	199,950	214,150	217,670
	165	—	—	—	97,540	103,550	107,920	119,920	125,150	131,930	137,100	129,120	149,640	164,620	186,270	199,470	213,080	188,440	191,540

These tables show the power input when the relative humidity is 85%.

The intake wet-bulb temperature is fixed to 90°F (32°C) when the intake dry-bulb temperature is 95°F (35°C) or higher.

The difference between the outlet water temperature and the inlet water temperature is 9°F (5°C).

However, if a difference of 9°F (5°C) cannot be secured, the lower limit flow rate shall be used.



Below – Data Book Power Input Example – Capacity Priority Mode:

		Intake air temp. °F																		
		-13	-4	5	14	19	23	32	36	41	45	50	61	68	77	86	95	104	109	
Outlet water temp. °F	77	—	—	—	—	—	—	—	—	40,790	39,870	39,470	39,640	40,460	40,770	41,310	41,900	42,510	42,930	43,070
	95	—	34,590	43,080	43,110	46,380	45,720	45,140	44,750	43,850	43,350	43,610	46,050	46,590	47,260	48,210	49,180	49,880	50,350	
	113	17,830	42,670	45,500	47,780	49,140	50,050	51,260	50,290	48,840	47,870	48,360	51,310	53,340	54,760	55,910	57,070	57,880	58,430	
	131	21,030	50,340	54,410	53,150	56,980	58,720	58,670	58,630	57,580	56,560	56,650	58,400	56,230	62,900	64,600	66,030	66,970	67,590	
	140	22,570	54,020	57,980	55,320	64,430	62,300	62,870	63,600	61,160	61,360	61,290	58,440	60,190	62,750	68,980	70,700	71,710	72,380	
	149	24,240	57,600	61,910	65,350	70,350	72,590	70,230	72,840	69,480	66,100	59,860	62,500	64,360	67,110	68,270	75,430	76,420	77,140	
	158	—	57,560	74,490	71,830	76,930	79,270	76,270	74,500	72,820	69,920	63,910	66,700	68,670	71,540	72,960	74,270	79,240	80,330	
	165	—	—	—	72,270	72,970	73,470	74,750	75,120	73,870	73,270	66,980	69,900	71,970	74,970	76,470	69,630	74,300	75,310	

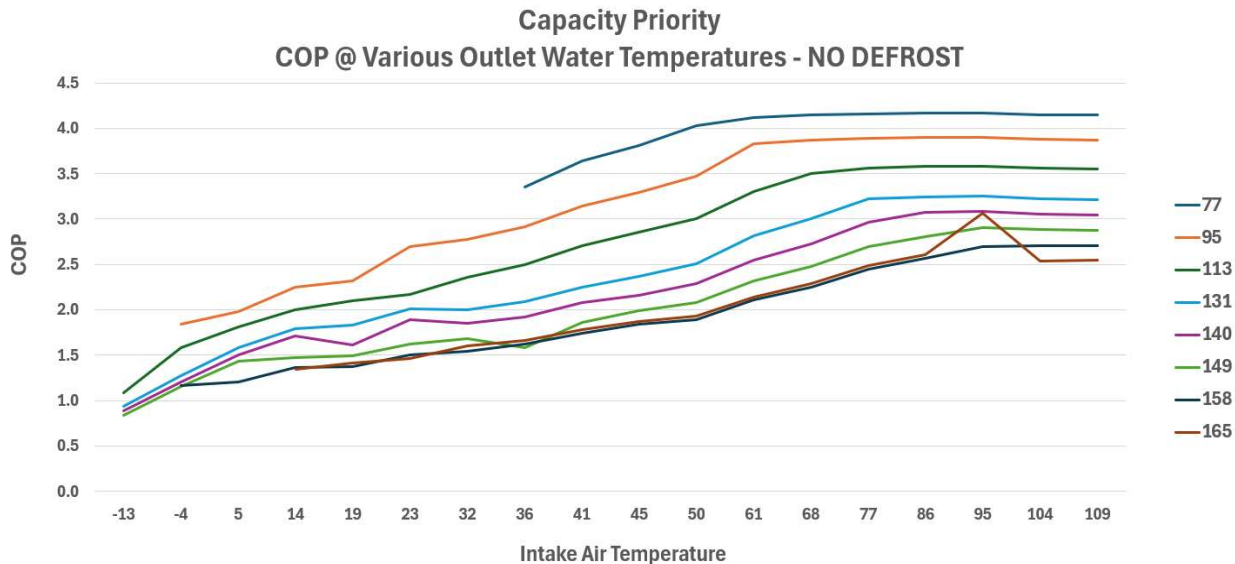
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The intake wet-bulb temperature is fixed to 90°F (32°C) when the intake dry-bulb temperature is 95°F (35°C) or higher.

The difference between the outlet water temperature and the inlet water temperature is 9°F (5°C).

However, if a difference of 9°F (5°C) cannot be secured, the lower limit flow rate shall be used.

Below – COP Derived from Data Book Charts – Capacity Priority Mode:



APPLICATION DETAILS & DESIGN CONSIDERATIONS

Closed Loop Applications ONLY and Minimum Requirements

The CAHV is designed with an integral refrigerant to hot water heat exchanger and is suited for closed loop applications ONLY. Typical closed loop hydronic components such as below are required for any closed loop system and should be included by the engineer of record including but not limited to:

- Proper initial fill with chemical treatment or glycol for colder climates below freezing conditions. Inhibited glycol should be used. 40% maximum polypropylene glycol is permitted.
 - A glycol fill system (by others) should be provided.
- Air separators for air removal from the system.
 - May be microbubble depending on size of system or centrifugal type for larger applications.
- Expansion tanks for system water volume expansion.
 - Sized from cold fill up to maximum operating pressure below system relieve valve setting. Sizing by engineer of record based on total system volume, fluid type and operating temperature range.
- Flow switches installed at EACH CAHV unit and tied to the CAHV control board proof of flow contact input, field provided. **A thermal dispersion type, outdoor NEMA rated, is recommended over vane/paddle type.**
- Strainers for proper protection of system pumps and at EACH CAHV unit. 60mesh should be used at EACH CAHV unit for HX protection.
- Pumps sized for full pressure drop of system application including primary and secondary pumps if applicable depending on final total building piping design – sizing is determined by engineer of record.
- Controls as required for building distribution pumping (speed control based on DPT, pump lead/lag, etc...) by others/field provided.
- Buffer tank for sufficient buffer capacitance for hydronic loop served by CAHV system – see minimum buffer volume section requirements.

CAHV System Minimum Buffer Volume.

A minimum system volume capacitance is required for the CAHV to maintain stable operation and prevent excessive cycling. This is important not only for maintaining and achieving system efficiency but also longevity. Per the factory documentation a minimum of 139 gallons per CAHV is required. The total system volume can be counted towards this minimum amount including all piping and equipment; however, **if a separation HX is used ONLY the volume between CAHV units and separation HX should be counted.**

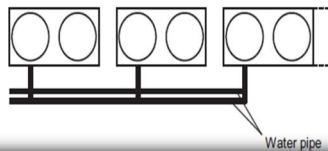
Below from Data Book – System Volume Requirements:

1. Required amount of water

If the amount of water in the water circuit (circulating water circuit) is insufficient, the unit operation hours may become shorter or the amount of water temperature change to be controlled may become extremely large. Also, the defrost operation during the heating mode may not function properly. Refer to the table below for the minimum amount of water required in the circuit. If the water pipe is too short to keep enough amount of water, install a cushion tank in the water pipe to ensure enough amount of water.

Model	Minimum amount of water [l (gal)]
CAHV-R136YAU (-BS)	525 (138.7)

* When multiple units are installed consecutively with the outlet water temperature of 55°C (131°F) or higher, the minimum amount of water is <360 × number of units>.



Minimum amount of water = $360 \times 3 = 1080 \text{ l}$ ($95.1 \times 3 = 285.3 \text{ gal}$)

Piping Details & Piping Design

Basic Constant Flow Piping Requirements Per CAHV

For basic constant flow to a CAHV module the below detail summarizes minimum piping provisions.

Note requirement for 60 mesh strainer, field flow switch, means of balance, and other required basic specialties for venting, draining, and servicing.

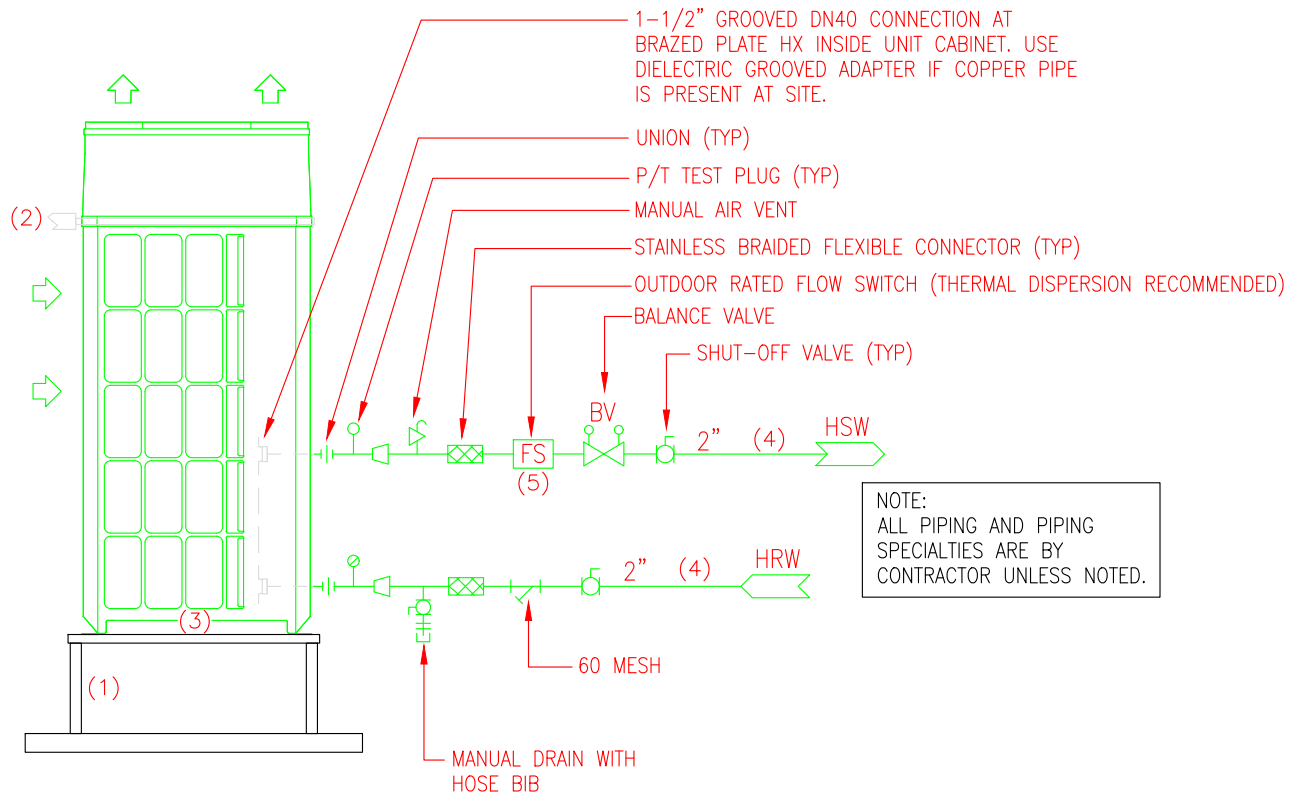


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Below – CAHV Basic Constant Flow Minimum Piping Provisions Detail:



NOTES:

1. IN COLD CLIMATES, INSTALL THE UNIT ON A MINIMUM 18-INCH HIGH RAISED OPEN BASE TO PREVENT DAMAGE FROM SNOW.
2. PROVIDE SEISMIC BRACING WHERE REQUIRED BY JURISDICTION (BY CONTRACTOR).
3. IN COLD CLIMATES HEAT TRACE UNIT BASE PAN (BY CONTRACTOR).
4. IN COLD CLIMATES HEAT TRACE ALL WATER PIPING OUTDOORS (BY CONTRACTOR). ENSURE HEAT TRACE AND INSULATION COVERS ALL EXPOSED HYDRONIC ACCESSORIES.
5. TIE FLOW SWITCH TO UNIT PROOF OF FLOW INPUT (CN221, 1-3). POWER TO FLOW SWITCH BY OTHERS. ACCESSORY THERMAL FLOW SWITCH AVAILABLE FROM METUS.

System Hydronic Integration w/ CAHV (Including Multiple CAHV Units).

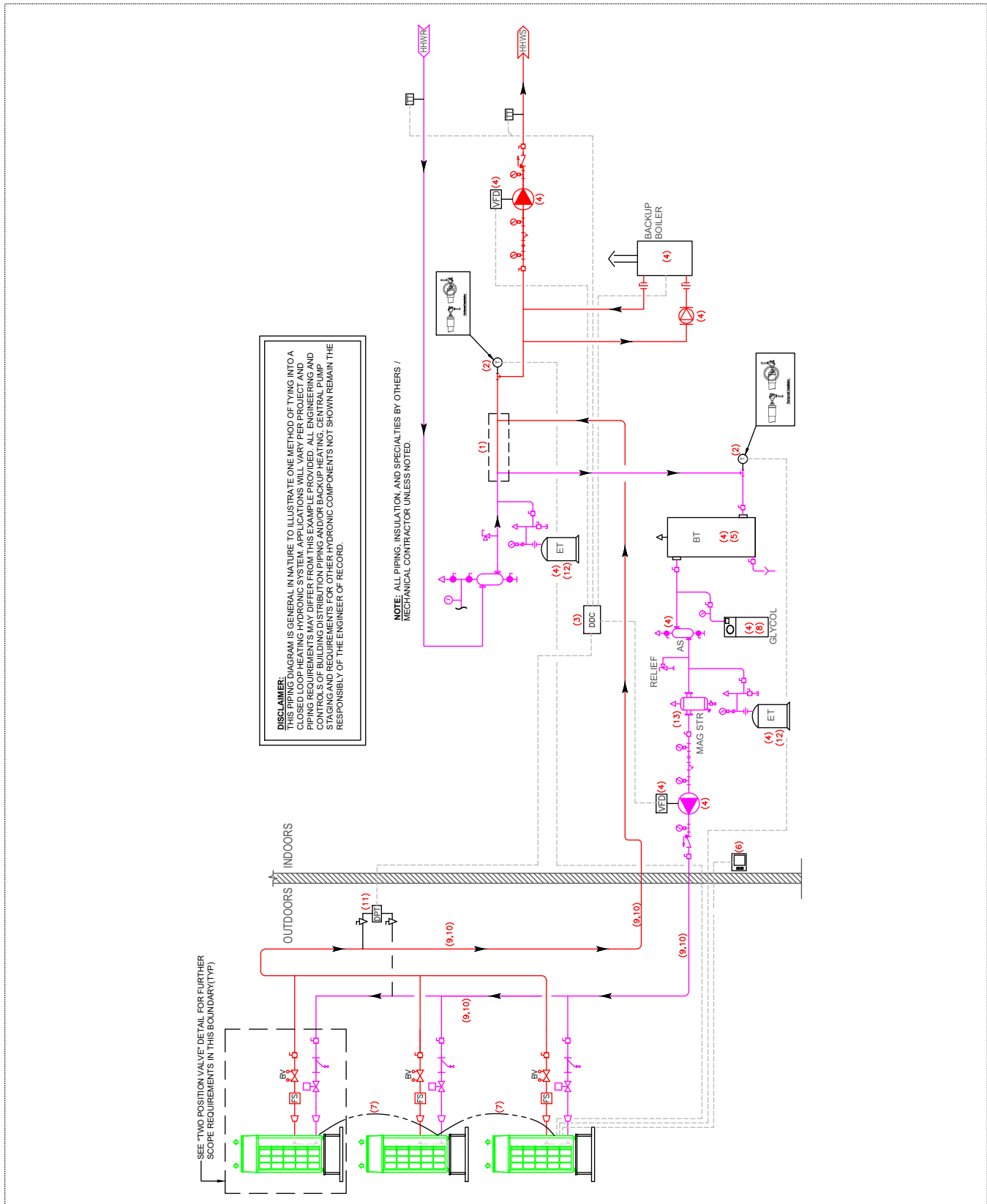
When integrating the CAHV unit into hydronic systems considerations for system volume as mentioned previously should be considered. Additionally controls for modulation of main building distribution pumps and lead lag operation would be required by others.

Also, when multiple units are present, to save pumping energy and prevent unheated water from idle modules blending with heated water from active module/s, separate tertiary pumps or motorized isolation valves at each CAHV module would be required.

The below typical piping diagrams illustrate piping integration into a closed loop system. Consult with a Mitsubishi representative for further details, as every application may vary slightly and required additional considerations not addressed in this example below.

In the below diagrams, note the need for a primary/secondary decouplers and separate controls for secondary pump modulation based on building distribution supply-return differential pressure transmitter (DPT)-by others. Also note, a separate primary pump is required with modulation by others in response to primary side DPT as modules are staged on/off by CAHV controls and corresponding isolation valves closed. Alternately, in place of valves at each CAHV unit, a separate dedicated constant speed tertiary pump could be used for each CAHV module instead of a main primary pump.

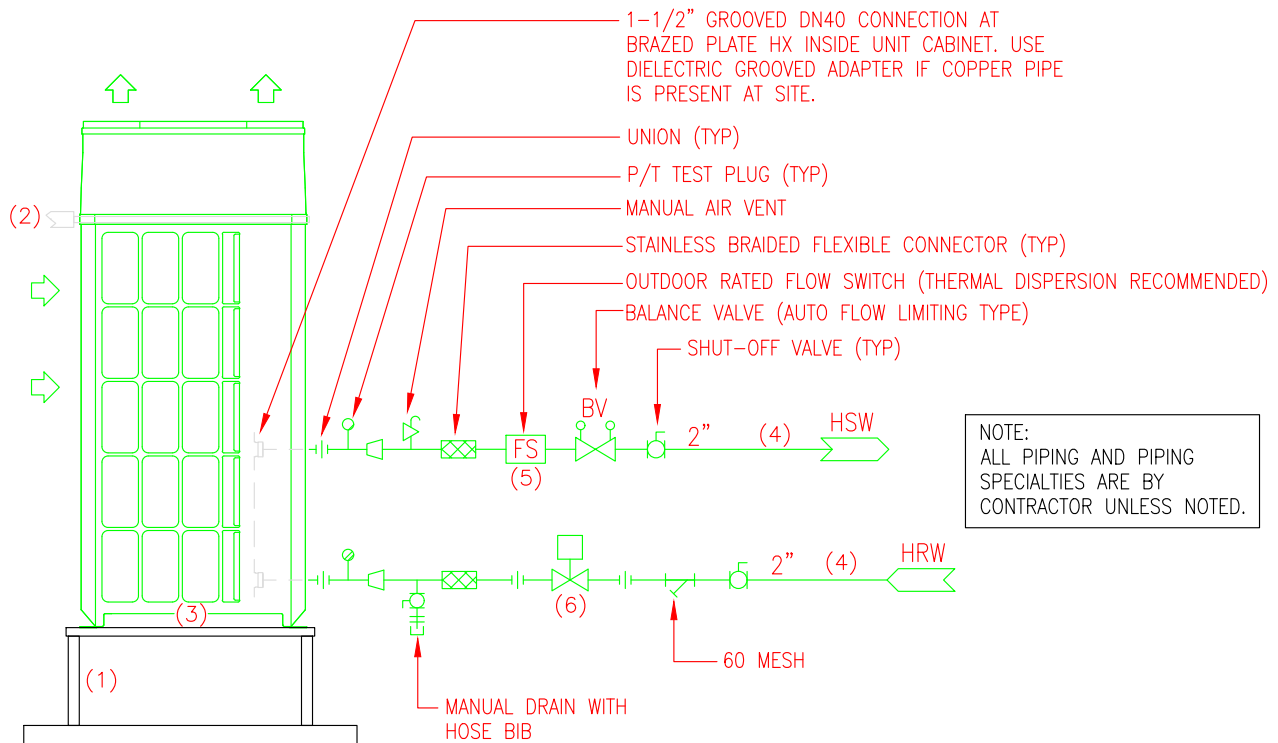
Below – Sampel Multiple CAHV Unit Hot Water System Piping Integration Diagram:



NOTES:

1. SIZE DECOUPLER PIPE FOR LESS THAN 4FT/SEC AND 2 TO 5 TIMES PIPE DIAMETER SEPARATION (NO LESS THAN 2FT).
2. REMOTE TEMPERATURE SENSING ACCESSORY, FURNISHED BY MANUFACTURER, FIELD INSTALLED - REFERENCE INSTALL MANUAL. WIRED TO MAIN CAHV UNIT IN GROUP BY M.C. (UP TO 16 CAHV'S MAX PER GROUP).
3. DDC CONTROLS, BY TCC, REQUIRED FOR TOTAL PLANT AND MAIN BUILDING DISTRIBUTION LOOP TEMPERATURE CONTROL INCLUDES BUT IS NOT LIMITED TO:
 - 3.1. PUMP STAGING AND MODULATION OF SECONDARY PUMPS.
 - 3.2. BACKUP BOILER STAGING/CONTROL.
 - 3.3. BOILER PUMP CONTROL/INTERLOCK.
 - 3.4. PRIMARY CAHV PUMP VFD CONTROL BY DIFF. PRESS TRANSMITTER.
 - 3.5. STAGING ON CAHV SYSTEM/S.
4. BY MECH. CONTRACTOR.
5. 139 GALLONS MINIMUM BUFFER VOLUME REQUIRED PER CAHV UNIT.
 - 5.1. SYSTEM VOLUME CAN BE COUNTED.
 - 5.2. WHEN SEPARATION HX IS PRESENT ONLY VOLUME OF PIPING CAN BE COUNTED BETWEEN CAHV/S AND HX.
6. CAHV REMOTE CONTROLLER - ONE PER SYSTEM GROUP (16 CAHV'S MAX PER GROUP) WIRED BY M.C. TO MAIN CAHV UNIT.
7. ALL M-NET WIRING BY M.C. REFERENCE INSTALL MANUALS FOR DETAILS.
8. GLYCOL MUST BE POLYPROPYLENE ONLY - 40% MAX ALLOWED.
9. INSULATION AND JACKET ALL PIPING PER CODE BASED ON SERVICE TEMP.
10. HEAT TRACE OF OUTDOOR PIPING IN COLDER CLIMATES ADVISED, AND IN ADDITION TO GLYCOL DEPENDING ON CLIMATE OR GLYCOL BURST PROTECTION - BY M.C.
11. DIFFERENTIAL PRESSURE TRANSMITTER FOR CAHV MAIN PUMP CONTROL, INSTALLED BY M.C..FURNISHED AND WIRED BY TCC.
12. REDUNDANT EXPANSION TANKS NOT REQUIRED IF LOOPS ARE NOT SEPARATED BY HX OR THERE IS NO PLANNED ISOLATION OF THE CAHV LOOP FROM MAIN BUILDING LOOP. EXPANSION TANK MUST COVER WORST CASE VOLUME FOR COMBINED LOOPS WITH SINGLE EXPANSION TANK LOCATION - DETERMINED BY ENGINEER OF RECORD.
13. MAGNETIC STRAINER (BY M.C.) RECOMMENDED FOR OLDER EXISTING PIPING; DUPLEX STRAINERS RECOMMENDED FOR SERVICEABILITY.

**Below – Minimum Piping Provision at CAHV – Multiple Unit System With Variable Primary Flow
(Motorized Isolation Valves at Each CAHV):**



NOTES:

1. IN COLD CLIMATES, INSTALL THE UNIT ON A MINIMUM 18-INCH HIGH RAISED OPEN BASE TO PREVENT DAMAGE FROM SNOW.
2. PROVIDE SEISMIC BRACING WHERE REQUIRED BY JURISDICTION (BY CONTRACTOR).
3. IN COLD CLIMATES HEAT TRACE UNIT BASE PAN (BY CONTRACTOR).
4. IN COLD CLIMATES HEAT TRACE ALL WATER PIPING OUTDOORS (BY CONTRACTOR). ENSURE HEAT TRACE AND INSULATION COVERS ALL EXPOSED HYDRONIC ACCESSORIES.
5. TIE FLOW SWITCH TO UNIT PROOF OF FLOW INPUT (CN221, 1-3). POWER TO FLOW SWITCH BY OTHERS. ACCESSORY THERMAL FLOW SWITCH AVAILABLE FROM METUS.
6. MOTORIZED TWO POSITION VALVE NORMALLY CLOSED, OUTDOOR RATED. VALVE AND TRANSFORMER BY OTHERS. TIED TO TB5 (70-71) ON CAHV

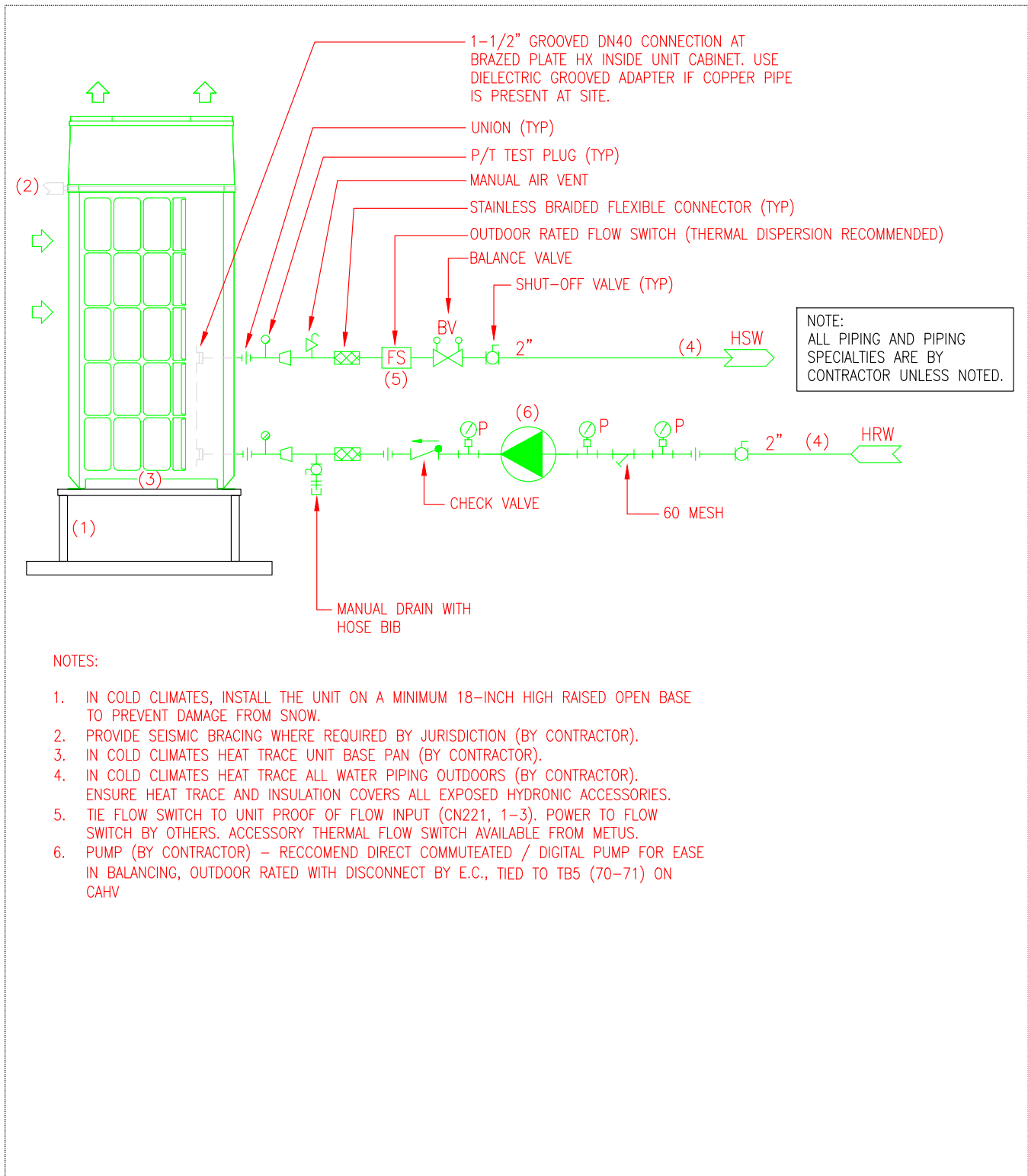


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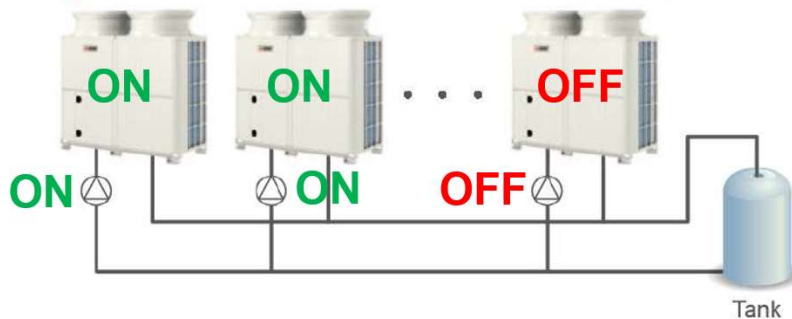
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Below – Minimum Piping Provision at CAHV
Alternate Multiple Unit System With Variable Primary Flow
Via Constant Speed Interlocked Tertiary Pumps at Each CAHV:



CAHV Pump Interlock & Flow Switch Functionality

As described, each CAHV unit can provide interlock with tertiary pump and/or tertiary two position valve. This is provided via dry contact on the unit board. Basic functionality of this interlock is detailed below.



The basic operations are as follows:

1. The unit with the THERMO OFF will turn off the pump operation output, (terminal 70-71: OPEN).
2. In the case of multiple units, when the water temperature reaches the target range, the units will stop through load control. However, if the last unit become THERMO OFF, the pump output of that unit will remain ON.
3. CAHV system can allow last CAHV unit pump interlock contact to open by setting SW6-4 ON
4. Proof of flow input (field flow switch) to CN221 (short required pin 1-3) for compressor operation.
5. ***Pump output remains active below thermal lockout!***

Pump/Valve Interlock Terminal

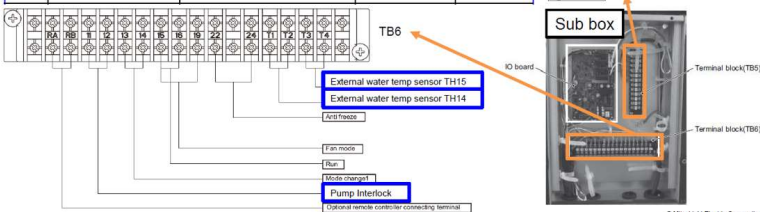
CN221:
Terminals 1-3 for
flow switch

TB5:
Terminals 70-71
contact output for
pump operation.

SW5-8:
ON: Pump follows
thermal On/Off
command.
OFF: Pump follows
On/Off status.

When using a local controller, check the types of input/output signals that are available and the operations that correspond to the signals.

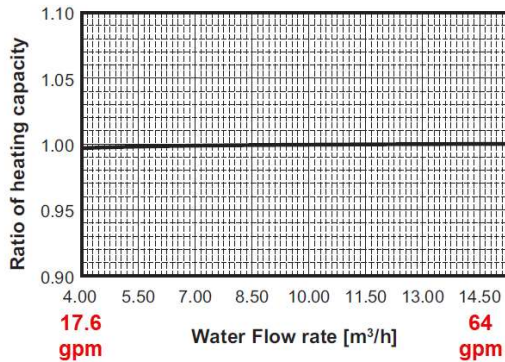
Type	Dry contact	ON(Close)	OFF(open)	TB / connector
Output	Pump operation command output	Close/ Open	(1) When SW5-8 is set to ON The pump will operate according to the Thermo-ON/OFF status of the unit. (2) When SW5-8 is set to OFF The pump will operate according to the status of the "Unit Operation" contact or the ON/OFF button on the remote controller button.	Under all conditions other than the ones listed on the left.
input	Pump Interlock	Normal/ Error	The unit is allowed to operate.	The unit will not operate.
	External water temp sensor	-	-	TB6 T1-T2
	External water temp sensor	-	-	TB6 T3-T4



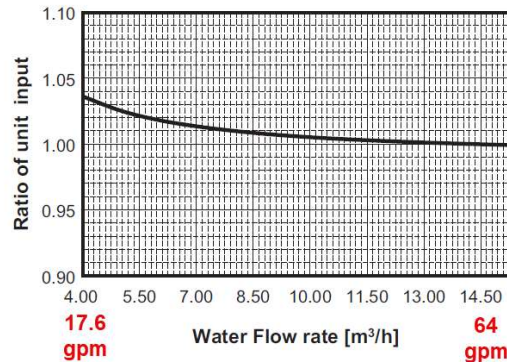
Flow Rate Limits and Desing Impacts on Delta T

The CAHV must be applied with flow rates in the published range. This is illustrated below from published data book correction charts. It is recommended in practice to **NOT design below 20gpm per module** and **preferably design closer to 30gpm minimum per module**. The flow switch trigger (field provided) should slightly below this value.

CAHV-R136YAU (-BS)



*Conditions Outdoor temperature 32°F (0°C)
Intake water temperature 122°F (50°C)
Frequency of compressor 100Hz



*Conditions Outdoor temperature 32°F (0°C)
Intake water temperature 122°F (50°C)
Frequency of compressor 100Hz

The minimum flow rate allowed per module will impact actual achieved water temperature differential as the CAHV unit become de-rated. During colder ambient temperatures, where units may be critically sized, low delta T operation would be common due to minimum flows that must be maintained. Therefore, in the majority of applications, a primary-secondary pumping scheme with decoupler will be required if higher building distribution water delta T is desired, with lower flow turndown on secondary side.

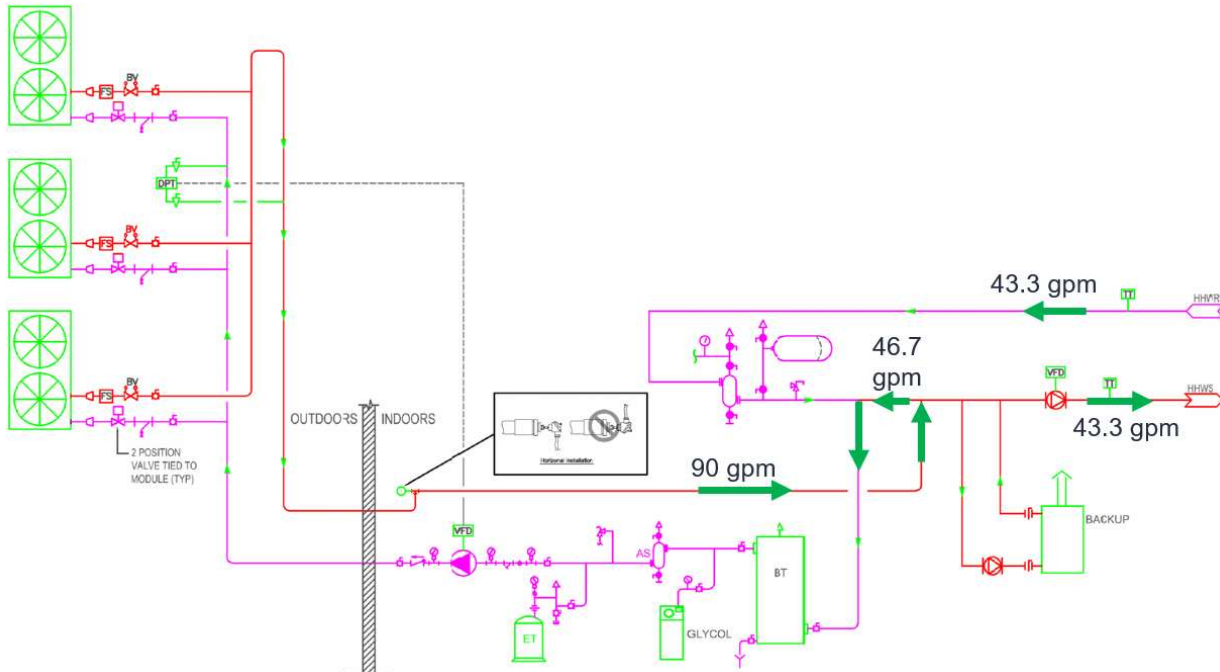
Below is an example:

Consider Case with Ambient design @ -4F:

- 195,000 btu/hr load for building @ 140F LWT
- CAHV = 65,000 but/hr EACH @ 140F LWT
- 30 gpm per CAHV

If Building Side is 10F delta?

- w/ Glycol - Building Side = $195,000 / 450 / (10F \text{ Delta}) = 43.3 \text{ gpm}$
- **CAHV side** (all modules ON) = $195,000 / 450 / 90\text{gpm} = \mathbf{4.8F \text{ Delta T}}$



Cold Climate Considerations (Hoods, Stands, Base Pan Heat)

In cold climate areas, especially with high snowfall and frequent wind driven freezing rain/snow and or hail, protection measures should be in place to protect the units and outdoor coil surfaces. Install snow hoods on discharge and intakes (accessories available). Elevate the units above the highest snowfall height. Also install base pan heat to ensure proper drainage on unit bottom casing weep holes. Gutter cable with 12w/ft can be used and should follow drainage weep hole pattern in bottom of unit casing.

It is also advised in colder climates, in addition to glycol, to heat trace all outdoor piping, then insulate and jacket.

See below guidelines from published data book:

3-4. Installing the unit in a snow area

In snowy areas, sufficient protection against snow and winds should be provided to ensure proper operation.

Even in other areas, appropriate measures should be taken to minimize the effects of winds and snow to ensure normal operation.

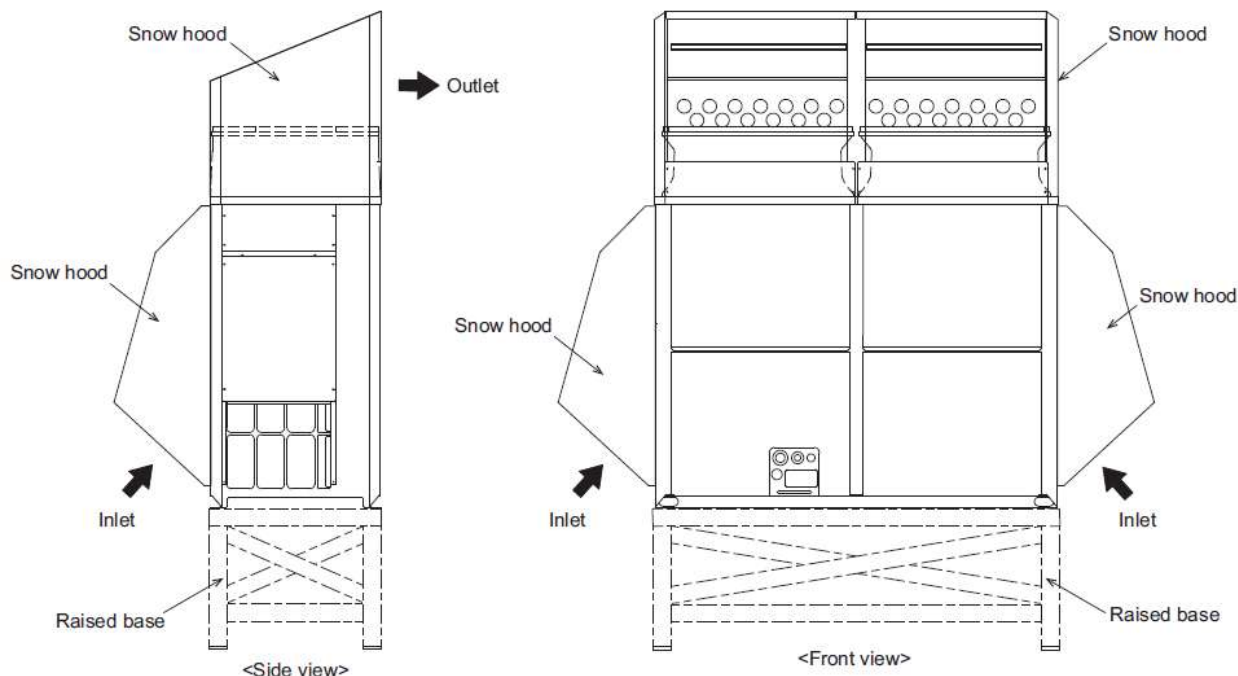
If the units are installed in the direct line of rain, winds, or snow, install snow hoods (on both the discharge and suction ducts).

Use a snow net or snow fence as necessary to protect the unit.

Install snow hoods in regions where the outdoor temperature is -10°C (14°F) or below.

(Note)

- Install the unit on a base approximately twice as high as the expected snowfall. The base must be made of angle steel or something to let snow and wind slip through the structure. The base width must not exceed the unit size, otherwise snow will accumulate on the base.
- Install the unit so that the outlet/inlet faces away from the wind.



(Note)

1. Install the unit so that the outlet/inlet faces away from the wind. Secure enough space around the unit to avoid a short cycle.
2. Do not install the unit in a place where snow may fall from the roof. Also, remove the snow on the unit before it accumulates.
3. Refer to the figure above when installing the base on site.

The CAHV units also contain an output contact (CN513) for interlock with field provided base pan heat.

Contact capacity of CN513.

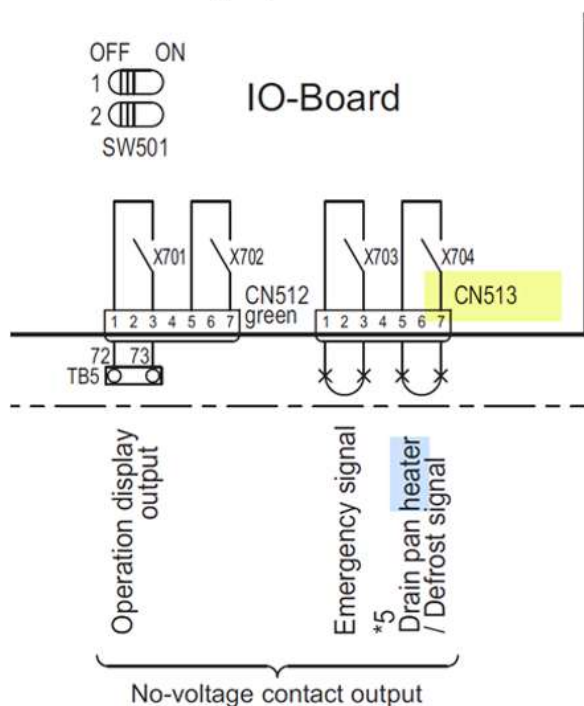
- Maximum Voltage
250V(AC) or 30V(DC)
- current
10mA ~ 3A

Contact is ON(Close) when Outside temperature is at or below 1°C (33.8F)

Contact is OFF(Open) when Outside temperature is at or above 3°C (37.4F)

*** There is 2°C differential for ON-OFF point.**

3. Water circuit (option)



Below – Example Image of Mounting in Cold Climate with Snow Hoods:



Defrost Considerations & Applications with Low Loop Temperatures

As illustrated previously, the minimum charted capacity correction range for leaving water temperature is 77F. Additionally, for defrost on the CAHV unit the water side temperature must be above 64F. See below from the published service manual for defrost start conditions. For these reasons, it is important that the pump or valve dedicated to the CAHV is interlocked properly to the CAHV board as shown in above sections on pump interlock. **Additionally, the water loop design for the CAHV's should be kept ideally above these temperatures, preferably closer to 80F to facilitate proper de-frost.**

Below – CAHV Defrost Start Conditions from Published Service Manual:

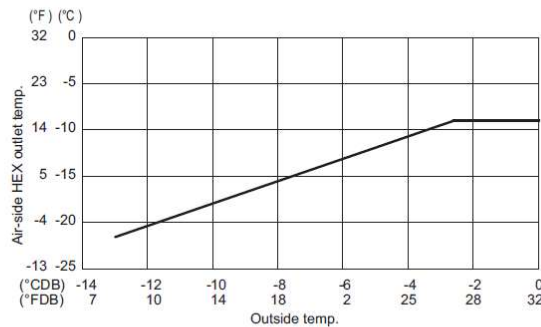
-4- Defrost operation

1. Defrost start

The defrost cycle will start when one of the following conditions 1 through 4 is met. Defrost operation will be performed in the circuit that meets the defrost-start condition below.

Defrost-start conditions 1

- 1) Three minutes have passed since the compressor started up.
- 2) Cumulative compressor operation time after the completion of the last defrost cycle has reached 25 minutes.
- 3) The air-side heat exchanger outlet temperature is equal to or below the defrost-start temperature. (See the figure at right.)
- 4) Inlet water temperature is above 18°C [64°F].



Defrost-start conditions 2

- 1) Twenty minutes have passed since the unit received an operation command signal.
- 2) Cumulative compressor operation time after the completion of the last defrost cycle has reached 20 minutes.
- 3) Air-side heat exchanger outlet temperature is below -22°C [-8°F].
- 4) Inlet water temperature is above 18°C [64°F].
- 5) Outside temperature is -13°C [9°F] or above.

Defrost-start conditions 3

- 1) Forty-five minutes have passed since the unit received an operation command signal.
- 2) Cumulative compressor operation time after the completion of the last defrost cycle has reached 240 minutes.
- 3) Under low pressure drop suppression control.
- 4) Inlet water temperature is above 18°C [64°F].
- 5) Compressor frequency is below a certain value.

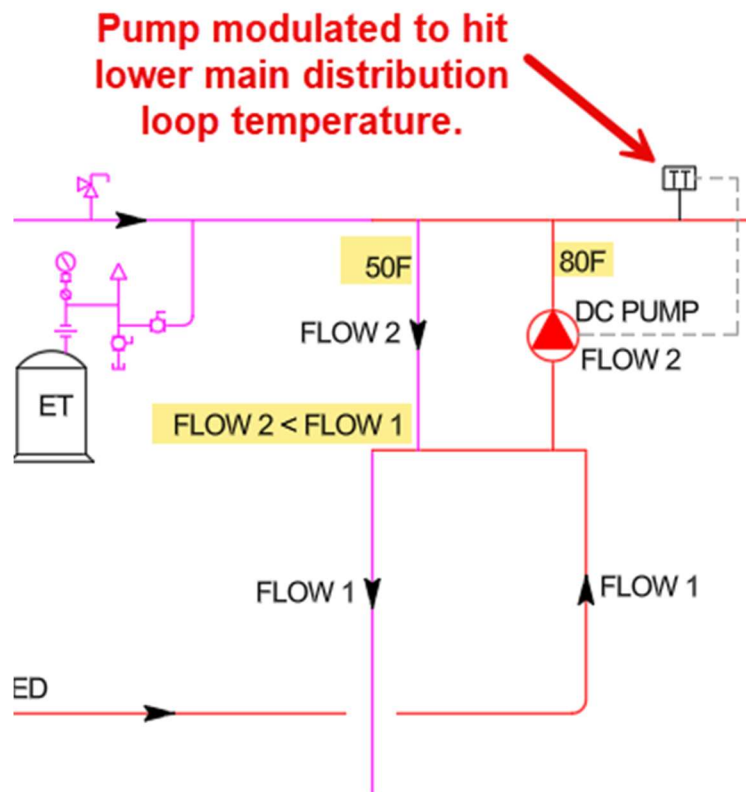
Defrost-start conditions 4

- 1) Compressor shell superheat is below 10K [18°F] over 30 minutes.
- 2) Inlet water temperature is above 18°C [64°F].

If applications are desired with hydronic loop distribution temperatures below this temperature, an injection circuit should be employed to maintain lower secondary lower loop temperatures, while maintaining the CAHV hydronic loop at 80F (including the required storage capacity).

A separate injection circuit with DC pump and temperature controls could then be used to inject a smaller flow rate into the main distribution circulation loop.

See the below overall larger piping schematic (second image below). Focusing on the injection circuit, the Flow 2 is less than Flow 1, as a larger delta T is present on this injection circuit. The injection circuit pulls low temp main distribution water into the CAHV loop and injects higher temperature CAHV supply water into the main distribution loop in order to achieve the blended lower target temperature.



Below – Overall General Example of Injection Circuit For Lower Loop Temperature Control

