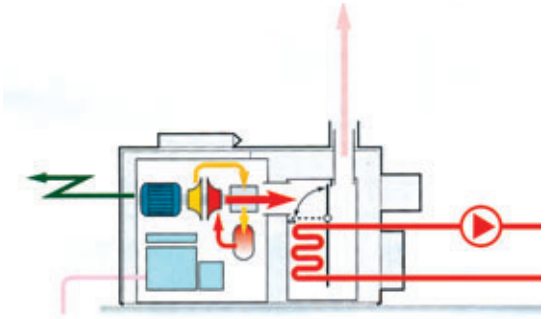
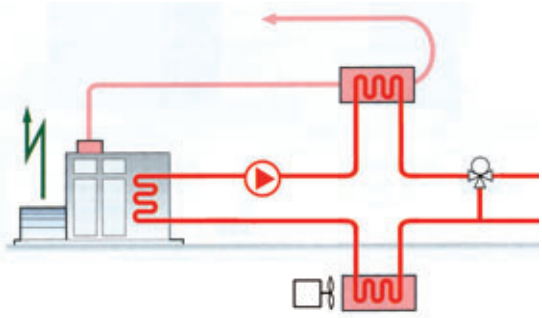
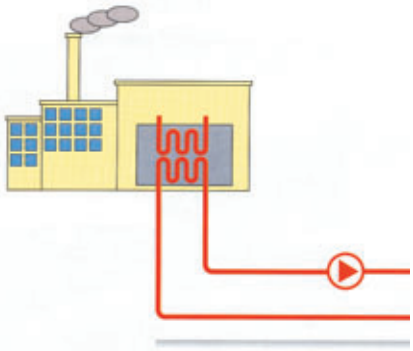
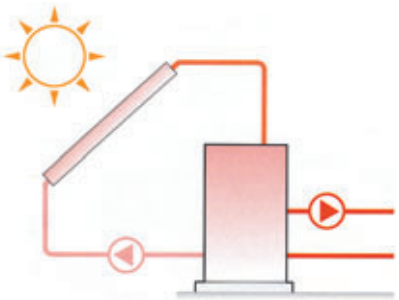
Water Fired Chiller/Chiller-Heater

WFC-S Series: 10, 20 and 30 RT Cooling









WE ARE FRIENDLY TO THE EARTH

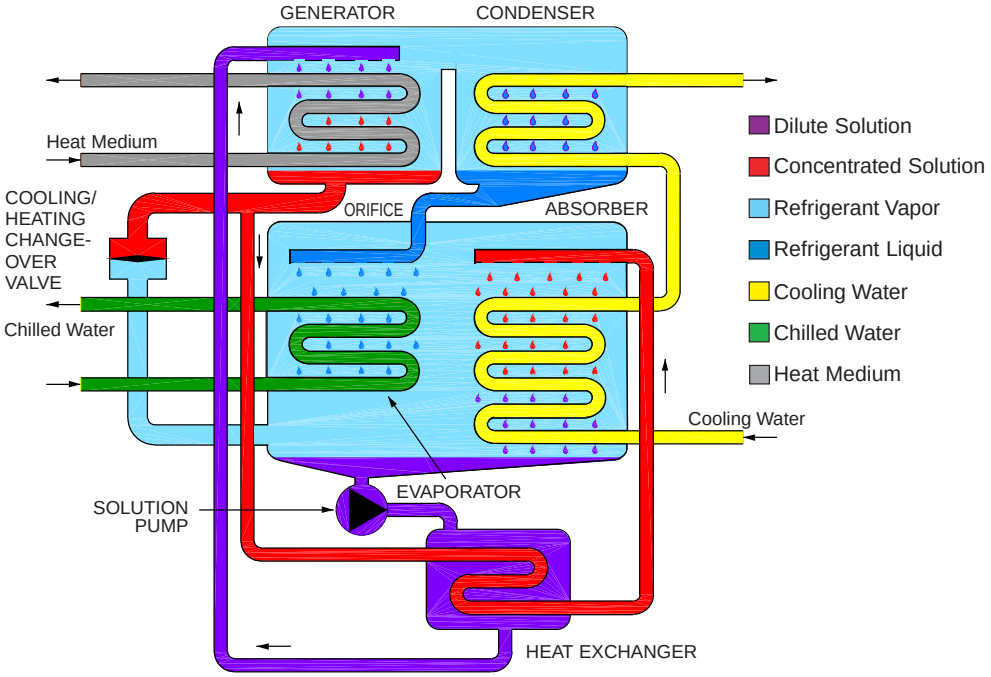
Water Fired SINGLE-EFFECT Chiller or Chiller-Heater

Yazaki water fired SINGLE-EFFECT chillers or chiller-heaters have cooling capacities of 10, 20 and 30 tons of refrigeration and produce chilled water for cooling or hot water for heating in comfort air conditioning applications. The absorption cycle is energized by a heat medium (hot water) at 158°F to 203°F from an industrial process, cogeneration system, solar energy or other heat source and the condenser is water cooled through a cooling tower.

Absorption Principle

The Yazaki absorption chiller or chiller-heater uses a solution of lithium bromide and water, under a vacuum, as the working fluid. Water is the refrigerant and lithium bromide, a nontoxic salt, is the absorbent. Refrigerant, liberated by heat from the solution, produces a refrigerating effect in the evaporator when cooling water is circulated through the condenser and absorber.

Cooling Cycle



Generator

When the heat medium inlet temperature exceeds 154.4°F, the solution pump forces dilute lithium bromide solution into the generator. The solution boils vigorously under a vacuum and droplets of concentrated solution are carried with refrigerant vapor to the primary separator. After separation, refrigerant vapor flows to the condenser and concentrated solution is precooled in the heat exchanger before flowing to the absorber.

Condenser

In the condenser, refrigerant vapor is condensed on the surface of the cooling coil and latent heat, removed by the cooling water, is rejected to a cooling tower. Refrigerant liquid accumulates in the condenser and then passes through an orifice into the evaporator.

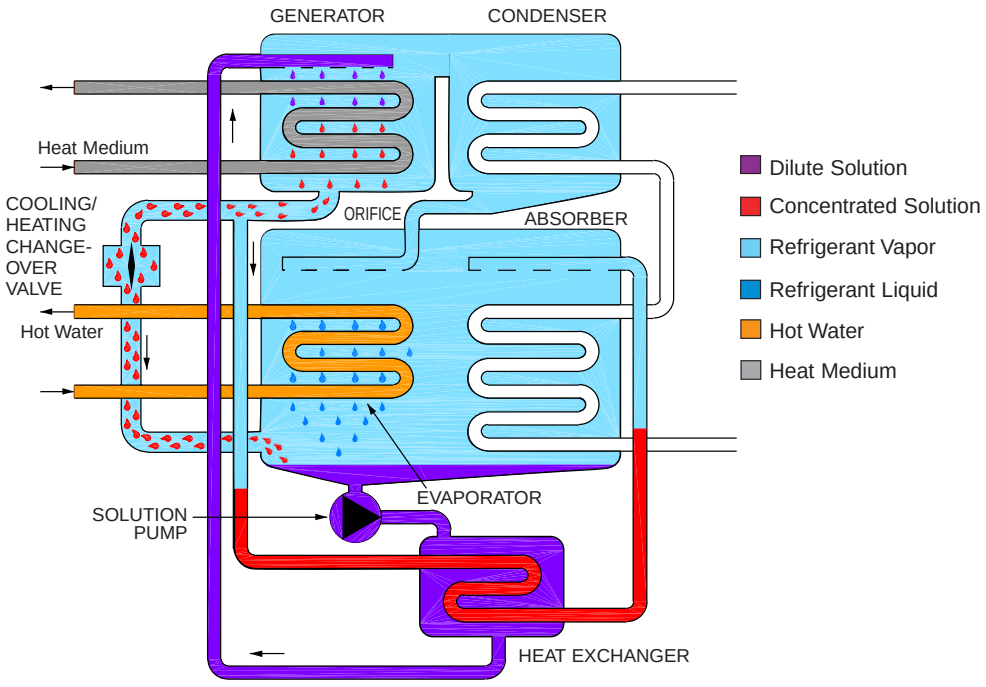
Heating Cycle

Evaporator

In the evaporator, the refrigerant liquid is exposed to a substantially deeper vacuum than in the condenser due to the influence of the absorber. As refrigerant liquid flows over the surface of the evaporator coil it boils and removes heat, equivalent to the latent heat of the refrigerant, from the chilled water circuit. The recirculating chilled water is cooled to 44.6°F and the refrigerant vapor is attracted to the absorber.

Absorber

A deep vacuum in the absorber is maintained by the affinity of the concentrated solution from the generator with the refrigerant vapor formed in the evaporator. The refrigerant vapor is absorbed by the concentrated lithium bromide solution flowing across the surface of the absorber coil. Heat of condensation and dilution are removed by the cooling water and rejected to a cooling tower. The resulting dilute solution is preheated in a heat exchanger before returning to the generator where the cycle is repeated.



Generator

When the heat medium inlet temperature exceeds 154.4°F, the solution pump forces dilute lithium bromide solution into the generator. The solution boils vigorously under a vacuum to generate refrigerant vapor and droplets of concentrated solution. Since the changeover valve is open during heating operation, the mixture of refrigerant vapor and concentrated solution flows directly into the evaporator. Some refrigerant vapor flows through the condenser before reaching the evaporator.

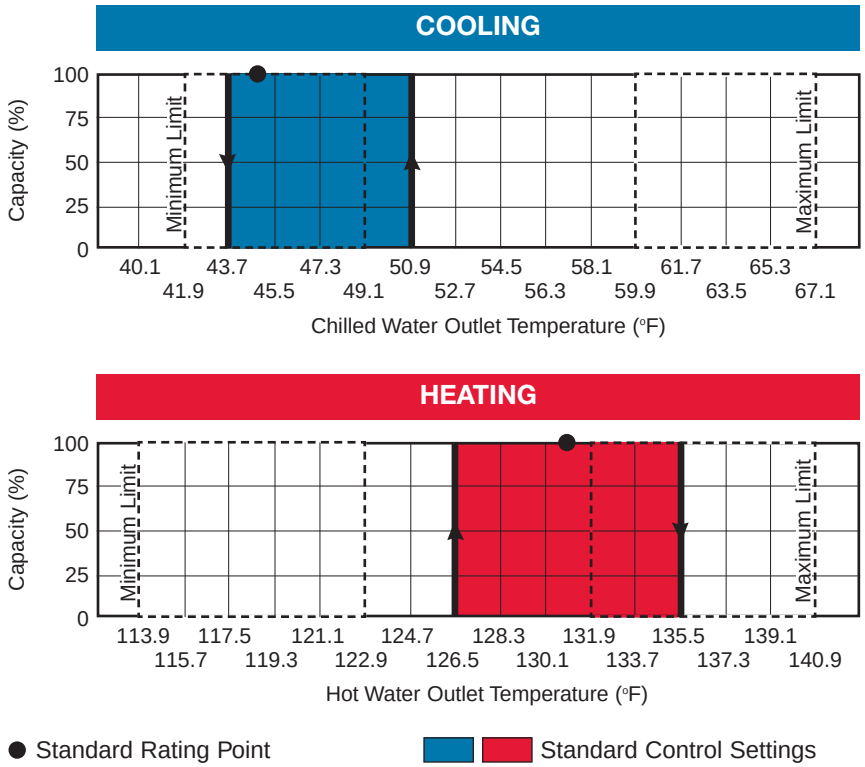
Evaporator

Hot refrigerant vapor condenses on the surface of the evaporator coil and heat, equivalent to the latent heat of the refrigerant, is transferred to the hot water circuit. The recirculating water is heated to 131°F. Refrigerant liquid mixes with concentrated lithium bromide solution and the resulting dilute solution returns to the generator where the cycle is repeated.

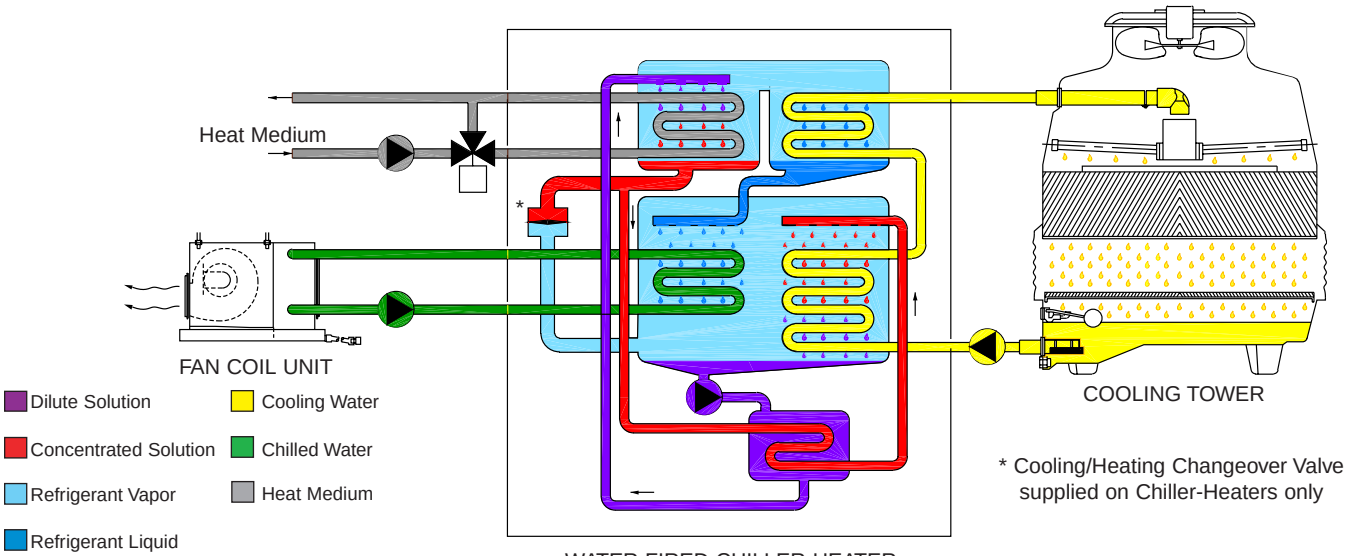
Features

- Absorption cycle energized by hot water at 158°F to 203°F from process, cogeneration, solar or other waste heat sources.
- Safe, odorless, non-toxic working fluids of lithium bromide and water operate under a vacuum at all times.
- Supplied as a chiller only or a chiller-heater for applications that require separation of heating water and heat medium circuits due to glycol, operating pressure, flow or piping limitations.
- Crystallization prevented in the generator by utilizing a solution pump and gravity drain-back system.
- Single hermetic pump controls solution flow.
- Faster cold start-up time than similar chillers with flooded generators.
- Chilled water and hot water outlet temperatures controlled by a built-in microprocessor with outputs to control a 3-way valve and/or heat medium pump (supplied by others).
- All chillers and chiller-heaters supplied with a standard weatherproof cabinet suitable for outdoor installation.
- Built-in shutdown controls for high heat medium temperature and abnormal cooling water conditions.
- Cooling capacities increased at 85°F cooling water and when energized by 203°F heat medium.
- Ideal for a two pipe hydronic system in which chilled or hot water is circulated to a central airhandling unit or multiple fan-coil units.
- Cooling or heating operation on chiller-heaters can be selected from a remote or built-in switch.
- Only 30 minute delay required for operation changeover.
- Transportation and lifting are simplified because of modular construction.
- Factory charged and performance tested.
- UL Listed for USA and Canada.

Control Characteristics



Application (Water Fired Cooling & Heating System - Cooling Operation)



Specifications

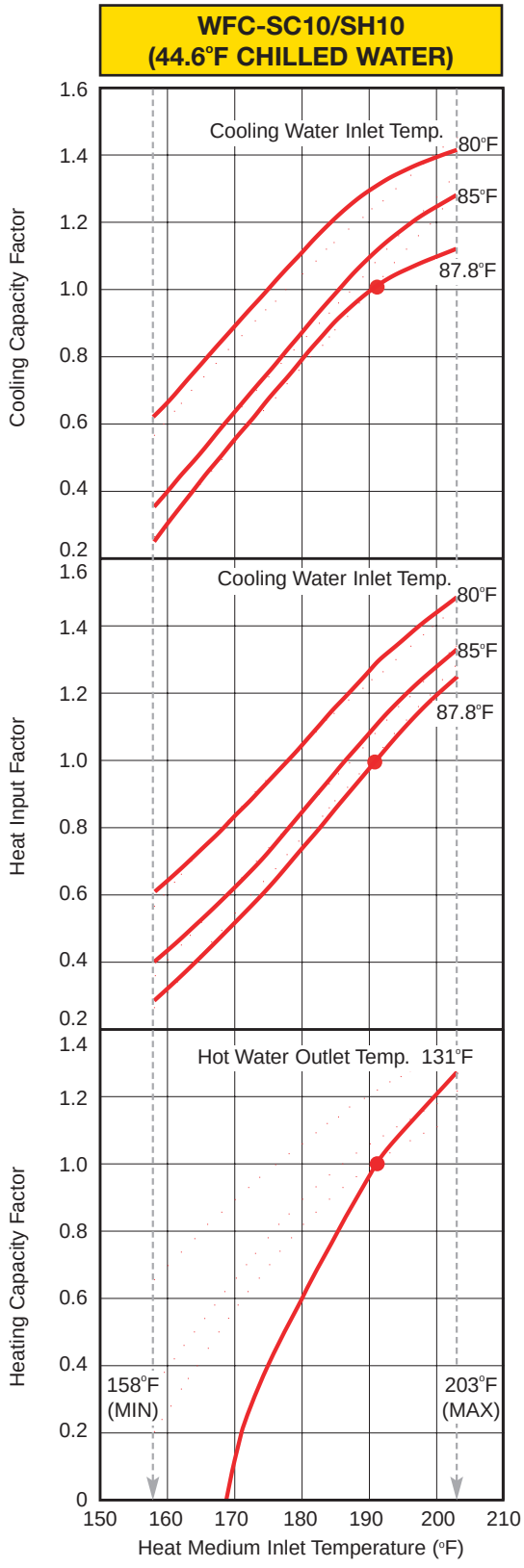
Model	WFC	SC10	SH10	SC20	SH20	SC30	SH30
Cooling	Capacity (Btu/hr x 1000)	120.0		240.0		360.0	
	Chilled Water Temp. (°F)	44.6 Outlet, 54.5 Inlet					
Heating	Capacity (Btu/hr x 1000)	—	166.3	—	332.6	—	498.9
	Hot Water Temp. (°F)	131.0 Outlet, 117.3 Inlet					
Chilled/Hot Water	Rated Water Flow (gpm)	24.2		48.4		72.6	
	Evap. Press Drop (psi)	8.1		9.6		10.1	
	Water Retention Volume (gal)	4.5		12.4		19.3	
Cooling Water	Heat Rejection (Btu/hr x 1000)	291.4		582.8		874.2	
	Inlet Temperature (°F)	87.8 (Standard)					
	*Rated Water Flow (gpm)	80.8		161.7		242.5	
	Cond./Abs. Press. Drop (psi)	12.3		6.6		6.7	
	Water Retention Volume (gal)	17.4		33.0		51.3	
Heat Medium	Input (Btu/hr x 1000)	171.4		342.8		514.2	
	Inlet Temperature (°F)	190.4 (Standard)					
		Temperature Range 158 (min.) - 203 (max.)					
	Rated Water Flow (gpm)	38.0		76.1		114.1	
	Generator Press. Drop (psi)	13.1		6.7		8.8	
	Water Retention Volume (gal)	5.5		14.3		22.2	
Electrical	Power Supply	208V, 60Hz, 3 ph					
	Consumption (W)	210		260		310	
Capacity Control		On - Off					
Noise Level	Sound Pressure dB(A)	49		49		46	
Piping	Chilled/Hot Water (in)	1-1/2 NPT		2 NPT		2 NPT	
	Cooling Water (in)	2 NPT		2 NPT		2-1/2 NPT	
	Heat Medium (in)	1-1/2 NPT		2 NPT		2-1/2 NPT	
Weight	Dry (lb)	1,100		2,050		3,200	
	Operating (lb)	1,329		2,548		3,975	

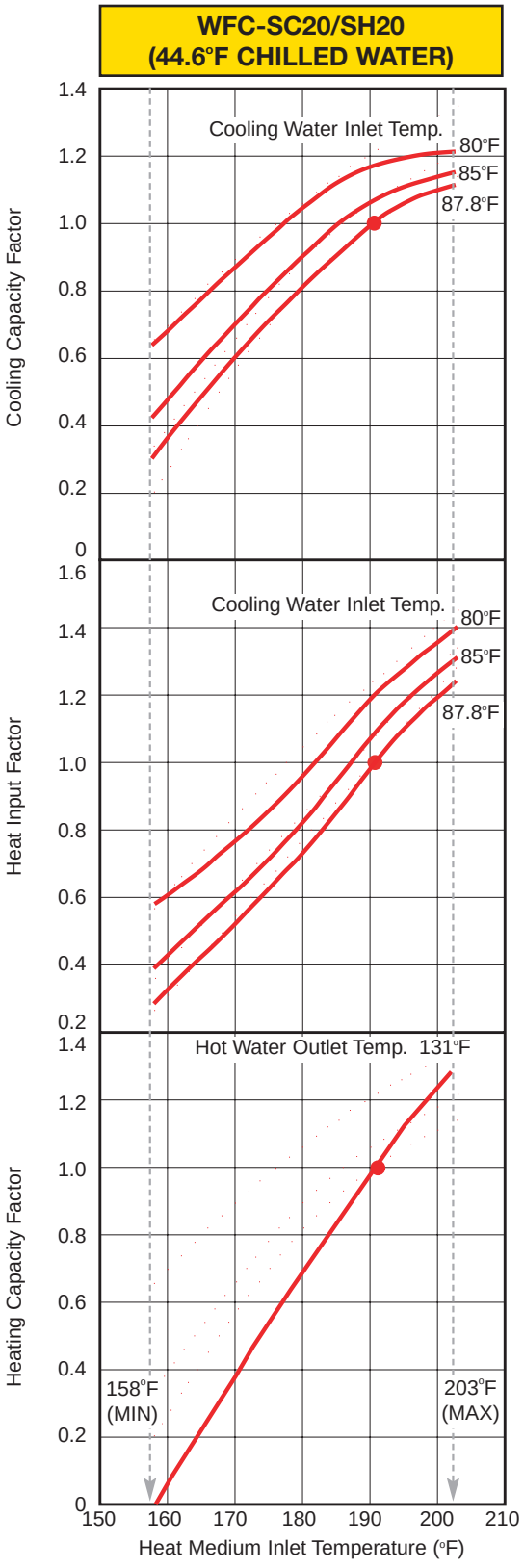
* Minimum cooling water flow

NOTES:

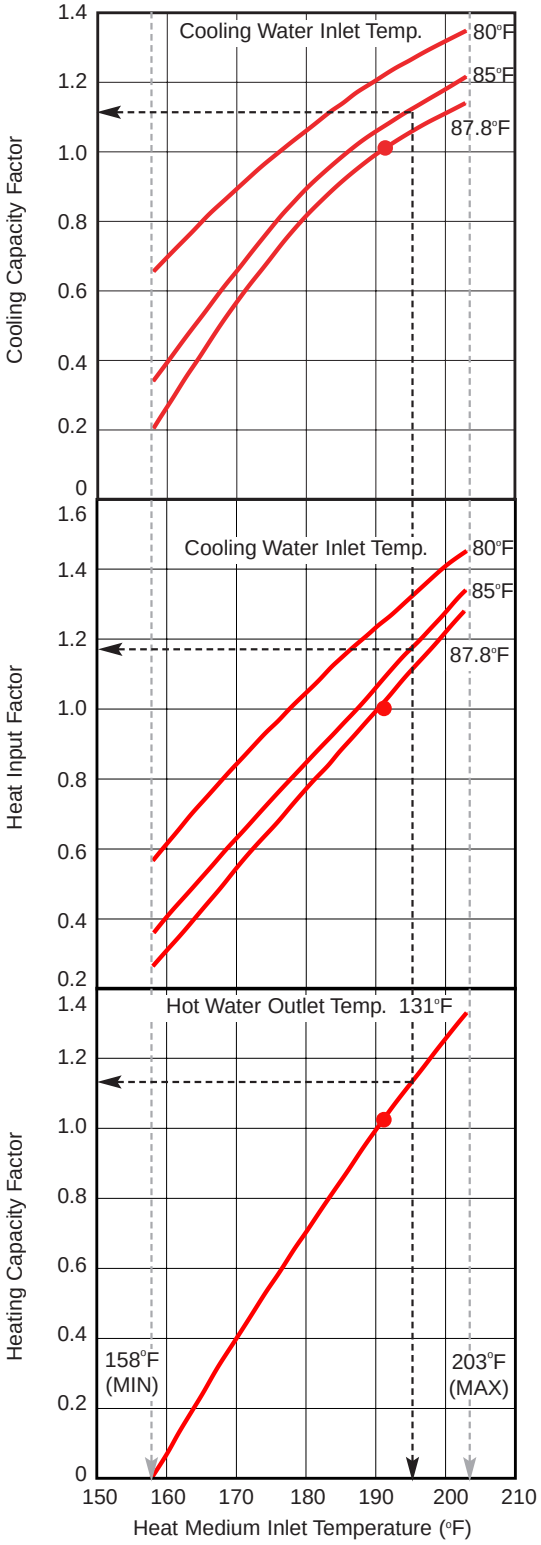
1. Specifications are based on water in all circuits and fouling factor of 0.0005 $ft^2hr°F/Btu$.
2. Do not exceed 85.3 psi operating pressure in any water circuit.
3. If heat medium inlet temperature exceeds 203°F the chiller/chiller-heater will shutdown and require manual reset.
4. Optional cooling water crossover piping with 3 in. type "L" copper connections available for WFC-SC20/SH20 and WFC-SC30/SH30.
5. Sound pressure noise level measured in a free field at a point 79 in. behind the chiller/chiller-heater and 59 in. above the ground.

Performance Characteristics

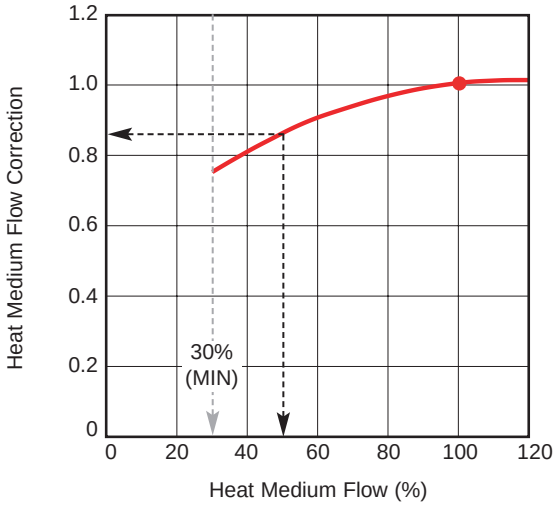




WFC-SC30/SH30 (44.6°F CHILLED WATER)



HM FLOW CORRECTION (44.6°F CHILLED WATER)



NOTES:

1. ● designates Standard Rating Point.
2. Capacity and Heat Input curves based on standard water flow rates in all circuits.
3. Heat Medium Flow Correction curve only applicable for heat medium inlet temperatures of 176°F to 203°F.
4. Heating Efficiency = 97%.
5. Performance based on standard fouling factor of 0.0005 $ft^2hr°F/Btu$ in all circuits.
6. Performance data may be interpolated but must not be extrapolated.
7. Expanded performance curves are provided for reference only. Contact Yazaki Energy Systems, Inc. to obtain certified performance ratings from the factory or to determine performance at other conditions outside the scope of this publication.

ABSORPTION CHILLER HEAT BALANCE

HEAT IN = HEAT OUT

$$Qg + Qe = Qc$$

Where, Qg = Heat input to generator
Qe = Cooling capacity
Qc = Heat rejected to cooling tower

COOLING CAPACITY

$$Qe = \text{CLG. CAP. FACTOR} \times \text{HM FLOW CORRECTION} \times \text{STD. CLG. CAPACITY}$$

HEAT INPUT (COOLING)

$$Qg = \text{HEAT INPUT FACTOR} \times \text{HM FLOW CORRECTION} \times \text{STD. HEAT INPUT}$$

HEATING CAPACITY

$$Qh = \text{HTG. CAP. FACTOR} \times \text{HM FLOW CORRECTION} \times \text{STD. HTG. CAPACITY}$$

Where, Qh = Heating Capacity

HEAT INPUT (HEATING)

$$Qg = \frac{\text{HEATING CAPACITY}}{\text{EFFICIENCY}} = \frac{Qh}{0.97}$$

TEMPERATURE DIFFERENCE (°F)

$$\Delta T = \frac{\text{ADJUSTED CAPACITY OR HEAT INPUT (MBH)}}{0.5 \times \text{FLOW (gpm)}}$$

PRESS. DROP FOR NONSTANDARD FLOW (psi)

$$\Delta P = \text{STANDARD PRESS. DROP} \times \left(\frac{\text{NONSTANDARD FLOW}}{\text{STANDARD FLOW}}\right)^2$$

EXAMPLE 1.

Given design conditions:

Heat medium inlet temperature	195°F
Heat medium flow	114.1 gpm
Cooling water inlet temperature	85°F
Cooling water flow	242.5 gpm
Chilled water outlet temperature	44.6°F
Hot water outlet temperature	131°F
Chilled/hot water flow	72.6 gpm
Absorption chiller-heater model	WFC-SH30

Refer to Capacity Factor curves and Specifications for model WFC-SC30/SH30. Since 114.1 gpm is standard, the Heat Medium (HM) Flow Correction is 1.0.

1. AVAILABLE COOLING CAPACITY:

   Cooling Capacity Factor = 1.12
   Heat Medium Flow Correction = 1.0
   Standard Cooling Capacity = 360.0 MBH
   Qe = 1.12 x 1.0 x 360.0 = 403.2 MBH (33.6 tons)

   Chilled Water $\Delta T = \frac{403.2}{0.5 \times 72.6} = 11.1°F$

   Chilled Water ΔP = 10.1 psi (Standard)

2. HEAT INPUT (COOLING):

   Heat Input Factor = 1.17
   Heat Medium Flow Correction = 1.0
   Standard Heat Input = 514.2 MBH
   Qg = 1.17 x 1.0 x 514.2 = 601.6 MBH

   Heat Medium $\Delta T = \frac{601.6}{0.5 \times 114.1} = 10.5°F$

   Heat Medium ΔP = 8.8 psi (Standard)

3. HEAT REJECTED TO COOLING TOWER:

   Qc = Qg + Qe = 601.6 + 403.2 = 1004.8 MBH

   Cooling Water $\Delta T = \frac{1004.8}{0.5 \times 242.5} = 8.3°F$

   Cooling Water ΔP = 6.7 psi (Standard)

4. AVAILABLE HEATING CAPACITY:

   Heating Capacity Factor = 1.12
   Heat Medium Flow Correction = 1.0
   Standard Heating Capacity = 498.9 MBH
   Qh = 1.12 x 1.0 x 498.9 = 558.8 MBH

   Hot Water $\Delta T = \frac{558.8}{0.5 \times 72.6} = 15.4°F$

   Hot Water ΔP = 10.1 psi (Standard)

5. HEAT INPUT (HEATING):

   $Qg = \frac{Qh}{0.97} = \frac{558.8}{0.97} = 576.1$ MBH

   Heat Medium $\Delta T = \frac{576.1}{0.5 \times 114.1} = 10.1°F$

   Heat Medium ΔP = 8.8 psi (Standard)

EXAMPLE 2.

Given design conditions:

Heat medium inlet temperature	203°F
Heat medium flow	57.0 gpm
Cooling water inlet temperature	85°F
Cooling water flow	242.5 gpm
Chilled water outlet temperature	44.6°F
Hot water outlet temperature	131°F
Chilled/hot water flow	72.6 gpm
Absorption chiller-heater model	WFC-SH30

Refer to Capacity Factor curves and Specifications for model WFC-SC30/SH30. Since 57.0 gpm is 50% of standard, the Heat Medium (HM) Flow Correction is 0.86.

1. AVAILABLE COOLING CAPACITY:

   Cooling Capacity Factor = 1.22
   Heat Medium Flow Correction = 0.86
   Standard Cooling Capacity = 360.0 MBH
   Qe = 1.22 x 0.86 x 360.0 = 377.7 MBH (31.5 tons)

   Chilled Water $\Delta T = \frac{377.7}{0.5 \times 72.6} = 10.4°F$

   Chilled Water ΔP = 10.1 psi (Standard)

2. HEAT INPUT (COOLING):

Heat Input Factor = 1.35
Heat Medium Flow Correction = 0.86
Standard Heat Input = 514.2 MBH
Qg = 1.35 x 0.86 x 514.2 = 597.0 MBH

$$\text{Heat Medium } \Delta T = \frac{597.0}{0.5 \times 57.0} = 20.9^{\circ}F$$

$$\text{Heat Medium } \Delta P = 8.8 \times \left(\frac{57.0}{114.1}\right)^2 = 2.2 \text{ psi}$$

3. HEAT REJECTED TO COOLING TOWER:

Qc = Qg + Qe = 597.0 + 377.7 = 974.7 MBH

$$\text{Cooling Water } \Delta T = \frac{974.7}{0.5 \times 242.5} = 8.0^{\circ}F$$

Cooling Water ΔP = 6.7 psi (Standard)

4. AVAILABLE HEATING CAPACITY:

Heat Capacity Factor = 1.33
Heat Medium Flow Correction = 0.86
Standard Heating Capacity = 498.9 MBH
Qh = 1.33 x 0.86 x 498.9 = 570.6 MBH

$$\text{Hot Water } \Delta T = \frac{570.6}{0.5 \times 72.6} = 15.7^{\circ}F$$

Hot Water ΔP = 10.1 psi (Standard)

5. HEAT INPUT (HEATING):

$$Qg = \frac{Qh}{0.97} = \frac{570.6}{0.97} = 588.2 \text{ MBH}$$

$$\text{Heat Medium } \Delta T = \frac{588.2}{0.5 \times 57.0} = 20.6^{\circ}F$$

$$\text{Heat Medium } \Delta P = 8.8 \times \left(\frac{57.0}{114.1}\right)^2 = 2.2 \text{ psi}$$

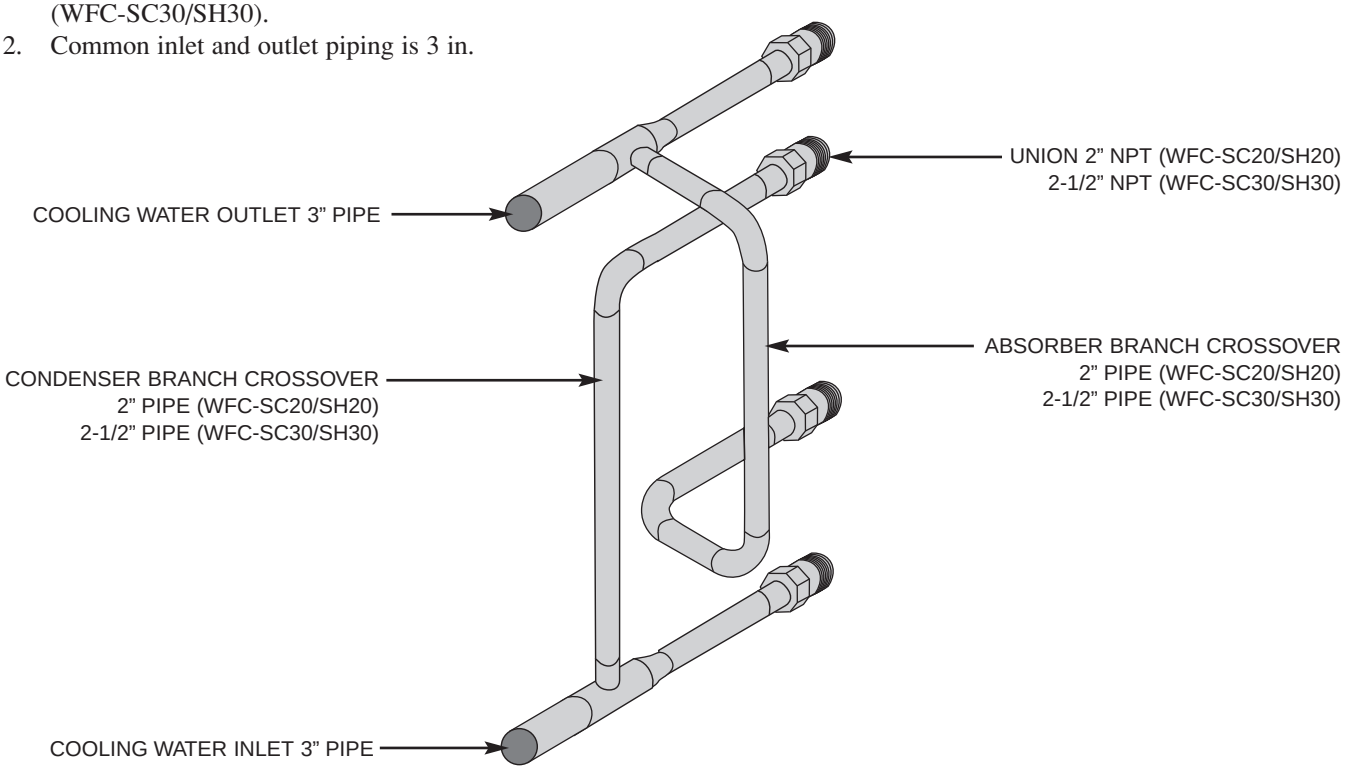
Cooling Water Crossover Piping (Optional)

The condenser and absorber of chiller/chiller-heater models WFC-SC20/SH20 and WFC-SC30/SH30 are connected in parallel by cooling water crossover piping installed at the jobsite. If this piping is fabricated at the jobsite by others it must be designed in accordance with the following recommendations to ensure balanced flow through the condenser and absorber:

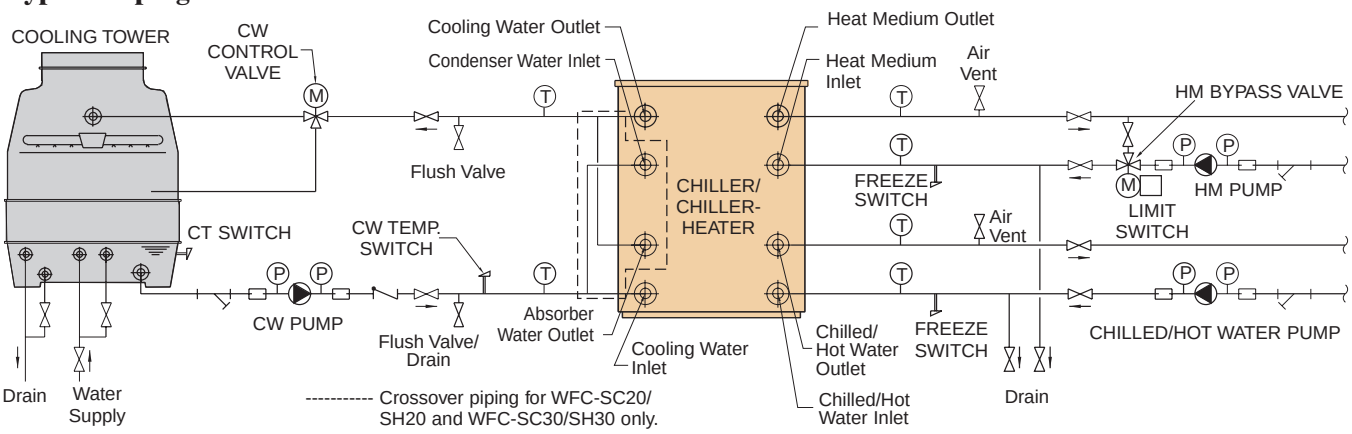
1. Branch piping is 2 in. (WFC-SC20/SH20) or 2-1/2 in. (WFC-SC30/SH30).
2. Common inlet and outlet piping is 3 in.

NOTES:

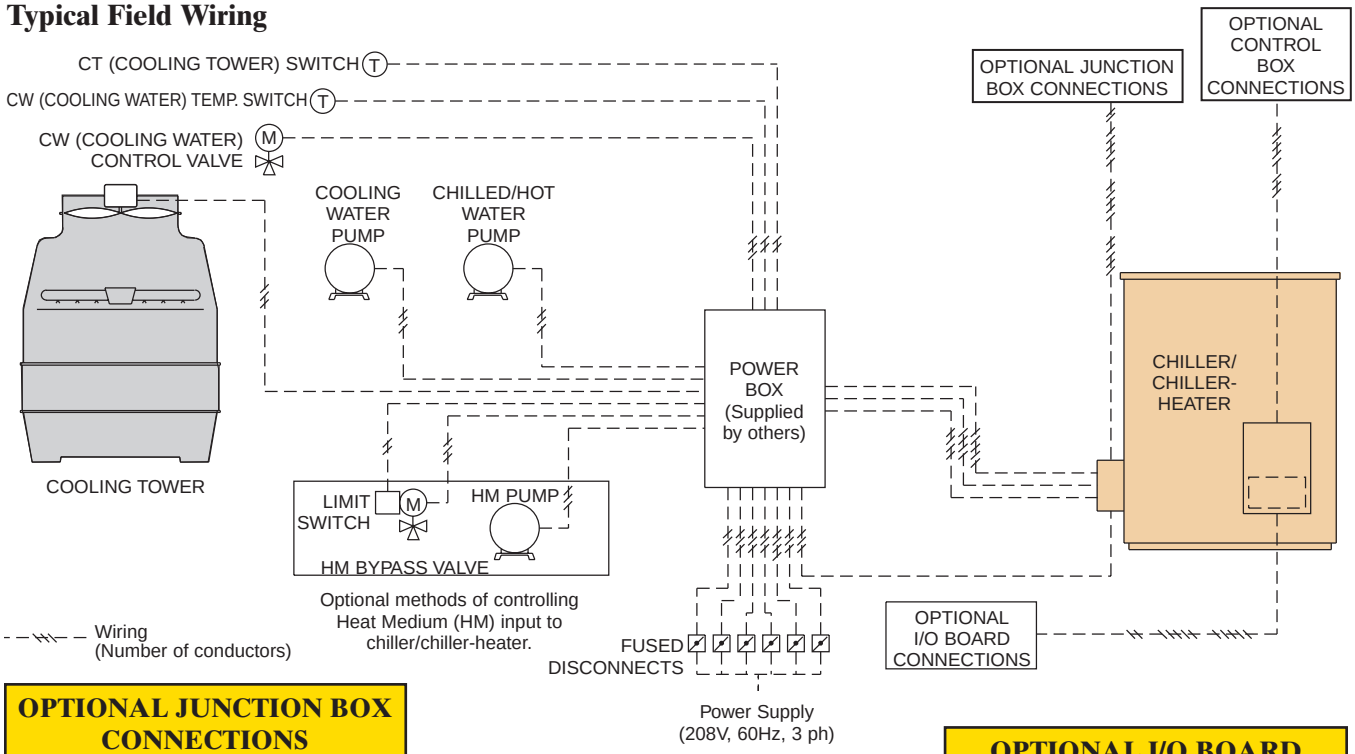
1. All pipe (or tube) sizing is nominal.
2. Install a manual balancing valve in the branch cooling water circuits to the condenser and absorber if flow is unbalanced due to changes in the piping configuration or pipe sizes.



Typical Piping



Typical Field Wiring



OPTIONAL JUNCTION BOX CONNECTIONS

- Remote cooling/heating mode selection (Model SH only)
- Remote start/stop selection (All models)
- Cooling tower fan control output (Alternative to CT Switch)
- Heating/cooling mode status
- Microturbine or engine override control output
- General shutdown alarm output

OPTIONAL CONTROL BOX CONNECTIONS

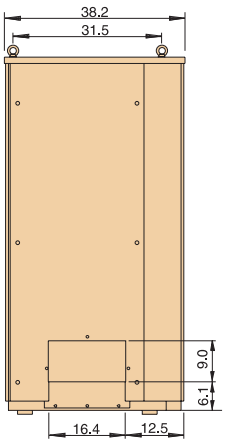
- Heat medium supply shutdown control output
- Auxiliary boiler control output
- Heat available input (Temp. switch supplied by others)
- Cooling water flow input (Flow switch supplied by others)

OPTIONAL I/O BOARD CONNECTIONS

- Shutdown interlock (Additional interlock)
- Freeze protection switch inputs for chilled/hot water and heat medium circuits (Temp. switches supplied by others)
- Chiller-heater standby status
- Operating status
- General fault alarm output

Dimensions

WFC-SC10/SH10



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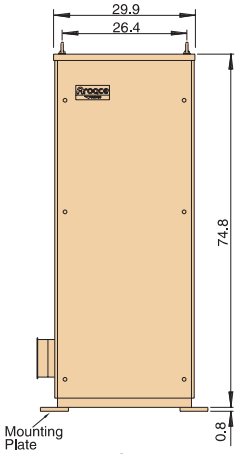

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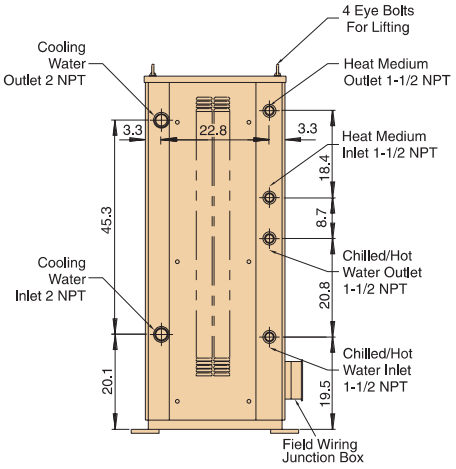
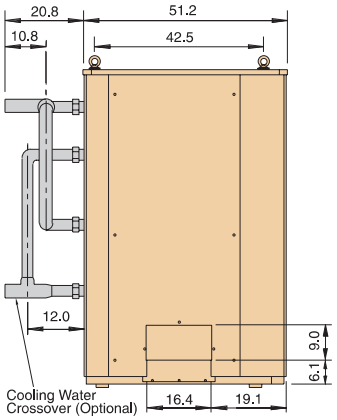


REAR

WFC-SC20/SH20



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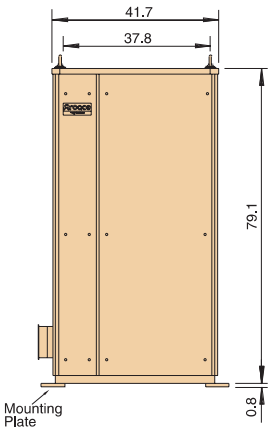

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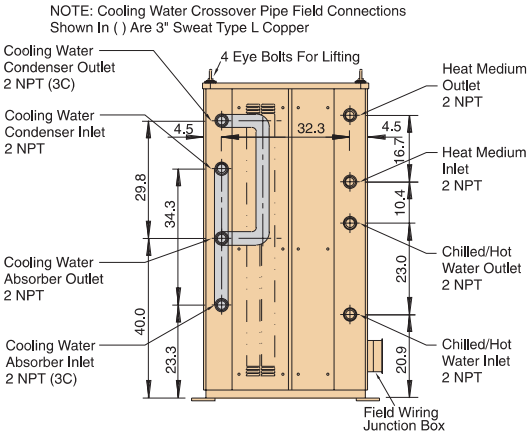

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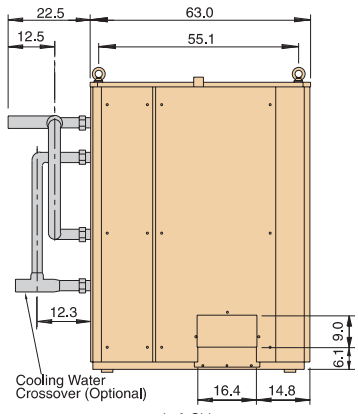
WFC-SC30/SH30



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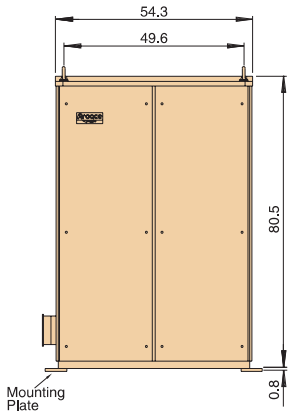

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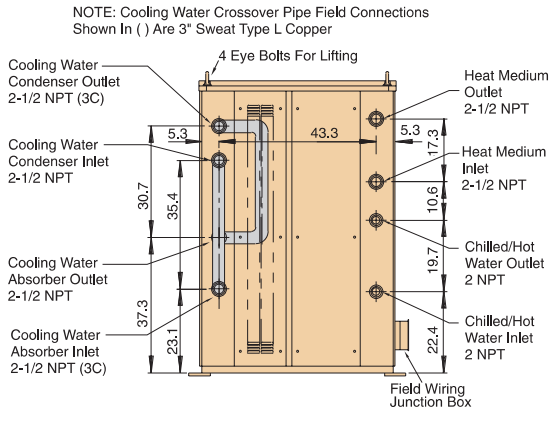

REAR

YAZAKI SALES REPRESENTATIVE/DISTRIBUTOR

For information concerning sales, operation, application
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75244-4516
Phone: 972-385-8725
Fax: 972-385-1324
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