Installation, Operation and Maintenance Manual

TTCC Series
Modular Cooling Tower™

Version MK1200-1 rev.6
Orig. 08/01/2025

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Chapter One: About This Manual

1.1 Scope

The information described herein pertains directly to the installation, operation and maintenance of the Tower Tech TTCC Series Fluid Cooler (also known as a Closed-Circuit Cooling Tower). The TTCC Series Fluid Cooler is a forced-draft, counter-flow design that allows modules to be arranged in a variety of configurations. Modules may be interconnected and additional modules added to accommodate virtually any cooling load.

1.2 Safety Messages

Pay particular attention to the following symbols when reading this manual:

ⓘ	NOTE	Notes are intended to clarify or make the installation easier.
⚠ CAUTION		Cautions are given to prevent equipment damage.
⚠ DANGER		**Danger warnings are given to alert installers and operators that personal injury and/or equipment damage may result if correct installation and operational procedures are not followed.**

Read all parts of this manual before installation or operating the tower. Contact our Customer Service Department at (405) 979-2123 if you have any questions.

⚠ CAUTION This product must be installed in strict compliance with the enclosed installation instructions and any applicable local, state, and national codes including, but not limited to building, electrical, and mechanical codes.

⚠ DANGER **Disconnect and lock out electrical power before attempting to inspect, repair, or perform maintenance on the module. Failure to follow installation instructions specified herein may create a condition whereby the operation of the product could cause personal injury, property damage, and/or death. Tower Tech assumes no liability for situations resulting from the failure to follow directions as specified in this manual.**

1.3 Reference

Forms referenced in this instruction can be ordered as follows:

Post Office Box:	Tower Tech ATTN: Literature P. O. Box 891810 Oklahoma City, OK 73189 U.S.A.
Street Address:	Tower Tech ATTN: Literature 100 E. California, Suite 210 Oklahoma City, OK 73104 U.S.A.
Electronic:	ATTN: Literature TEL (405) 979-2100 FAX (405) 979-2131 Literature@TowerTechUSA.com

1.4 Customer Service Support

Your satisfaction is important to us. Please direct any questions you may have regarding installation, operation, or maintenance of your Tower Tech Modular Cooling Tower to our knowledgeable Customer Service Support staff.

E-Mail Us at Service@TowerTechUSA.com

Call Us at 405-979-2123 Monday through Friday, 8:00 a.m. to 5:00 p.m. Central Time.

Chapter Two: TTCC Series Fluid Cooler Features

2.1 Model Nomenclature

Example: **TTCC-HC-i21945**

TTCC — **Model Series** — **XX** **YY** **ZZ**

Model Series -

FC = Evaporative
HC = Hybrid

Model Designation -

i1 = 1 Fans, 1 x 1 Configuration
i2 = 2 Fans, 1 x 2 Configuration
i3 = 3 Fans, 1 x 3 Configuration
i4 = 4 Fans, 1 x 4 Configuration

Fill Media Type -

19 = CF1900 *

* Cross-fluted fill media having a flute diameter of 19 millimeters is the basis of TTXR performance certification by Cooling Technology Institute (CTI). Other fill media types are available however their thermal performance may not be certified by CTI.

Motor Power -

22 = 2.2 kW / Fan
29 = 2.9 kW / Fan
30 = 3.0 HP / Fan
37 = 3.7 kW / Fan
45 = 4.5 kW / Fan
48 = 4.8 kW / Fan
50 = 5.0 HP / Fan
56 = 5.6 kW / Fan
75 = 7.5 HP / Fan

2.2 Configuration TTCC-FC – Evaporative Fluid Cooler

The Tower Tech TTCC Closed Circuit Cooler is characterized as a forced-draft, counter-flow evaporative fluid cooler.

The TTCC-FC evaporative design features a single layer of closed-circuit fluid cooling coils which can operate in either dry- or wet-mode using an integral recirculating water spray cooling system.

A 3-D section view displaying the internal components of the TTCC-FC Evaporative Fluid Cooler is depicted in Figure 1.

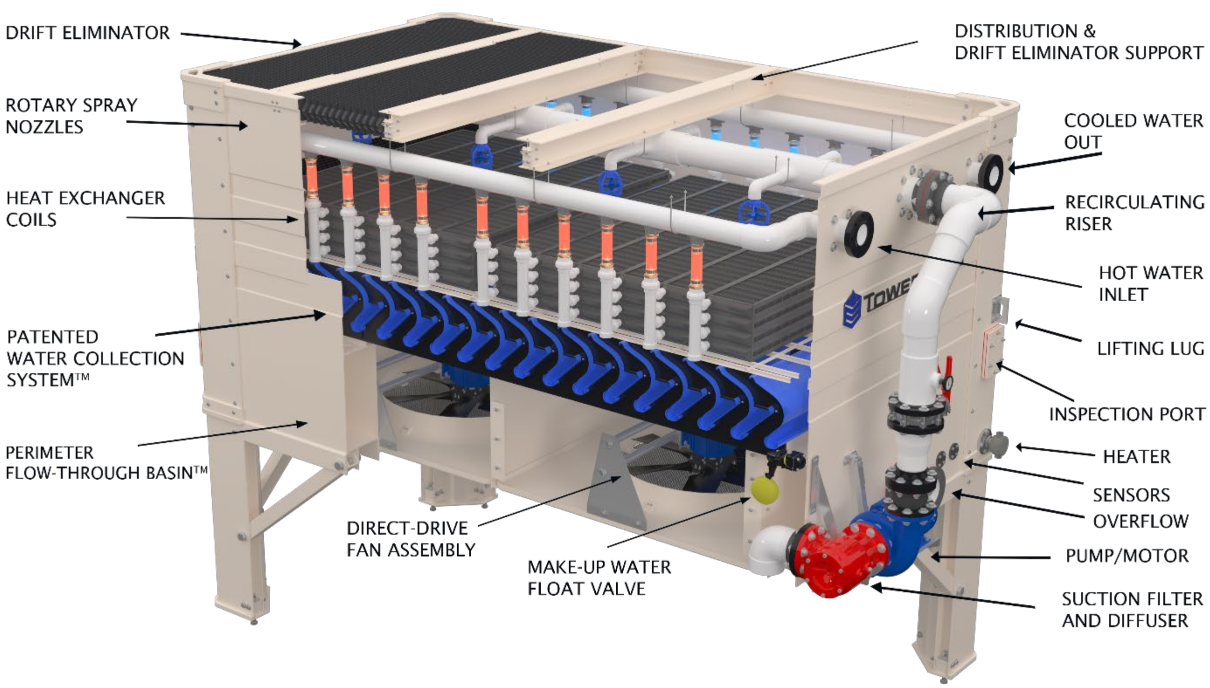


Figure 1 – TTCC-FC Evaporative Fluid Cooler 3-D Cut-Away View

2.3 Configuration TTCC-HC – Hybrid Fluid Cooler

The Tower Tech TTCC Series Fluid Cooler is characterized as a closed-circuit, forced-draft, counter-flow evaporative fluid cooler.

The TTCC-HC Hybrid design expands the range of performance with the addition of a second layer of closed-circuit fluid cooling coils plus multiple layers of fill media which can operate in either dry- or wet-mode using an integral recirculating water spray cooling system.

A 3-D section view displaying the internal components of TTCC-HC Hybrid Fluid Cooler is depicted in Figure 2.

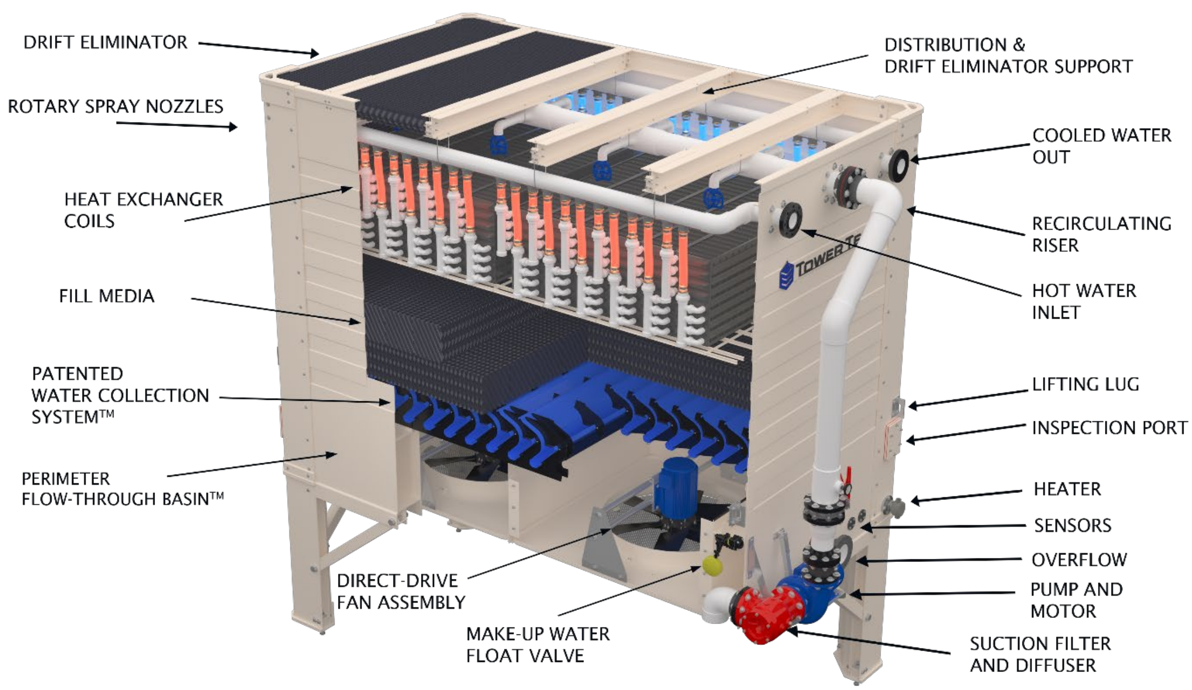
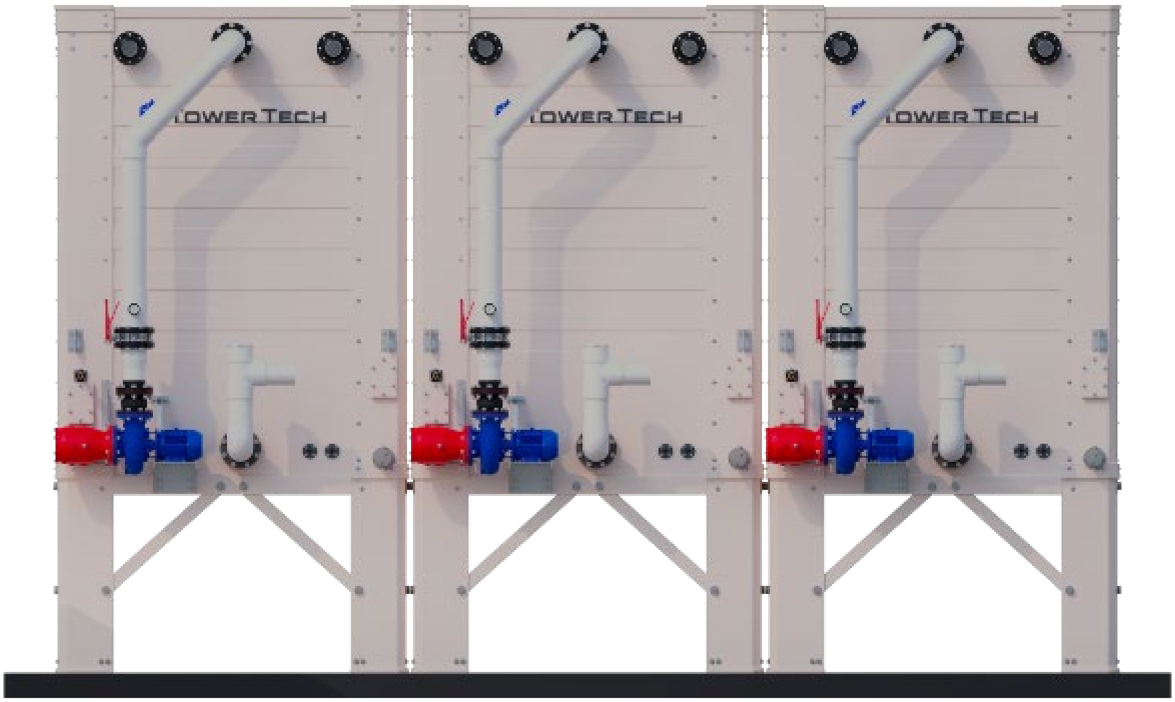


Figure 2 – TTCC-HC Hybrid Fluid Cooler 3-D Cut-Away View

2.4 Modular Expansion

The TTCC Series Fluid Cooler is distinguished by its modular design and bottom inlet airflow. This enables the individual modules to be interconnected and closely packed in numerous configurations to accommodate virtually any cooling capacity and footprint. This design is quickly adaptable to accommodate future expansion of cooling tower capacity.



Note: Keep all vents clear and open. Standpipes must be heat traced and insulated in cold climates.

Figure 3 – TTCC Series Fluid Cooler Arrangement

2.5 Flow-Thru Basin and Water Collection System

The recirculating water basin in the TTCC Series Fluid Cooler is comprised of a unique, patented Flow-Thru Basin™ consisting of four perimeter box beams (Perimeter Basin Walls). This structure forms the base of each tower module. A unique, patented Water Collection System™ (WCS) located above the fan motors serves as an air-water separator, capturing cooled recirculation water falling from the fill media and XchangeTech coils. The WCS channels the cooled water into the Flow-Thru Basin and is directed to the recirculation pump located at one end of the module. This unique enclosed system with its high flow velocity (~5-7 fps) contains no quiescent areas for water to stagnate and scrubs the basin walls and floor continually, thereby minimizing the problem of sediment accumulation that is common to all other cooler designs.

Figure 4 shows the internal placement of the WCS, Flow-Thru Basin, motors, and fans within a cooler. Each cooler is equipped with an externally mounted recirculating spray water pump that is flanged for easy maintenance. Standard equipment for each cooler includes a threaded make-up water connection, a mechanical float valve, a flanged overflow connection, and a pump suction diffuser with screen to collect any debris ahead of the pump inlet.

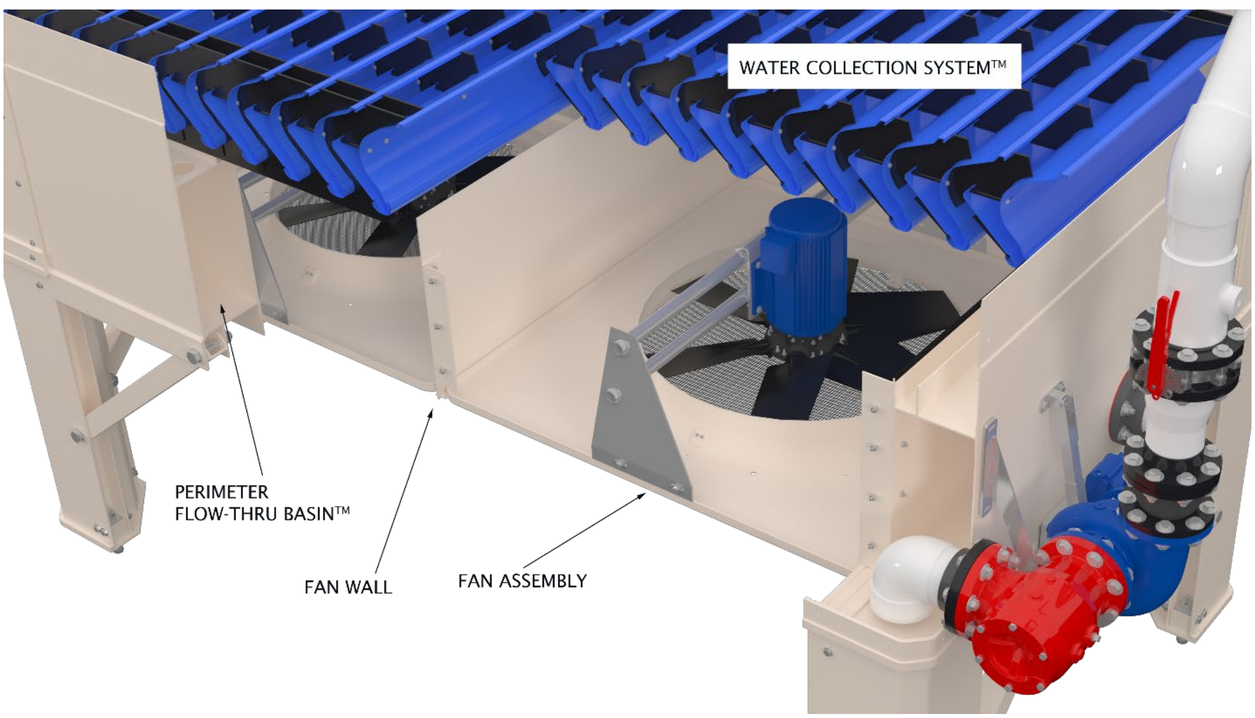


Figure 4 – Water Collection System, Flow-Thru Basin, Fans, Pump

2.6 Make-Up Connection / Float Valve

The TTCC Series Fluid Cooler is supplied with a one-inch threaded float valve (see Figure 5). The fitting is Female National Pipe Thread (FNPT). The connection flange is made from high quality plastic to eliminate corrosion. The maximum rated operating pressure for the valve is 100 psi (7.03 kgf/cm2). See literature in the Appendix section.

You must install a pressure reducer valve if operating pressure exceeds 100 psi (7.03 kgf/cm2).

The make-up water piping should contain an electric solenoid valve and anti-siphon/breaker device before the valve connection: Refer to local codes for details.

Figure 5 – Mechanical Float Valve

2.7 Water Level Sight Glass

The TTCC Series Fluid Cooler is equipped with a sight glass on the inspection port below the make-up float valve. A rubber boot is provided to limit sunlight from entering the basin and should be re-attached after every use.

Figure 6 – Sight Glass Inspection Port

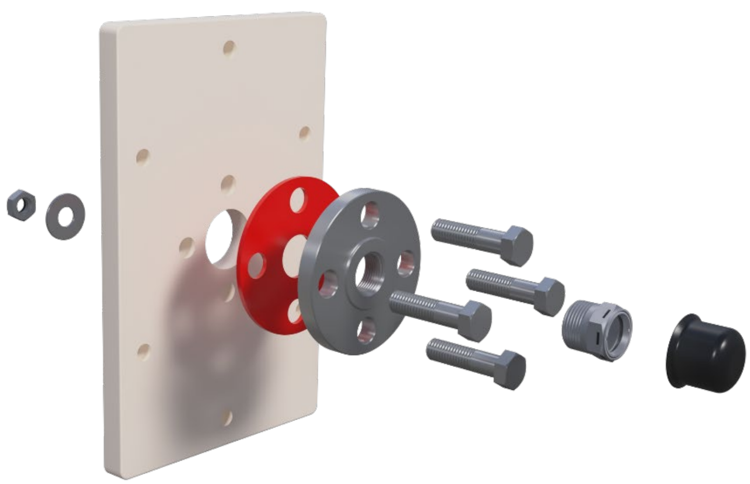


Figure 7 – Sight Glass Inspection Port Exploded View

2.8 Basin Drain Solenoid Valve

The TTCC Series Fluid Cooler is supplied with a two-inch threaded basin drain fitting and 24vac normally closed solenoid valve. The valve is mounted to a Tower Tech standard winter drain kit and is wired to the control panel for automatic drain operation. The entire assembly may be removed from the tower basin if necessary for service or replacement.

Tower Tech recommends routing piping from the valve out from under the tower in any direction which does not obstruct or interfere with routine fan service activity. Figure 6 shows typical piping, including PVC union to allow removal of the valve.

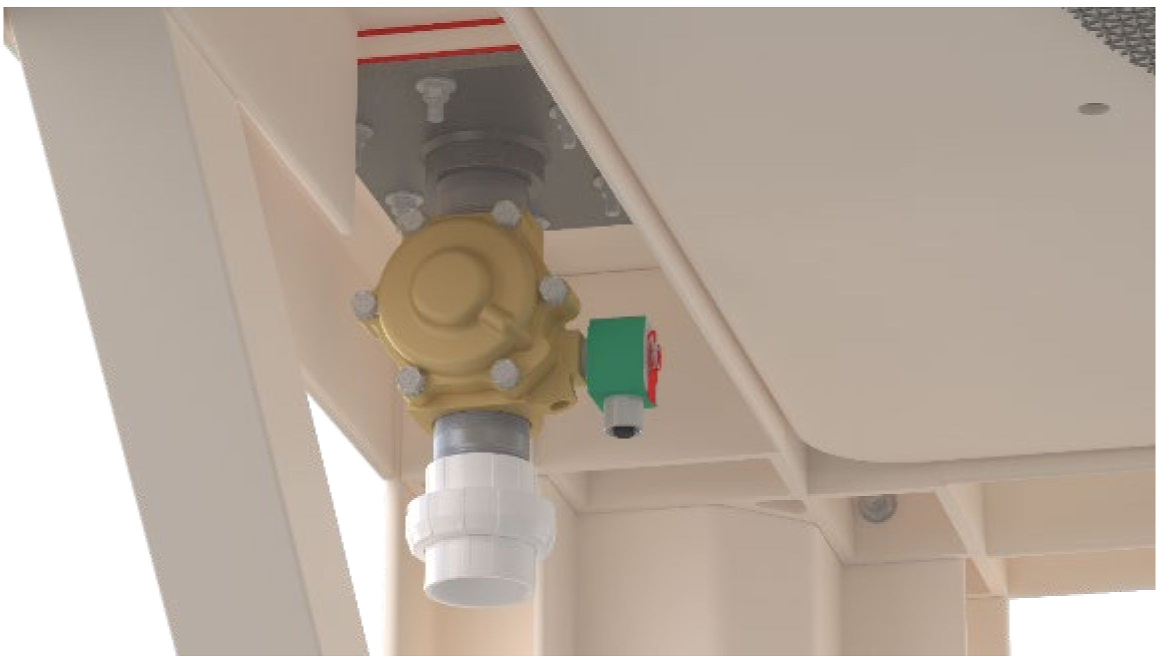


Figure 8 – Basin Drain Solenoid Valve

Model	ASCO™ 210 2-Way Solenoid Valve
Body Material	Brass, Stainless Steel
Pipe / Port Size	2”
Port Type	NPTF
Function	2-Way – 2/2 Normally Closed
Flow	45 Cv
Voltage	24 AC
Max Oper. Pressure	24 bar
Environment	Outdoor

2.9 Spray Nozzle

Figure 9 – Spin-Free™ Spray Nozzle

The TTCC Series Fluid Cooler contains Spin-Free™ spray nozzles that disperse water from the distribution piping above the XchangeTech tubes. The nozzle requires less pressure to operate than a conventional nozzle, is virtually maintenance free, and improves cooler performance. The nozzle design provides uniform water loading achieved by a square distribution pattern.

The spray nozzle combines a low-profile lateral spray pattern with a low-pressure orifice. This allows the nozzle to be positioned as close as one inch above the surface of the cooling coils, saving several feet of pump head. In addition, the use of a turbine in the nozzle to break up the flow is much more efficient than the atomization approach used in a conventional nozzle.

Debris that typically clogs conventional nozzles will pass directly through the spray nozzle. This is accomplished by the 2” (5.08 cm) nozzle throat and inlet coupled with the brisk rotating agitation action provided by the nozzle's turbine.

Significant increases in performance can be achieved with the use of the spray nozzle because of improved fill coverage and control of the flow pattern size. The nozzle orifice is shaped to provide a square spray pattern, thereby uniformly wetting the entire fill media. This improves cooler performance and reduces the likelihood of scaling due to the occurrence of dry regions within the fill and XchangeTech coil packs. This flexible capability is not present in fixed orifice spray nozzles which must remain very near design flow to provide the required spray coverage.

2.10 Recirculating Spray Pump Assembly

Cooling water recirculation is achieved using a Scot MotorPump^{tm} used in combination with a Suction Diffuser with Stainless Steel Strainer. Specifications for these components will be found in the appendix section of this manual.

Figure 10 – Recirculating Pump with Motor and Suction Diffuser

Figure 11 – Recirculating Pump Assembly Exploded View

2.11 Recirculating Spray Pump Data

Engineering Data

60 Hz, 40° C., 200V, 230V, 460V or 575V

Model TTCC	No. Pumps	kW / Pump	kW / Module	HP / Pump	HP / Module	Volts	FLA / Fan	FLA / Module	SFA (MMC) / Pump [a]	SFA (MMC) / Module [a]	Eff'y [b]	RPM	S.F.
	Pump Motors	**3 Phase, 60 Hz, 40° C., 200V, 230V, 460V or 575V**											
i1 & i2	1	3.7	3.7	5.0	5.0	200	14.9	14.9	18.6	18.6	89.5%	1750	1.25
						230	13.0	13.0	16.3	16.3	89.5%		
						460	6.5	6.5	8.1	8.1	89.5%		
						575		0.0	0.0	0.0			
i3 & i4	2	3.7	7.4	5.0	10.0	200	14.9	29.8	18.6	18.6	89.5%	1750	1.25
						230	13.0	26.0	16.3	16.3	89.5%		
						460	6.5	13.0	8.1	8.1	89.5%		
						575		0.0	0.0	0.0			

a Baldor motor data. SFA (MMC) refers to Service Factor Amps (Maximum Motor Current).
Size VFD for SFA (MMC) when motor is operated by VFD bypass.

b Rating is NEMA nominal efficiency. Standard motors, TEAO severe duty, direct drive, with L10 100,000 hour sealed bearings, inverter duty with quantum shield wiring, class "H" insulation (minimum).
Motors meet NEMA MG-1 Part 31 requirements for inverter duty use.

c Metric dimensions approximate.

Table 1 – Pump Data

2.12 Fan Motors

TTCC Series Fluid Coolers are equipped with Baldor brand motors that are direct-drive, totally enclosed air over (TEAO), 6-pole, induction-type, inverter-ready, with Class H (Class F minimum) insulation, and L_{10} sealed bearings rated for 100,000-hour life with sealed case. All Baldor motors on TTCC coolers meet IP55 and NEMA MG-1 Parts 30 and 31 requirements. Standard available motor types:

<u>60Hz 40°C</u>. Available 3.0 HP, 5.0 HP, or 7.5 HP. Available at 200V, 230V, 460V and 575V.

<u>60Hz 50°C</u>. Available 3.0 HP, 5.0 HP or 7.5 HP. Available at 190V, 230V, 380V or 460V.

<u>50Hz 40°C</u>. Available 2.2 kW, 3.7 kW, 4.8kW or 5.6 kW. Available at 190V-208V, 220V, 380V-415V or 440V.

<u>50Hz 50°C</u>. Available 2.9 kW or 4.5 kW. Available at 190V-208V and 380V-415V.

Motor type and power level depends on tower model selected and required design conditions. Refer to Table 2 for Fan Motor Data.

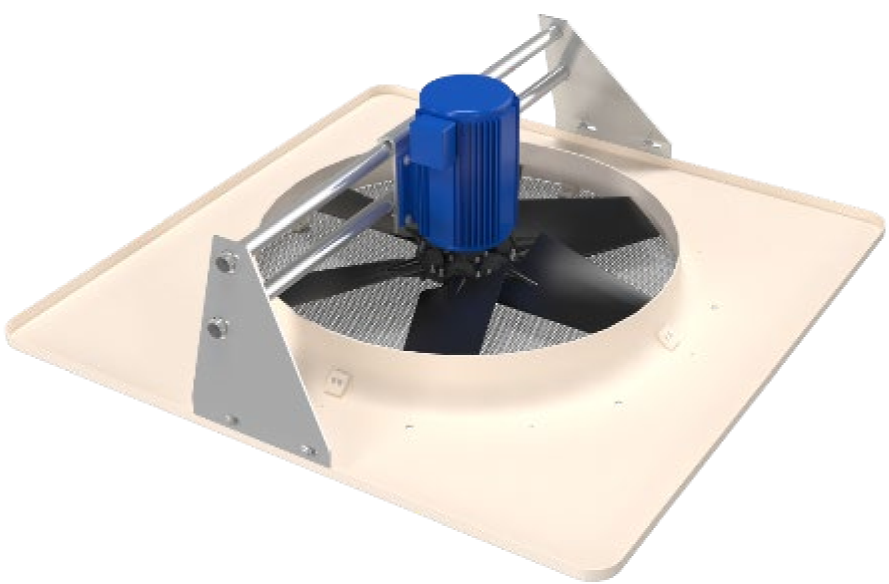


Figure 12 – Fan Motor, Motor Support, Fan, Fan Shroud

2.13 Engineering Data

Engineering Data

60 Hz, 40° C., 200V, 230V, 460V or 575V

Model	Fan Motors					3 Phase, 60 Hz, 40° C., 200V, 230V, 460V or 575V								Connections [c]			
TTCC	No. Fans	kW / Fan	kW / Module	HP / Fan	HP / Module	Volts	FLA / Fan	FLA / Module	SFA (MMC) / Fan [a]	SFA (MMC) / Module [a]	Eff'y [b]	RPM	S.F.	Inlet Dia.	Outlet Dia.	Makeup Dia.	Overflow Dia.
i10x30	1	2.2	2.2	3.0	3.0	200	11.4	11.4	13.1	13.1	90.2%	1180	1.15	4" (100mm)	4" (100mm)	1" FNPT (25mm)	6" (150mm)
						230	9.7	9.7	11.2	11.2	90.2%						
						460	4.9	4.9	5.6	5.6	90.2%						
						575		0.0	0.0	0.0							
i10x50		3.7	3.7	5.0	5.0	200	18.0	18.0	20.7	20.7	90.2%	1180					
						230	15.0	15.0	17.3	17.3	90.5%						
						460	7.5	7.5	8.6	8.6	90.5%						
						575		0.0	0.0	0.0							
i10x75		5.6	5.6	7.5	7.5	200	27.0	27.0	31.1	31.1	91.0%	1180					
						230	23.0	23.0	26.5	26.5	91.7%						
						460	11.5	11.5	13.2	13.2	91.7%						
						575		0.0	0.0	0.0							
i10x10		7.5	7.5	10.0	10.0	200	26.1	26.1	30.0	30.0		1200					
						230	23.6	23.6	27.1	27.1							
						460	11.8	11.8	13.6	13.6	90.5%						
						575	N/A										
i20x30	2	2.2	4.4	3.0	6.0	200	11.4	22.8	13.1	26.2	90.2%	1180	1.15	4" (100mm)	4" (100mm)	1" FNPT (25mm)	6" (150mm)
						230	9.7	19.4	11.2	22.3	90.2%						
						460	4.9	9.7	5.6	11.2	90.2%						
						575		0	0.0	0.0							
i20x50		3.7	7.4	5.0	10.0	200	18.0	36	20.7	41.4	90.2%	1180					
						230	15.0	30	17.3	34.5	90.5%						
						460	7.5	15	8.6	17.3	90.5%						
						575		0	0.0	0.0							
i20x75		5.6	11.2	7.5	15.0	200	27.0	54	31.1	62.1		1180					
						230	23.0	46	26.5	52.9							
						460	11.5	23	13.2	26.5							
						575		0	0.0	0.0							
i20x10		7.5	15	10.0	20.0	200	26.1	52.2	30.0	60.0		1200					
						230	23.6	47.2	27.1	54.3							
						460	11.8	23.6	13.6	27.1							
						575	N/A										
i30x30	3	2.2	6.6	3.0	9.0	200	11.4	34.2	0.0	39.3		1180	1.15	4" (100mm)	4" (100mm)	1" FNPT (25mm)	6" (150mm)
						230	9.7	29.1	11.2	33.5							
						460	4.9	14.55	5.6	16.7							
						575		0	0.0	0.0							
i30x50		3.7	11.1	5.0	15.0	200	18.0	54	20.7	62.1		1180					
						230	15.0	45	17.3	51.8							
						460	7.5	22.5	8.6	25.9							
						575		0	0.0	0.0							
i30x75		5.6	16.8	7.5	22.5	200	27.0	81	31.1	93.2		1180					
						230	23.0	69	26.5	79.4							
						460	11.5	34.5	13.2	39.7							
						575		0	0.0	0.0							
i30x10		7.5	22.5	10.0	30.0	200	26.1	78.3	0.0	90.0		1200					
						230	23.6	70.8	0.0	81.4							
						460	11.8	35.4	0.0	40.7							
						575	N/A										

2.13 Engineering Data, Continued

Engineering Data

60 Hz, 40° C., 200V, 230V, 460V or 575V

Model TTCC	Fan Motors No. Fans	kW / Fan	kW / Module	HP / Fan	HP / Module	3 Phase, 60 Hz, 40° C., 200V, 230V, 460V or 575V Volts	FLA / Fan	FLA / Module	SFA (MMC) / Fan [a]	SFA (MMC) / Module [a]	Eff'y [b]	RPM	S.F.	Connections [c] Inlet Dia.	Outlet Dia.	Makeup Dia.	Overflow Dia.
i40x30	4	2.2	8.8	3.0	12.0	200	11.4	45.6	13.1	52.4		1180	1.15	4" (100mm)	4" (100mm)	1" FNPT (25mm)	6" (150mm)
						230	9.7	38.8	11.2	44.6							
						460	4.9	19.4	5.6	22.3							
						575		0	0.0	0.0							
i40x50		3.7	14.8	5.0	20.0	200	18.0	72	20.7	82.8		1180					
						230	15.0	60	17.3	69.0							
						460	7.5	30	8.6	34.5							
						575		0	0.0	0.0							
i40x75		5.6	22.4	7.5	30.0	200	27.0	108	0.0	124.2		1180					
						230	23.0	92	0.0	105.8							
						460	11.5	46	0.0	52.9							
						575		0	0.0	0.0							
i40x10		7.5	30	10.0	40.0	200	26.1	104.4	30.0	120.1		1200					
						230	23.6	94.4	27.1	108.6							
						460	11.8	47.2	13.6	54.3							
						575	N/A										

[a] Baldor motor data. SFA (MMC) refers to Service Factor Amps (Maximum Motor Current). Size VFD for SFA (MMC) when motors will be operated by VFD bypass.

[b] Rating is NEMA nominal efficiency. Standard motors, TEAO severe duty, direct drive, with L_{10} 100,000 hour sealed bearings, inverter duty with quantum shield wiring, class "H" insulation (minimum). Motors meet NEMA MG-1 Part 31 requirements for inverter duty use.

[c] Metric dimensions approximate.

Table 2 –Engineering Data

2.14 Fans

Figure 13 – Typical 8-bladed 7WR Fan

High efficiency axial fans with a unique airfoil design are used on all TTCC Series Fluid Coolers.

The fan blades are made of high-strength, fiberglass reinforced polypropylene held in place by a die cast aluminum-silicon alloy hub. The high-efficiency fan blades are adjustable-pitch and thus can be set at various pitch angles to allow for maximum performance. After installation, the fans are adjusted to allow a nominal 1/4" tip clearance from the throat of the fan shroud. Minimum balancing tolerances are based on ISO balancing standard TC/108, DR 1940. A G6.3 balancing grade is used at 860 RPM.

Eight different fan models are used in the TTCC Series Fluid Coolers and vary based on motor selection (refer to Table 3).

Horsepower/kW	No. of Blades	Pitch Angle (Degrees)	Blade Profile
3.0HP	3	30	7WR
5.0HP	6	29	7WR
7.5HP	8	30	7WR
2.2kW	6	29	7WR
2.9kW	8	28	7WR
3.7kW	8	31	7WR
4.5kW	4	29	9WR
5.6kW	8	25	9WR

Table 3 – Fan Data for Motors

2.15 Fan Shroud

Figure 14 – Fan Shroud

The fan shroud used on the TTCC Series towers is made using a hand lay-up process using fiberglass mat and chopped fiberglass strands, or a resin transfer molding process employing fiberglass mat. The shroud's unique design radius provides a smooth transition for the air entering the fan, maximizing fan efficiency and thereby reducing energy costs. Using fiberglass construction, the shroud is very lightweight and strong, and resists corrosion indefinitely. The shroud assembly includes a durable stainless steel safety screen which is removable for service.

2.16 XchangeTech Coils

Figure 15 – Individual Coil with union connectors used in all TTCC models

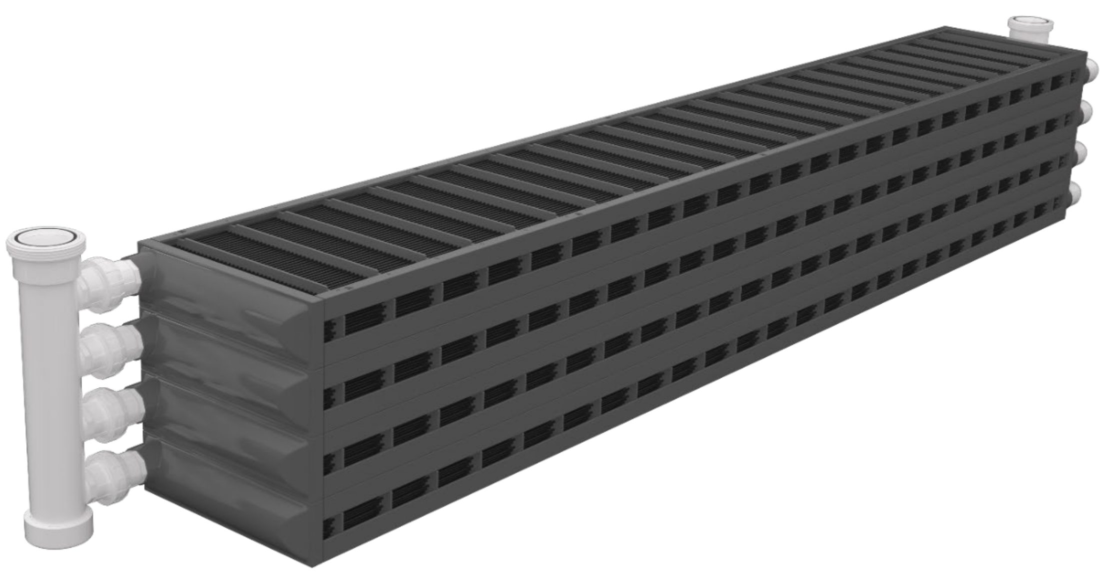


Figure 16 – Typical Pack of Four Coils with Unions and Headers

The TTCC Series Fluid Cooler is designed to cool a fluid consisting of a mixture of water and propylene glycol flowing inside nylon XchangeTech tubes and reject the heat by conduction through the tube wall to the fluid (air or water) flowing over the outside of the tubes. With the recirculating spray water off in dry cooling mode, the cool air stream flowing over the coils absorbs heat energy by conduction and heat is rejected to the atmosphere. With the recirculating spray water flowing, this water absorbs heat energy by conduction through the tube walls and simultaneously cooled through evaporation by the air flowing over the recirculated water.

The TTCC Series Fluid Cooler has 2 modes of operation as follows:

1. Fans only – Fans are operated by a variable frequency drive (VFD) when cool air only is sufficient to reject the process water heat.

2. Fans and water spray – Evaporative cooling of the recirculating water to the fan air.

The Tower Tech XchangeTech coils are smaller and lighter yet have a much larger surface area per cubic foot than conventional metal tube heat exchangers. This improves efficiency by increasing conduction of process heat to the outside of the tube. The large surface area is beneficial for evaporative cooling of the recirculating spray water. It performs like fill media in a cooling tower.

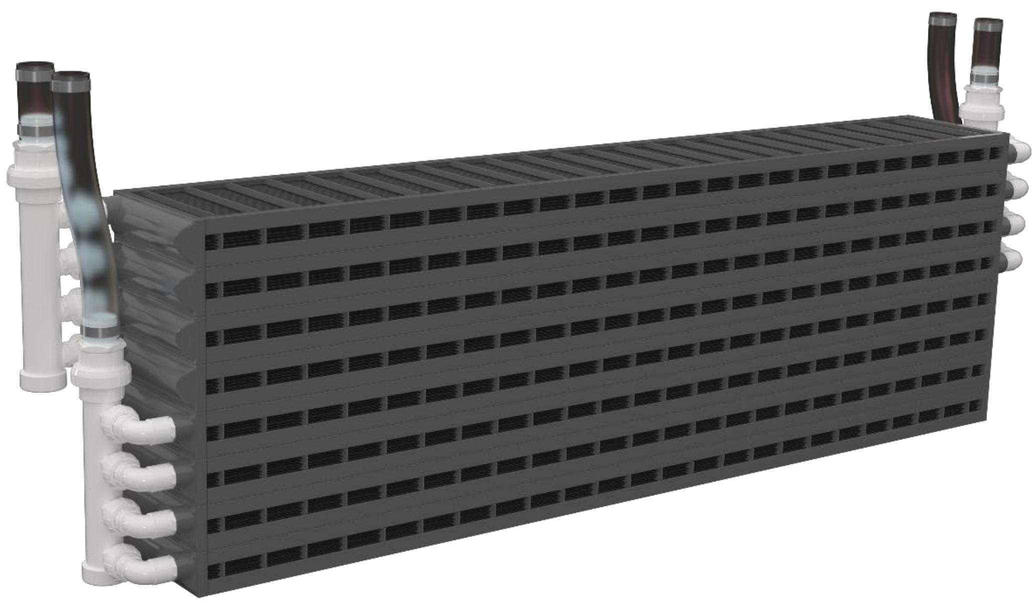


Figure 17 – Double Coil Pack with Hoses used in TTCC Hybrid

2.17 XchangeTech Drain System

In the event of a leak in a XchangeTech coil, it will be necessary to drain the fluid into a suitable storage container while repairs are performed. Each bundle of XchangeTech coils is fitted with a drainage tube at the bottom of the return header. See Figures 18 and 19.
Fluid volume is 1.3 Gallons per Coil Pack plus hoses and headers.
Drainage tubes are interconnected and routed to a manual drain valve located at the inspection port on the right rear corner post. See Figures 20 and 21.

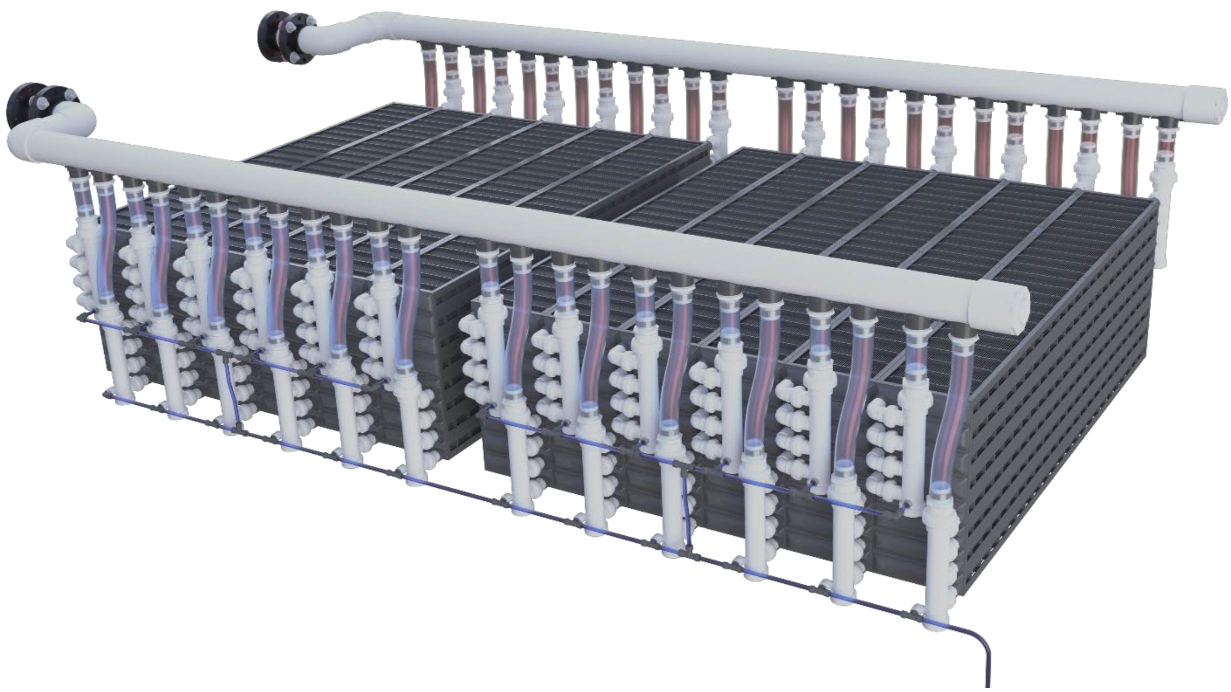


Figure 18 – Drain Tubes Attached to Hybrid Double Coil Packs

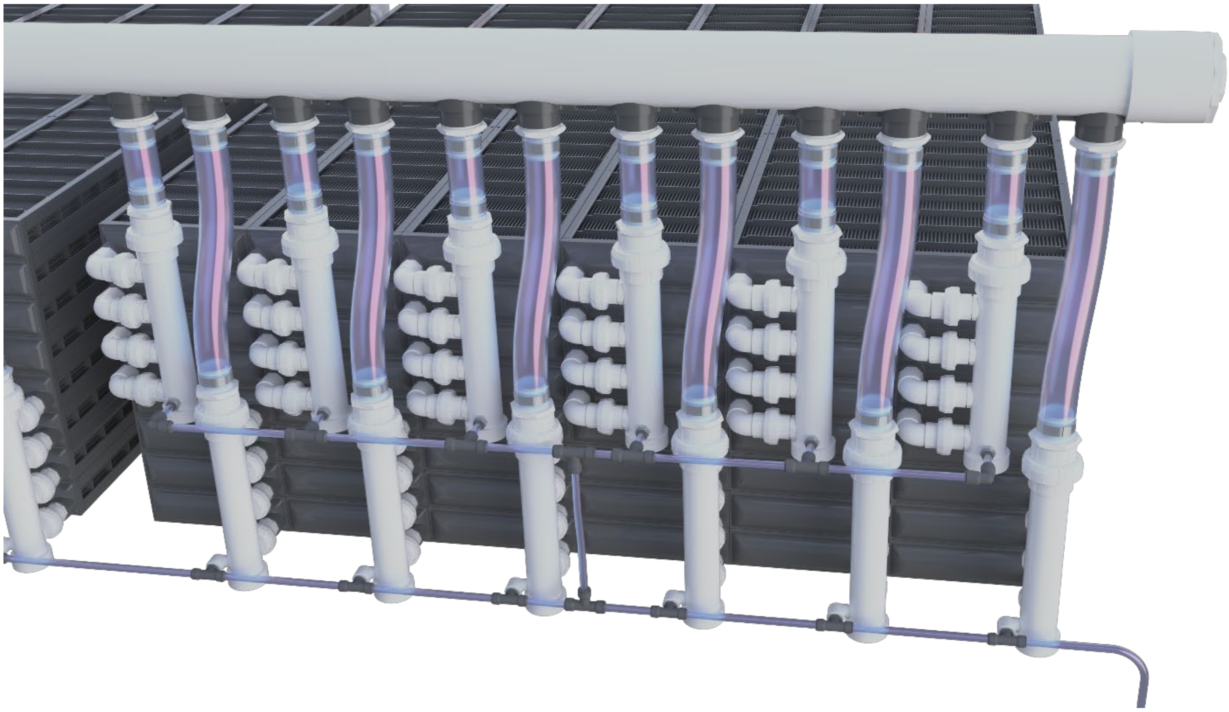


Figure 19 – Drain Tubes Attached to Hybrid Double Coil Packs

Figure 20 – XchangeTech Drain Valve Front

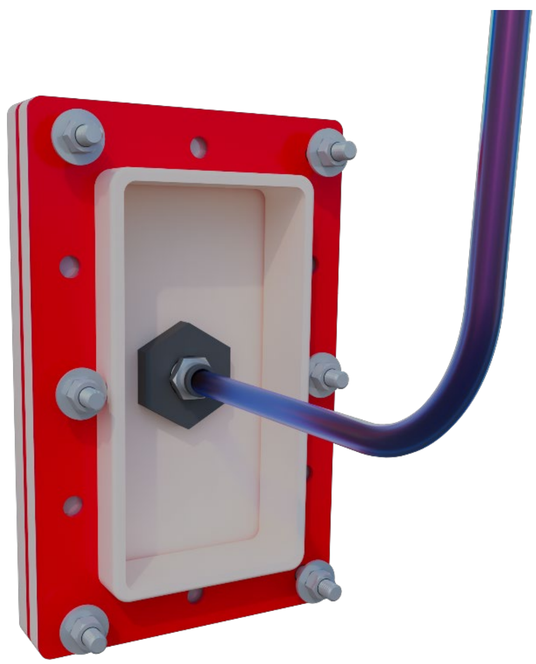


Figure 21 – XchangeTech Drain Valve Rear

2.18 External Basket Filter

Tower Tech requires the use of an external basket filter to prevent contaminants such as hair, lint or debris from fouling the heat exchanger tubes. The filter shall be installed by others upstream of the heat exchanger inlet connection at a location suitable for inspection and service. Follow installation instructions per vendor literature.

Vendor literature can be found in the appendix section of this manual and at this address:
https://fluidtrol.com/product/sw-basket-strainers/

Configuration: In-Line
Connection: 6" Flanged
Weight: 45 LBS (not including fluid)
Housing: FRP / PVC Sch 80, ANSI B16.5, Class 150
Basket: 316 Stainless with 1/8" Holes on 3/16" Staggered Centers
Lid: 1" Clear Acrylic, Vented
Seals: EPDM
Hardware: 316 Stainless Steel
Standards: AWSD1.1, AWSD1.3, ASME B31.4, ASME B31.9

Figure 22 – Basket Strainer

2.19 Fill Media

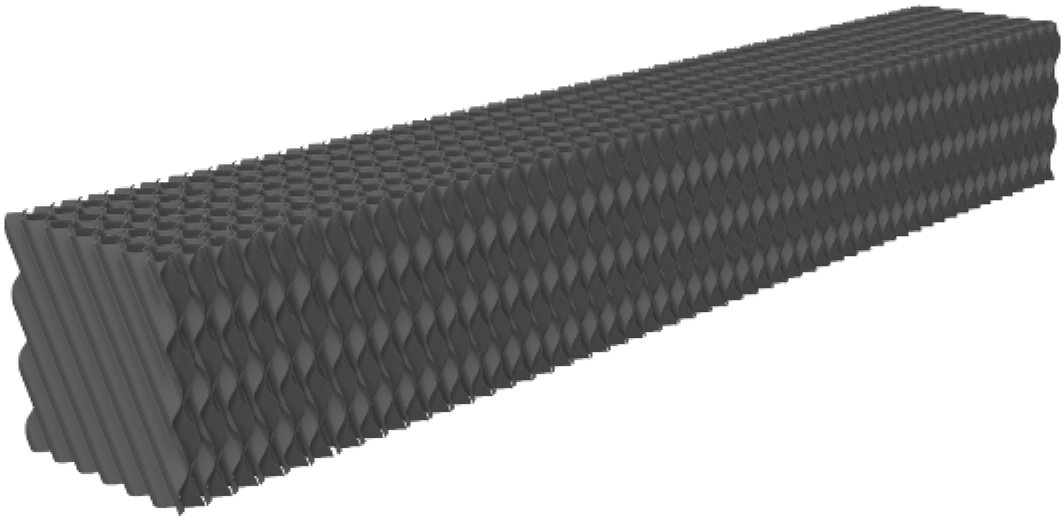


Figure 23 – Fill Media

An important component of a hybrid closed circuit cooler is the use of additional heat transfer surface with fill media. The fill's efficiency is a function of its ability to promote contact between the air and water with a minimum resistance or impedance to airflow. The fill media used by Tower Tech meets the rigorous standards of the Cooling Technology Institute (STD-136[88]) by having uniform thickness and hole, air bubble, free of foreign matter and free of other manufacturing defects which may adversely affect performance. Refer to Table 4 for fill media data.

⚠ CAUTION The fill bearing capacity can be affected by the accumulation of silt, dirt, process leaks, and debris. The weight of the fill media is supported by Tower Tech's patented Water Collection System. The load bearing capacity of the fill media is 25 lbs. per cubic foot during tower operation. Annual inspection of the fill surface area to assess fouling is recommended to ensure that this bearing capacity is not exceeded.

2.20 Fill Media Data

Attribute	Fill Media Specifications 19mm Cross-Fluted Fill
Sheet Thickness (nom.)	10 mil (std.), 15 mil (opt.)
Material	PVC (std.), HPVC (opt.)
Standard Fill Log Length	72 in (1800 mm)
Standard Fill Log Depth	12 in (300 mm)
Standard Fill Log Width	12 in (300 mm)
Surface Area	48 ft^2/ft^3
Flame Spread Rating	<5 (ASTM E-84)
UV Inhibitor	Yes

Table 4 – Fill Media Data

2.21 Drift Eliminator

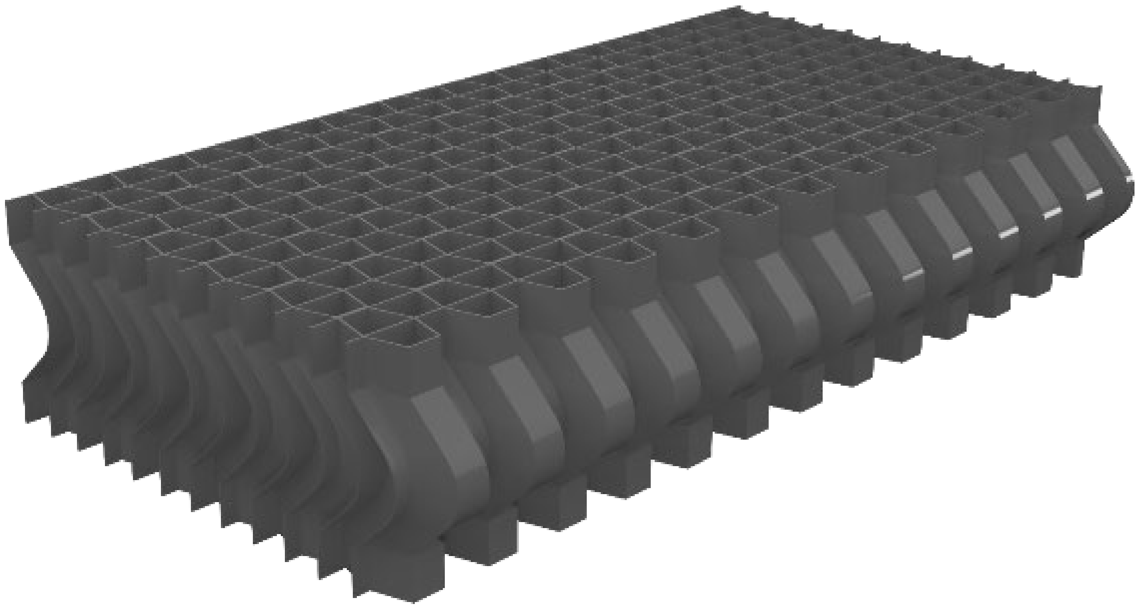


Figure 24 – Drift Eliminator

The TTCC Series Fluid Cooler utilizes a low-pressure sinusoidal-shaped drift eliminator that provides three distinct changes in flow direction to enhance drift capturing capability. The PVC material is virtually impervious to rot, decay, or biological attack. An ultraviolet inhibitor manufactured into the product extends the life expectancy. Refer to Table 5 for drift eliminator data.

Attribute	Specification
Sheet Thickness (nom.)	10 mil (std.), 15 mil (opt.)
Material	PVC (std.), HPVC (opt.)
Standard Module Length	36 in. (900 mm)
Standard Module Depth	5.5 in. (139.7 mm)
Standard Module Width	12 in. (304.8 mm)
Forced Directional Changes	3
Drift Loss	0.0004% or less (EPA 13A)
Flame Spread Rating	<15 (ASTM E84)
UV Inhibitor	Yes

Table 5 – Drift Eliminator Data

2.22 Safety Point Brackets

CAUTION Safety point bracket is rated not to exceed 5,000 lbs. for a fall protection system.
DO NOT ATTEMPT TO LIFT TOWER USING THE SAFETY POINT BRACKETS.
Any attempt to lift tower using these brackets will void the warranty.

TTCC Series Fluid Coolers are designed to reduce maintenance requirements and allow routine inspections to be safely performed from ground level. The Tower Tech design does not require service personnel to enter the cooling tower for routine inspection or service. The maintenance schedule in Section 10.1 only requires service personnel to enter the tower for annual inspections.

OSHA regulations only require permanent platforms, stairways and walkways when routine maintenance is required for an individual more than six feet off the ground. When service personnel must enter the cooler, the modular walls serve as a fall restraint for the personnel working inside. Even with safety being a top consideration in the design, certain service applications require the technician to adhere to strict fall restraint requirements when accessing the top of the cooler.

TTCC Series Fluid Coolers have a safety point bracket mounted inside the tower below each top corner cap. The safety point brackets have been tested and certified to hold 5,000 lbs. each. A certified engineer must design any fall restraint system to meet the customer's requirements along with any local, state, federal and OSHA requirements. The safety bracket is a certified point to which a fall restraint system can be attached.

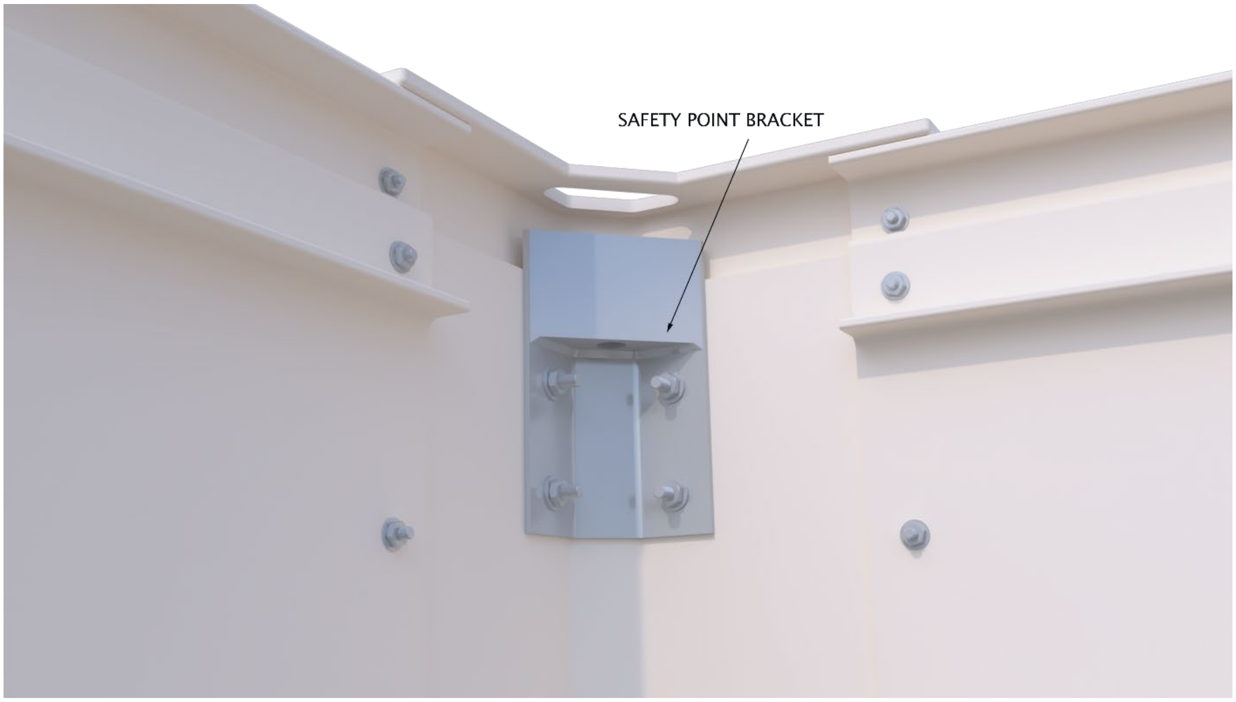


Figure 25 – Safety Point Bracket

2.23 Power and Control Wiring

The end-user is responsible for making all field wiring connections.

DANGER Install a lockable disconnect switch in close proximity and within sight of the cooling tower to protect authorized service personnel. Ensure the switch is separated from all other circuits.

Do not perform service work on or near the fans without first ensuring the fan motor is electrically disconnected and locked out.

Only a licensed electrician should attempt to troubleshoot any electrical components on Tower Tech Modular Cooling Towers.

CAUTION Waterproof-type connectors MUST be used so that water and moisture cannot be drawn into the box or panel when connecting electrical power and control wiring to a junction box or control panel.

Field wiring to the module must conform to the provisions of the National Electric Code (NEC), ANSI / NFPA No. 70 (in U.S.A.), current Canadian Electric Code (CEC) A22.1 (in Canada) and/or local ordinances. The unit must be electrically grounded in accordance with the NEC and CEC (as specified above) and/or local ordinances.

Each motor is factory pre-wired to a Control Panel located at the end of the cooler module. All motor wiring is 12-4 AWG except 208/230V 7.5 HP motors or 190V 5.6 kW (7.5 HP) motors which use 10-4 AWG. Wiring is Alpha brand, variable-frequency drive compatible, liquid tight, oil resistant, quantum-shielded, flexible cable. Refer to Table 2 for amperage requirements at various motor horsepower sizes.

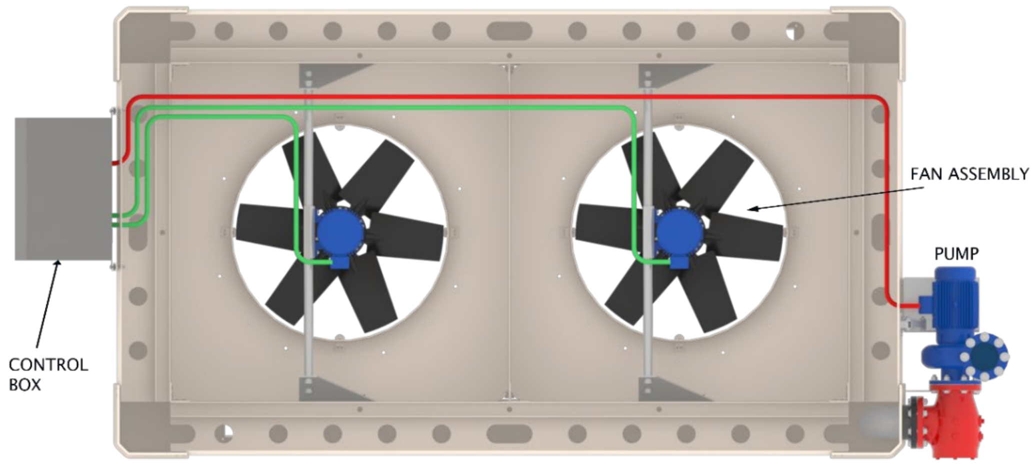


Figure 26 – Typical Wiring Layout

Chapter Three: Materials of Construction

3.1 General

The TTCC Series Fluid Cooler is factory pre-assembled. All walls, structural members, and internal components in wetted areas are non-corrosive fiberglass, various plastics and stainless steel hardware. PVC is used exclusively in the recirculating water distribution system and in other non-structural members. Fan guard screens are in the dry area below the tower module and are fabricated with impervious plastic and stainless steel.

3.2 Tower Walls

TTCC Series Fluid Cooler walls provide a perimeter shell around the XchangeTech and tower fill media and other internal components. The three sections that comprise the walls, the Perimeter Basin Walls, the Mid-Walls, and the Top-Walls are some of the largest pultruded components in the world. The Perimeter Basin Wall serves as both a structural member and a cold water reservoir. Walls are joined vertically by tongue and groove joints and are sealed using a polyurethane adhesive vibration dampener and sealant to prevent leaks. Transversal Perimeter Basin Walls are joined to longitudinal Perimeter Basin Walls using a fiberglass Corner Enclosure that provides further structural and sealing integrity to the tower box. Stainless steel fasteners are used to bolt the walls together and to join them to the Corner Enclosures. Coated stainless steel fasteners are employed in wet areas. Refer to Table 6 for details on wall design specifications.

Attribute	Specification
Material Composition	Fiberglass Reinforced Plastic, Isophthalic Resin
Manufacturing Process	Pultrusion
Material Thickness	¼" (6.35mm) min.
Material Thickness	½" (12.7mm) min. Corner Enclosure & Substructure
Flame Spread Rating	ASTM E84/94-V0 Flammability Classification (UL 94)
Smoke Rating	650 (ASTM E662)
Self-Extinguishing	Yes (ASTM D635)
UV Inhibitor	Yes (UV resistant fiber layer employed)

Table 6 – Wall Data

3.3 Fan Motor Support

Fan motor supports are bolted to the pultruded basin wall (refer to Figure 4), The motor support is manufactured from stainless steel tubing and plate. Motors are mounted to a stainless steel plate that is welded onto the motor support framework. Stainless steel fasteners are used exclusively in its assembly.

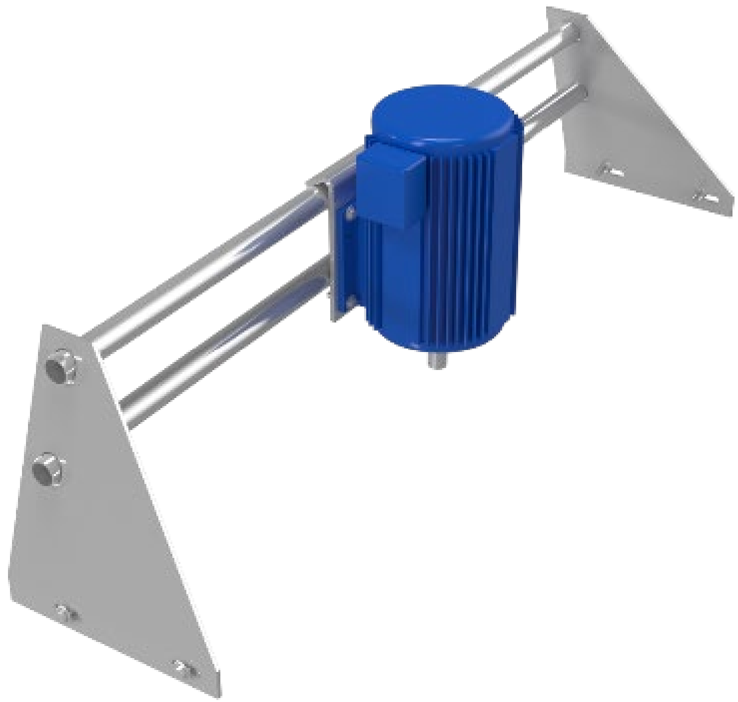


Figure 27 – Fan Motor Support

3.4 Tower Internals

TTCC Series Fluid Cooler internal components are described in Table 7.

Component	Material		Component	Material
Fill Media	10 mil PVC (std.), 15 mil PVC (opt.)		Sub-Structure Legs	FRP (Pultruded)
Drift Eliminators	10 mil PVC (Thermoformed)		Wind Wall Partitions	ABS (Extruded)
Spray Nozzle	HDPE (Injection Molded)		Modular Base Support & Footpad	Nylon (Injection Molded)
Water Distribution Header & Laterals	PVC		Fan Shroud	Hand Lay-Up Chopped Fiberglass Strands or Resin Transfer Molded Fiberglass (Flame Retardant)
Water Collection System	ABS (Extruded)		XchangeTech	Nylon
Header Inlet Flange	PVC (Injection Molded)		Inspection Ports	Nylon (Injection Molded)
Hardware	304 Stainless Steel		Motor Support	304 Stainless Steel

Key: FRP = Fiberglass Reinforced Plastic Pultrusion
PVC = Poly-Vinyl Chloride (Self-Extinguishing)
ABS = Acrylonitrile, 1,3-Butadiene, and Styrene Copolymer (Flame Retardant)
PP = Polypropylene
HDPE = High Density Polyethylene

Table 7 – Materials of Construction; Internal Components

Chapter Four: Optional Equipment

4.1 Sub-Structure (Leg) Kit

Tower Tech offers a pultruded fiberglass substructure connected to each corner of the tower module. (Refer to Figure 25.) With sub-structures up to 8 feet (243.8 cm) in height, the TTXR Series Modular Cooling Tower is certified to withstand 200 mph/93 psf (321.8 KPH/454 KSM) wind load. The sub-structure anchors to steel, concrete piers, or to a concrete slab. Braces attach to the Perimeter Basin Walls to provide rigid support.

As a rule, increased leg height will improve tower performance by increasing the air inlet area. Use higher sub-structure leg heights if obstructions adjacent to the tower reduce airflow to the tower. Sub-structure leg heights of 4-foot (182.9 cm) are the most common. For air inlets above 12’ high the preferred method of installation is with 1-foot (30.5 cm) sub-structure legs (“stub” legs) that mount on top of a raised pier or steel.

Sub-structure kit includes:

- ✓ Pultruded fiberglass legs – Typical heights are 1 foot (30.5 cm), 4 feet (121.9 cm), 6 feet (182.9 cm), 8 feet (243.8 cm), 10 feet (304.8 cm), and 12 feet (365.8 cm)
- ✓ Footpads
- ✓ FRP tubular braces – Not required for 1 foot (30.5 cm) legs
- ✓ Assembly hardware (folding leg bracket optional)

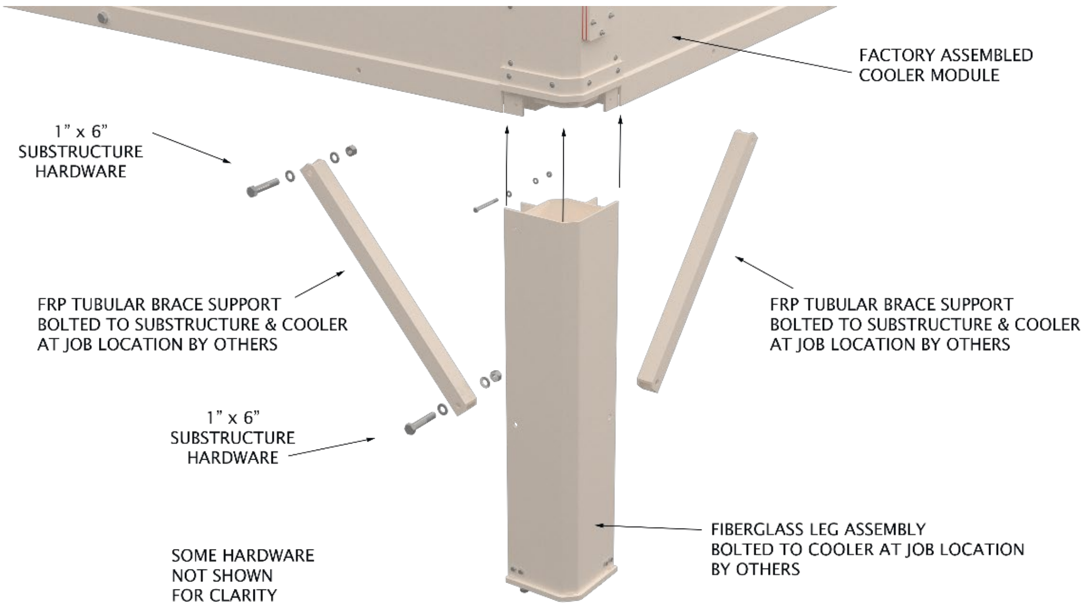


Figure 28 – Tower Sub-Structure

4.2 TTCC Cooler Control Panel

Figure 29 – Typical Control Panel with Unistrut Mounts

Figure 30 – Typical Control Panel Front Operators

The TTCC Series Fluid Cooler has a prewired control panel.

Typical Features Included:

- Single point power wiring
- Door mounted disconnect
- VFD fan speed control
- Recirculating pump starter with motor protection
- Optional Basin Heater control
- PLC with a door mounted operator input screen
- Remote enable
- Remote temperature set point
- Powder coated steel NEMA 4 Enclosure
- Optional NEMA 4X stainless steel or molded plastic.

Tower Tech supplies a complete wiring schematic with all control panels. Custom panels and tower wiring requirements are assigned a discrete project number for easy identification. Standard, factory pre-wiring uses shielded 12-4 AWG 460V wiring, however other voltages require use of NEC-appropriate wire sizes. Wiring used in all coolers is Alpha brand, VFD compatible, quantum-shielded, liquid tight, oil resistant, flexible cable.

⚠ CAUTION All power wiring conduits are to enter and exit the control cabinet at the bottom of the control cabinet. Penetration of the top or sides of the control cabinet will void the electronics warranty. All control wiring conduits are to penetrate the control cabinet on the bottom of the control cabinet, as close to left-hand side as space allows.

⚠ CAUTION All load cable from the VFD to the cooling tower motors should be properly grounded on both ends according to VFD and motor manufacturers' recommendations. All communication wire to be shielded twisted pair conductor and properly grounded on one end only.

⚠ CAUTION When cooler control panel is more than 6 feet above standing level, consideration should be given to service access.

Figure 31 – Typical Control Panel Installed

4.3 Variable Frequency Drive

Tower Tech motors are inverter duty rated and meet NEMA MG-1 Part 31 specifications. The use of variable-frequency drives (VFD) provides the tightest temperature control; 0.5°F (.28°C) is typical in most applications. The VFD will speed up or slow down the fans as required to maintain a constant process fluid temperature.

⚠ CAUTION All load cable from the VFD to the cooling tower motors should be properly grounded on both ends according to VFD and motor manufacturers' recommendations. All communication wire to be shielded twisted pair conductor and properly grounded on one end only.

4.4 Immersion Basin Heater

Tower Tech offers an optional pre-engineered basin heater package for the TTCC Series Fluid Cooler. Each package includes:

- Standard stainless steel electric immersion heater
- Water level and temperature sensor/probe
- Wiring diagram
- Installation and operating instructions
- Required flange fittings for probe and heater pre-installed into cooler

The immersion basin heater is intended to prevent icing of the basin water when the cooler is not in operation.

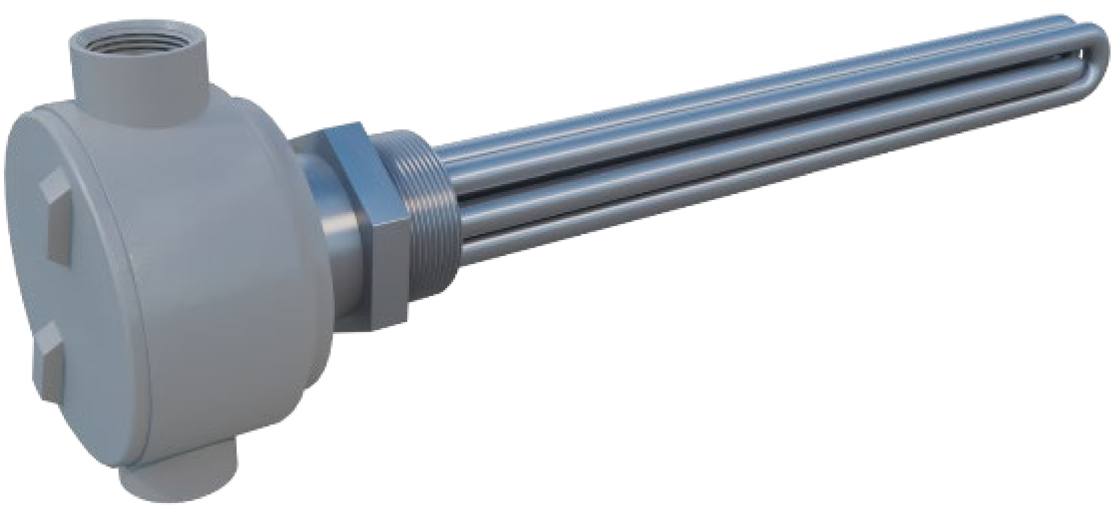


Figure 32 – Immersion Basin Heater

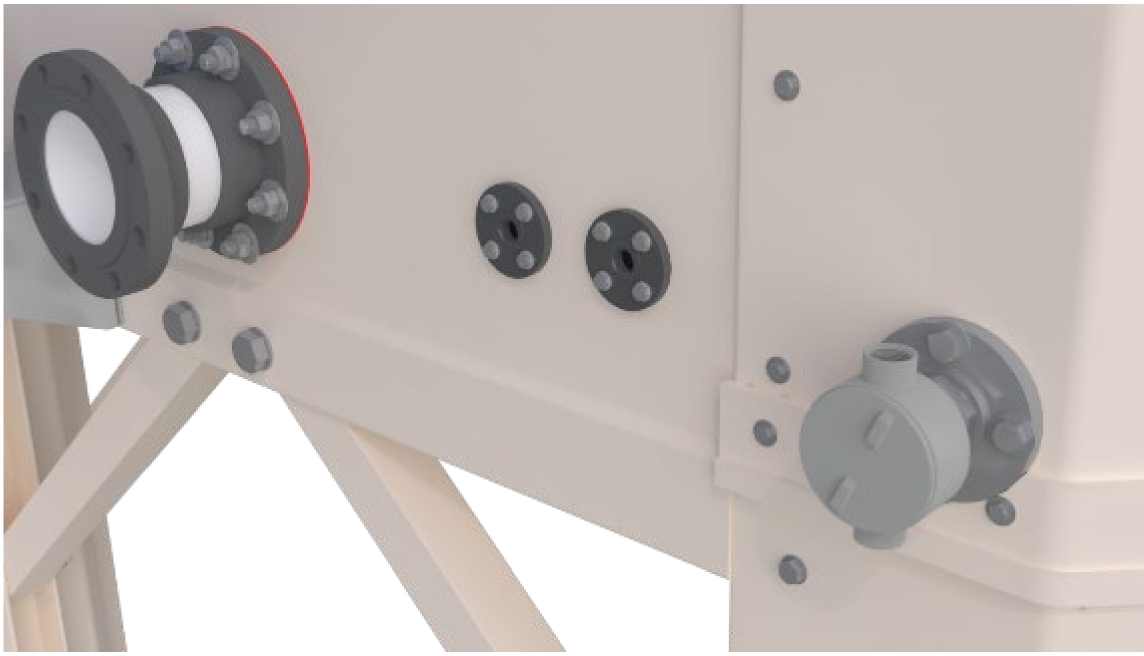


Figure 33 – Immersion Basin Heater and Sensor Probe Location

For winter shut down operation, Tower Tech offers an optional immersion basin heater with a corrosion- and liquid-proof enclosure. The control is a combination controller and probe (temperature and water level sensor) preset to 45°F (7.2°C). The control panel contains the electronic temperature/flow liquid level control, control voltage transformer, and the magnetic contactor used to energize and de-energize the heater. Each heater element contains a fused thermal cut-off device to prevent overheating the element.

⚠ DANGER Each heater element contains a fused thermal cutoff device that MUST be wired into the safety circuit as detailed in the installation wiring drawing. This cutoff device is wired in series with any other optional safety devices.

Immersion basin heaters MUST be deactivated when no water is present in the cooling tower. Failure to do so could result in overheating of the basin heater element and accidental fire.

INDEECO - 6KW Heater Data					
Voltage	# of Heaters	KW Per Element	Total Amps	# Panels needed	Panel Amp Rating
208/3	1	6	16.7	1	39.33
208/3	2	12	33.3	1	39.33
208/3	3	18	50.1	1	64
208/3	4	24	66.7	1	80
240/3	1	6	15.1	1	39.33
240/3	2	12	30.2	1	39.33
240/3	3	18	45.2	1	48
240/3	4	24	60.3	1	64
480/3	1	6	7.5 RL	1	14.5
480/3	2	12	15.1	1	39.33
480/3	3	18	22.6	1	39.33
480/3	4	24	30.2	1	39.33
575/3	1	6	5.8 RL	1	14.5
575/3	2	12	11.7 RL	1	14.5
575/3	3	18	17.4	1	39.33
575/3	4	24	23.2	1	39.33

NOTE: "RL" denotes custom panel with the relabeled panel tag. Relabeled panel has 40-amp contactor, however the tag is rated for 14.5 amps max.

Stock Control Panel Listing					
Max Panel Amps	Number of Circuits	Maximum Panel kW Rating			Enclosure Dimensions
		480 Volts / 3 Phase			
40	1	14.2	16.6	33.2	8" x 10" x 6"
48	1	17.2	19.9	39.8	10" x 12" x 7"

Table 8 – Indeeco 6kW Data

INDEECO - 9KW Heater Data					
Voltage	# of Heaters	KW Per Element	Total Amps	# Panels needed	Panel Amp Rating
208/3	1	9	25.01	1	40
208/3	2	18	50	2	40
208/3	3	27	75	3	40
208/3	4	36	100	4	40
240/3	1	9	21.68	1	40
240/3	2	18	43.36	1	48 (2 circuits)
240/3	3	27	65.04	2	48/2C & 40/1C
240/3	4	36	86.72	2	48 (2 circuits)
480/3	1	9	10.84	1	40/2C
480/3	2	18	21.68	1	40/2C
480/3	3	27	32.52	1	48/4
480/3	4	36	43.36	1	48/4
575/3	1	9	9.05	1	40/2C
575/3	2	18	18.1	1	40/2C
575/3	3	27	27.15	1	48/4C
575/3	4	36	36.2	1	48/4C
Stock Control Panel Listing					
Max Panel Amps	Number of Circuits	Maximum Panel kW Rating			Enclosure Dimensions
		Volts / 3 Phase			
40	1	14.2	16.6	33.2	8" x 10" x 6"
48	1	17.2	19.9	39.8	10" x 12" x 7"

Table 9 – Indeeco 9kW Data

Consult Section 9.4 for information on installation and start-up of basin heater. Refer to basin heater manufacturer's user manual for complete details on set-up, validation, and operation of the basin heater.

4.5 Vibration Control

Tower Tech does not require vibration switches for the TTCC Closed Circuit Cooler because of the small motor size, inherent structural stability of the modular tower, and using adhesive vibration dampening sealants for many structural connections.

DANGER **Should a customer wish to use a vibration switch, the tower modules must be fitted with a remote method of resetting the vibration switch to ensure that the reset process does not offer potential for injury. The latter is done at owner's own risk and Tower Tech assumes no liability for damages to personnel or property resulting from the use of a vibration switch.**

CAUTION Vibration Isolators are not required or recommended for the TTCC Closed Circuit Cooler. Vibration isolation springs cannot be attached directly to the substructure leg and will void the warranty. If specifications or code requires vibration isolation, then springs must be attached below an I-beam frame that all the substructure legs attach on top of or vibration pads can be used directly below the substructure legs.

CAUTION The Flowline Control Panel must be properly grounded according to the Manufacturer's requirements. All communication wires must be properly grounded on one end only.

Chapter Five: Preparing for Installation

5.1 Weights and Dimensions: Hybrid Coolers

TTCC Model	Weight in Lbs (kg)		Dimensions Per Illustration Below[a] (cm)					
	Shipping[b]	Operating	A	B	C	D	E	F
i1xxxx-HC	4441 (2015)	5555 (2520)	8'-00" (243.8)	11'-00" (335.3)	8'-00" (243.8)	1'-09" (53.3)	10'-3" (312.4)	4'-0" (121.9)
i2xxxx-HC	6421 (2913)	8281 (3757)	8'-00" (243.8)	11'-00" (335.3)	14'-00" (426.7)	1'-09" (53.3)	10'-3" (312.4)	4'-0" (121.9)
i3xxxx-HC	8720 (3956)	11327 (5138)	8'-00" (243.8)	11'-00" (335.3)	20'-00" (609.6)	1'-09" (53.3)	10'-3" (312.4)	4'-0" (121.9)
i4xxxx-HC	10699 (4853)	14053 (6375)	8'-00" (243.8)	11'-00" (335.3)	25'-11" (790)	1'-09" (53.3)	10'-3" (312.4)	4'-0" (121.9)

Notes:
a: Dimensions are approximate and should not be used for construction purposes.
b: Tower weights may vary due to optional equipment, residual water from factory testing, rain, etc. Weights shown are guidelines only and do not include substructure or other accessories not directly attached to the tower module during shipping.

Table 10 – Weights and Dimensions: Hybrid Coolers

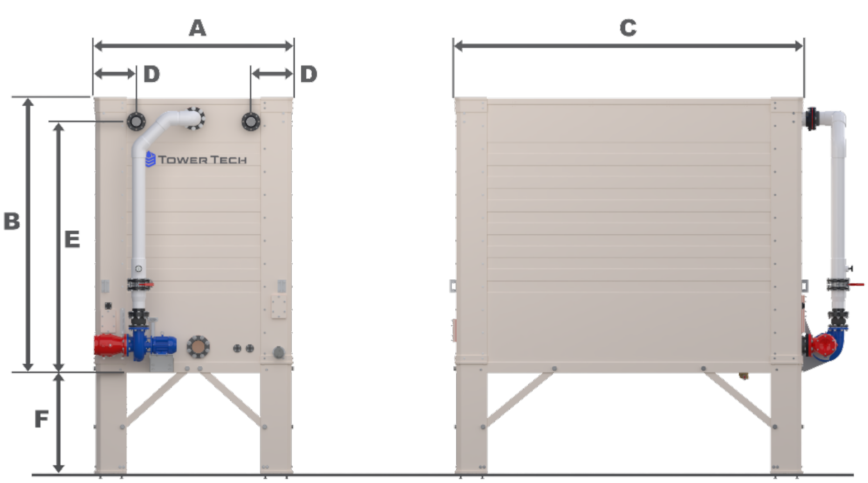


Figure 34 – Dimensions - i1xxxx-HC & i2xxxx-HC

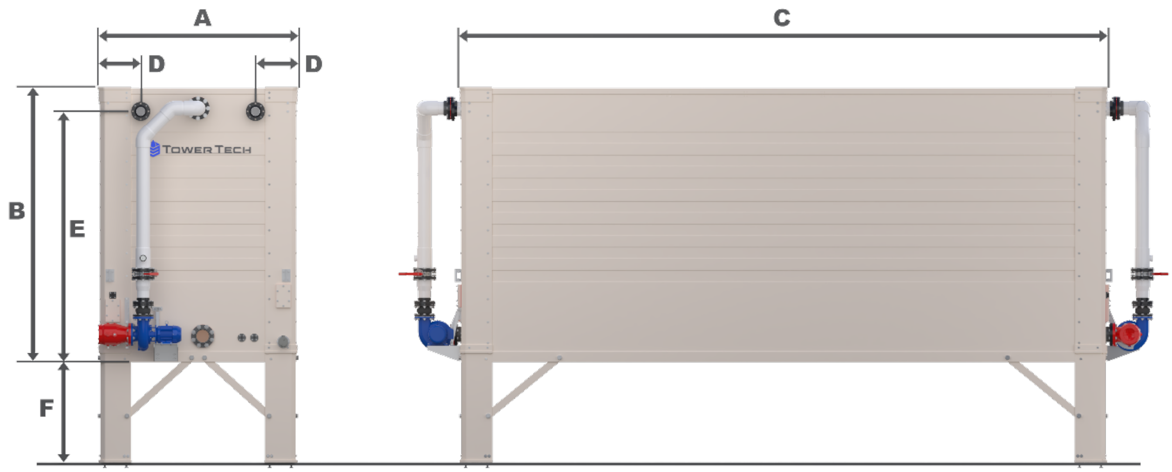


Figure 35 – Dimensions - i3xxxx-HC & i4xxxx-HC

5.2 Weights and Dimensions: Evaporative Coolers

TTCC Model	Weight in Lbs (kg)		Dimensions Per Illustration Below[a] (cm)					
	Shipping[b]	Operating	A	B	C	D	E	F
i1xxxx-FC	3850 (1746)	4964 (2252)	8'-00" (243.8)	7'-04" (335.3)	8'-00" (243.8)	1'-09" (53.3)	6'-07" (312.4)	4'-0" (121.9)
i2xxxx-FC	5533 (2510)	7393 (3354)	8'-00" (243.8)	7'-04" (335.3)	14'-00" (426.7)	1'-09" (53.3)	6'-07" (312.4)	4'-0" (121.9)
i3xxxx-FC	7580 (3438)	10187 (4621)	8'-00" (243.8)	7'-04" (335.3)	20'-00" (609.6)	1'-09" (53.3)	6'-07" (312.4)	4'-0" (121.9)
i4xxxx-FC	9262 (4202)	12616 (5723)	8'-00" (243.8)	7'-04" (335.3)	25'-11" (790)	1'-09" (53.3)	6'-07" (312.4)	4'-0" (121.9)

Notes:
a: Dimensions are approximate and should not be used for construction purposes.
b: Tower weights may vary due to optional equipment, residual water from factory testing, rain, etc. Weights shown are guidelines only and do not include substructure or other accessories not directly attached to the tower module during shipping.

Table 11 – Weights and Dimensions: Evaporative Coolers

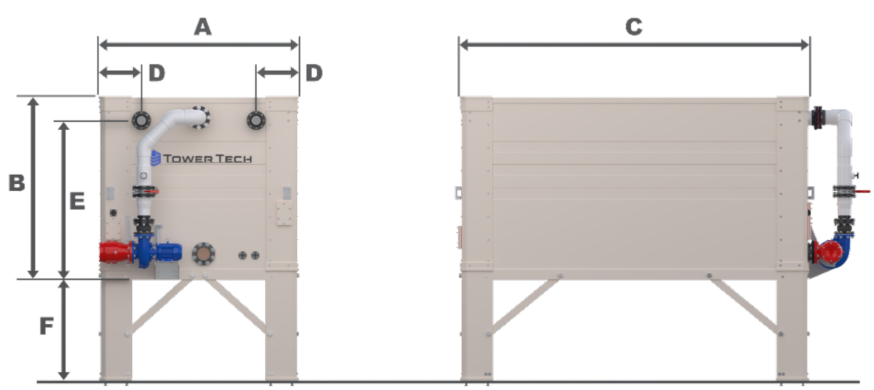


Figure 36 – Dimensions - i1xxxx-FC & i2xxxx-FC

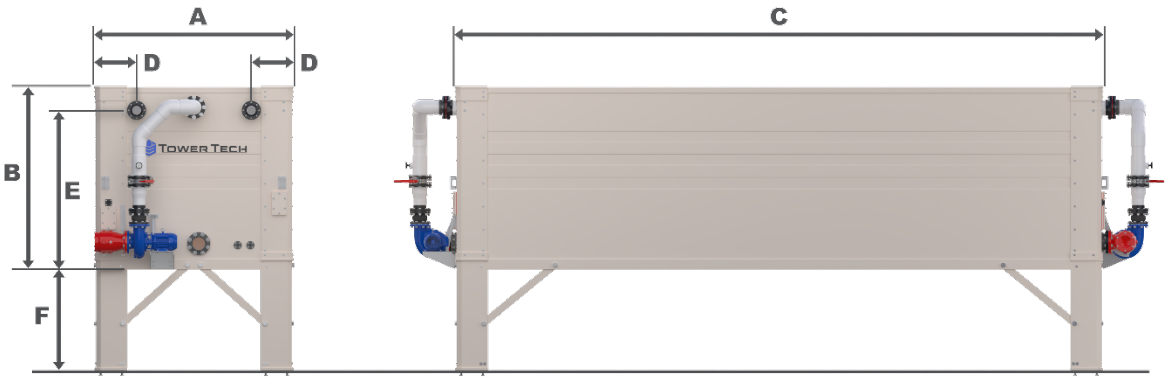


Figure 37 – Dimensions - i3xxxx-FC & i4xxxx-FC

5.3 Limitations

The TTCC Closed Circuit Cooler must be installed in accordance with the current edition of the following national and local safety codes:

- National Electric Code
- Local electric utility requirements
- Local plumbing and wastewater codes
- Other applicable municipal codes

Components added to a module to meet local codes are installed at the customer's expense. Tower Tech assumes no responsibility for the impact of such components on the thermal performance or the structural integrity and longevity of the tower. Please see your Tower Tech Sales Engineer for further details.

The size of the module for proposed installation should be based on calculations provided by the client (owner or owner's agent) at the time of cooler specification and are made according to generally accepted methods of thermal calculation.

The thermal performance of the TTCC Closed Circuit Cooler is certified by the Cooling Technology Institute in accordance with its standard STD-201 and has been assigned CTI validation number C17H-15R00. This certification is your assurance that the proposed capacities accurately reflect actual cooling tower performance. CTI certification under STD-201 is limited to thermal operating conditions with entering wet bulb temperatures between 50° F and 90°F (12.8°C and 32.2°C), a maximum process fluid temperature of 125°F (51.7°C), a cooling range of 4°F (2.2°C) or greater, and a cooling approach of 5°F (2.8°C) or greater.

5.4 Closed Circuit Cooler Location

TTCC Closed Circuit Cooler can be located wherever there is unrestricted air circulation. A clear area of 4 feet around the module or modules should be maintained. In installations where this is not possible, consult Tower Tech for suitable solutions that may include alternate substructure heights or module orientation.

⚠ CAUTION Module is designed principally for outdoor installation. Contact your Tower Tech Sales Representative for details regarding indoor use and necessary equipment and accommodations.

5.5 Environmental Safety Considerations

A cooling module must be installed in a location where contaminated cooler discharge air cannot be drawn into any building fresh-air ducts. The purchaser should obtain the services of a Licensed Professional Engineer or Registered Architect to certify that the location of the cooler complies with applicable air pollution, fire, and clean-air codes.

5.6 Re-Circulation Considerations

Re-circulation is a condition that arises when warm moisture-laden exhaust air is inadvertently drawn back into a cooler's intake. This condition elevates the cooler's entering wet bulb temperature and affects the cooler's capacity to cool to design requirements. Re-circulation commonly occurs when coolers are located within enclosed areas or near obstructions and other equipment that exhausts hot, humid air. Pumps, control panels, piping, and buildings can all be impediments to the smooth, unimpeded flow of air into a cooler. To minimize re-circulation Tower Tech recommends the following:

- Position the top of the cooler at least as high as any adjacent walls, enclosures, buildings, shrubbery, winter snow fall lines or other significant structures.
- Minimize the opportunity for exhaust air to migrate downward by placing cooler as close to the interfering structure as possible. Note that this should be balanced against the possibility of air restriction.
- If air restriction is a concern, it is recommended that enclosures provide air entry or ventilation via louvers, slots, or similar openings.

5.7 Interference Considerations

Interference is a condition that arises when the cooler is situated down wind or near a heat emitting source. To avoid interference, careful placement of the cooler is essential. Consider the following:

- A cooler should be designed for the entering wet bulb temperatures at the proposed cooler location rather than ambient wet bulb for the locality.
- Install the cooler upwind of the interference utilizing prevailing summer winds as the guideline.
- Remove any obstructions to free flow of exiting air. Such obstructions create static pressures that negatively impact air velocity through the cooler.

5.8 Leveling Tolerance

Use a level slab or piers in conjunction with a support leg for ground level installation. The thickness and size of the pad should meet local codes and unit weight requirements.

⚠ CAUTION A full level bearing must be provided under each footpad area. Failure to provide may result in damage to the tower ranging from seal leaks to loss of structural integrity.

Maintain level tolerance to ¼-inch (6.35 mm) maximum across the entire length or width of the module.

5.9 Foundation/Slab or Pier Requirements

Weight information is provided in the drawings for coolers. Information provided includes dry shipping weight and operating weight. Roof structures must be able to support the maximum load of the module including wind and seismic loads. Install the module on a solid steel frame or appropriate substructure.

5.10 Positioning

Install modules with a minimum of 2 inches (5.1 cm) between them to accommodate inherent manufacturing tolerances for the cooler and for ease of field installation.

CAUTION Do not install towers with more than 6 inches (15.2cm) clearance between modules without Tower Tech engineering review and approval.

5.11 Piping Design and Installation

All piping and other equipment external to the TTCC Closed Circuit Cooler module must be stand-alone and self-supported. Tower Tech recommends the use of an appropriate flexible flange connection on each cooler inlet and outlet connection to better accommodate minor piping tolerances. Failure to use a flexible flange may result in damage to the cooler structure as well as adjacent piping. Final connections to the cooler must be field fitted after tower installation to prevent pipe stress on the cooler. Heavy duty fender washers should be used on all flange connections to the cooler to avoid stress cracking of the PVC flange due to over torquing. Tighten all connections to proper torque requirements.

Never support piping, ladders, walkways or stairways from a TTCC Closed Circuit Cooler without approval from Tower Tech Engineering. Never attach control panels to plumbing or piping as this may induce vibration.

CAUTION Avoid blocking cooler air inlets with piping or other equipment to prevent air restrictions that could diminish tower performance. Avoid installing piping or other equipment underneath the module that could restrict access to mechanical equipment for service and maintenance.

5.12 Sub-Structure Installation

CAUTION If the holes for the substructure legs or bracing do not align with the cooler, do not drill new holes or bore out the existing holes. You can lower the weight of the cooler onto the fiberglass leg to ensure it has been fully inserted into the corner base support of the modular cooler. Drift pins can be used to fully align the holes for easier insertion of the attachment hardware.

5.13 Installation of One Foot (30.5 cm) Sub-Structure

With the cooler lifted off the trailer, in an open area above level ground, do the following:

1. Attach the 1' tall sub-structure leg (vertical support beam) to the cooler's modular base support using two ½" x 6" stainless steel hex bolts with washers and nuts per leg (finger tighten).

2. Once the 1' tall sub-structure leg is loosely secured, the cooler can be lowered onto its main support beam or pier. Upon setting cooler, verify that the module is level. Refer to Section 5.3 Tolerances for detail.

3. Tighten all 1" dia. Bolts to 50 ft. lbs. Tighten all bolts less than 1" dia. To 30 ft. lbs.

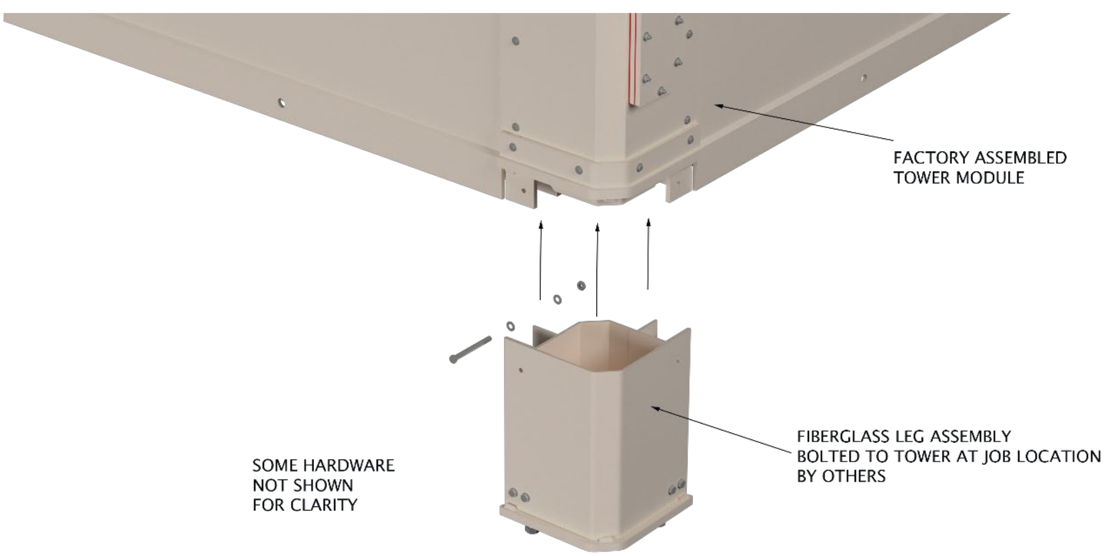


Figure 38 – Installation Detail for 1' Sub-Structure

5.14 Installation of Sub-Structures Taller Than One Foot (>30.5 cm)

With the cooling tower lifted off the trailer, in an open area above level ground, do the following:

1. Attach each leg (vertical support member) to the cooler's module base support using two ½" x 6" stainless steel hex bolts with washers and nuts (finger tighten).

2. Attach two tubular FRP braces to the module's apron and to each pultruded FRP leg using 1" x 6" stainless steel hex bolts with washers and nuts (finger tighten). Refer to Section 5.3 Tolerances for detail.

3. The cooler module can be lowered onto its main support beam, pier or pad after the legs and braces are attached. After setting the cooler, verify that it is plumb and square.

4. Tighten all 1" dia. Bolts to 50 ft. lbs. Tighten all bolts less than 1" dia. To 30 ft. lbs.

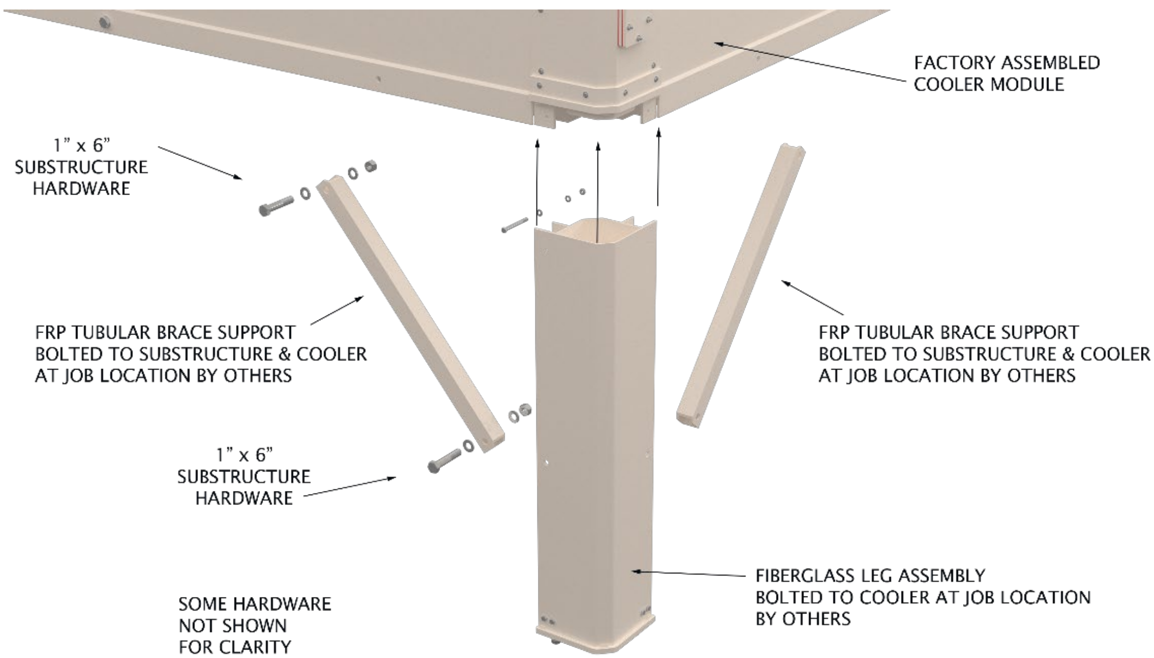


Figure 39 – Installation Detail for Sub-Structures Taller Than One Foot (>30.5 cm)

5.15 Installation of Sub-Structure Footpad

With the cooling tower lifted slightly above the main support beam or pad do the following:

1. Set the cooler into position with each footpad on the anchor bolt or location where the anchor bolt will be installed. The size and length of the anchor bolt to be provided by a structural engineer. Refer to cooler submittal drawings for leg geometric properties. Tower Tech can provide seismic and wind loading calculations upon request for each cooler model. The maximum diameter of the anchor bolt is 1" (25.4mm) for the square washer, provided by Tower Tech, to fit onto the anchor bolt. Tower Tech requires the anchor bolt to extend a minimum of 5 ½" (139.7mm) above the bottom of the footpad as shown in Figure 38.

2. Once the sub-structure leg is lowered onto its main support beam, pier or pad and the footpad is secured then verify the module is level. Refer to Section 5.3 Tolerances for detail.

3. Fill the pocket around the anchor bolt to top of two horizontal leg bolts with non-shrink grout before installing the square washer. Before grout sets, install the square washer on top of the two horizontal leg bolts. Tighten the anchor nut, provided by others, and torque to 50ft-lbs. Square washer should engage the two horizontal bolts securing the footpad to the leg. Re-torque to structural engineer's specification after grout has set.

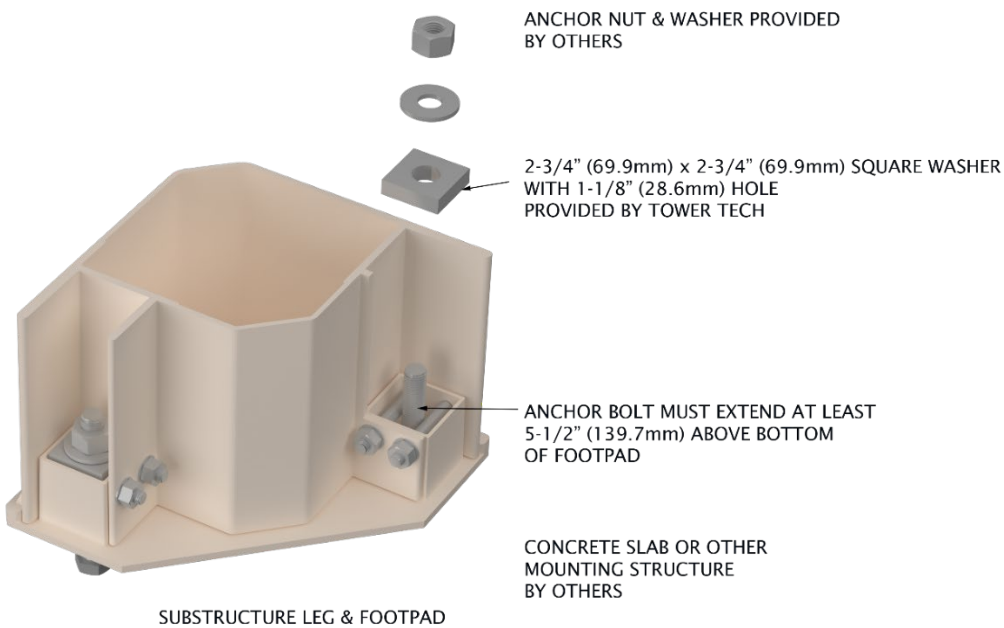


Figure 40 – Installation Detail for Sub-Structure Footpad

Chapter Six: Rigging and Handling

DANGER The lifting points are integral to the cooler structure. Damage to the cooler caused by improper lifting invalidates the cooler warranty.

6.1 Introduction

Factory assembled TTCC Closed Circuit Coolers shipped on flatbed trailers should be lifted directly from the trailer to the final point of installation. Sub-structure kit or other optional equipment is shipped on a separate pallet on the same trailer as the tower module. Optional accessory equipment will be shipped on separate pallets (Refer to Table 11).

The owner shall be responsible for lifting and placement of the cooler. Owner shall furnish all incidental materials required for location of cooler in its final position. All work shall be in accordance with requirements of local/municipal governing authorities and all U.S. Occupational Safety & Health Administration safety guidelines.

The accompanying lifting diagrams and procedure are for general information purposes only, and owner shall have full responsibility for the work.

DANGER Inspect each cooler module's lifting hardware prior to lifting module to check for shipping damage and security of lifting hardware. Never lift a cooler module if its lifting hardware is cracked or loose as damage to the cooler may result.

CAUTION Do not lift a cooler without first removing excess water (rainwater, snow melt, ice) from the cooler basin, which can drastically increase tower weight and cause an imbalance. Lift tower slowly to ensure one end doesn't tip forward and damage the cooler.

CAUTION All installation operations must be performed as specified by a site-specific safety plan, which is the responsibility of the customer. Only qualified, experienced personnel should perform rigging. Use lifting equipment properly sized for the unit being lifted. Do not attempt to lift a module during high winds or inclement weather.

6.2 Accessory Location Checklist

Accessories will always ship on pallets and be shipped with the cooler unless there are specific request for drop shipping. Packaging of accessories will depend on type of accessory, the size of the component and number of accessories purchased with the modular cooling tower. See Table 11 for a general guide to the accessory location.

All hardware and accessories are inspected and documented prior to shipment. When the shipment arrives, all components should be inventoried and reconciled with the shipping documents.

Component *	Shipping Location
Basin Heater Control Panel	Boxed, bubble wrapped and palletized
Basin Heater Element/s	Boxed, bubble wrapped and palletized
Basin Heater Sensor	Attached by cable to the Basin Heater Control Panel
Electronic Level Control Panel Kit B	Boxed and placed inside Tower Leg that is shrink wrapped, marked and palletized
Electronic Level Control Sensor Kit A	Bubble Wrapped inside Tower Leg that is shrink wrapped, marked and palletized
Electronic Level Control Sensor Kit B	Bubble Wrapped inside Tower Leg that is shrink wrapped, marked and palletized
Electronic Level Sensor Still Well Pipe	Bubble Wrapped inside Tower Leg that is shrink wrapped, marked and palletized
Mechanical Float Ball and Stem	Installed inside tower basin
RTD (Temperature Sensor)	Bubble wrapped inside Panel (T5400 only)
Substructure Braces and Legs	Palletized and shipped on truck bed
Substructure Hardware	Boxed and palletized with substructure legs
Pump and Diffuser	Boxed and palletized if not pre-mounted on tower
External Basket Strainer	Boxed and palletized
Coil Process Fluid Inline Inlet Filter	Boxed and palletized
T5400 Control Panel	Boxed and palletized if not pre-mounted on tower
VFD Controls	Boxed and palletized if not installed in T5400 Panel

*Components and Accessories are optional items and may not be included with each project.

Table 12 – Accessory Location List

6.3 Lifting Procedure

DANGER **Under NO circumstance should a cooler module be lifted above any personnel.**

DANGER **Never attempt to lift or move a cooler module using a forklift as damage to the cooler, as well as injury to personnel, may result.**

CAUTION Excessive side loading can result in leakage caused by broken seals, permanent bending of structural members, or ultimate failure of the casing panels. Place the cooler on a sound and level surface whenever ground storage is needed. Always use diagonal cribbing across each corner when setting the cooler on the ground or other surface without substructure attached to prevent damage to the bottom side of the cooler module.

Should the cooler need to be transloaded or temporarily placed on the ground prior to its final positioning, always place the cooler on a sound and level surface. Care shall be always taken not to distort or rack the cooler module's envelope. Cribbing should be installed at each corner using a minimum of 4" x 4" beams placed on a 45° angle to prevent damage to the Modular Base Supports (MBS) as shown in Figure 45.

1. Check the cooler's condition prior to lifting. Report any damage to the manufacturer prior to the acceptance of the cooler.

2. Remove any excess water (rainwater, snow melt, ice) from the cooler module's cold water basin prior to lifting the tower, as excess water can drastically increase tower weight causing failure of the tower lifting mechanism.

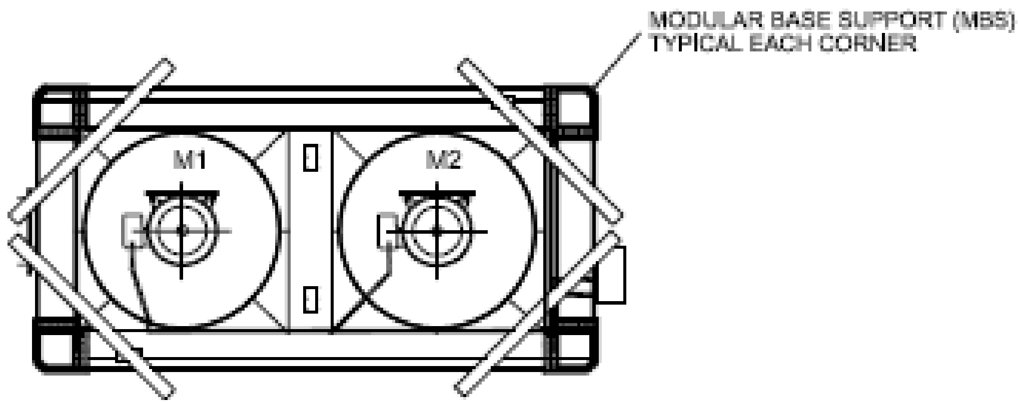


Figure 41 – Cribbing Detail

3. Inspect the lifting bracket attachment for cracks or loose hardware.

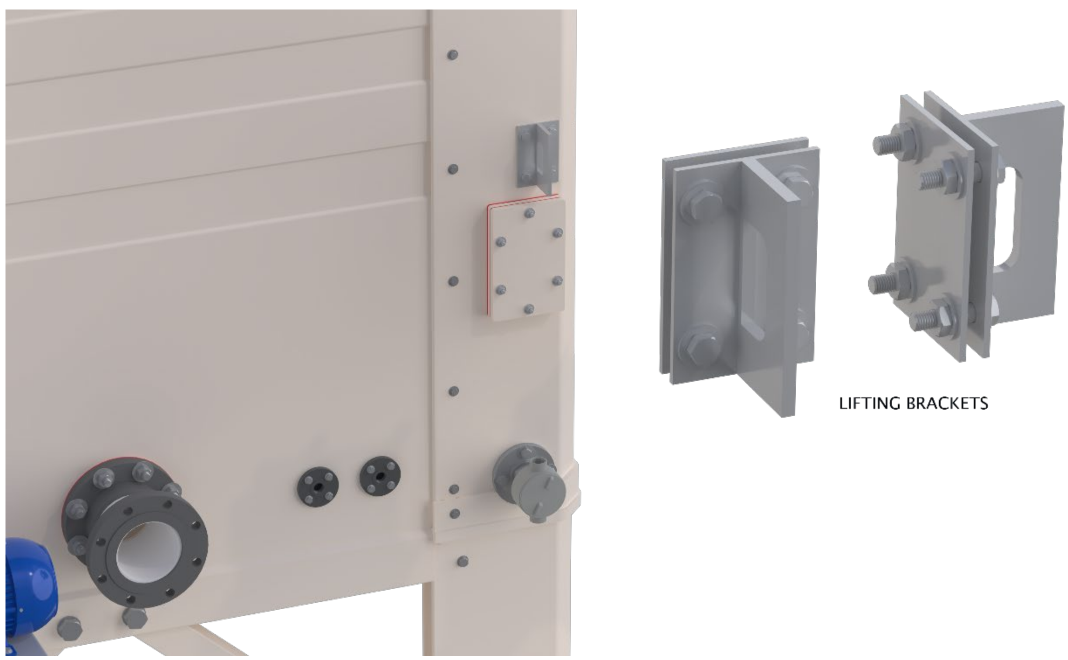


Figure 42 – Lifting Bracket

4. Prepare and position lifting items such as clevis, lifting cables, spreader beam, guide rope and/or any other incidental items needed for a complete and safe lifting operation. Refer to Figure 47 and Table 12 for appropriate lifting cable length and the spreader beam length. Spreader bar must run the full length of the cooler as shown in Figure 47 and not the short side of the cooler. Recommended cable and beam lengths are designed to minimize side loading of module walls. Position crane at the center of the cooler, misaligned lifting will damage the cooler shell and/or its water tightness.

5. Lift the cooler module from the trailer and attach the sub-structure kit. Verify that the cooler support platform is level and, if not, provide ample shimming such that full bearing is achieved under the cooler's footpads. Uneven tower placement will lead to operational difficulties.

6. Lower the cooler module to its final position. Secure with anchoring bolts. Lower the crane and check the tower for stability while it is still attached to the crane.

7. Check module for plumb and stability then tighten all hardware at leg braces before detaching the crane.

8. Proceed with the cooler startup operation.

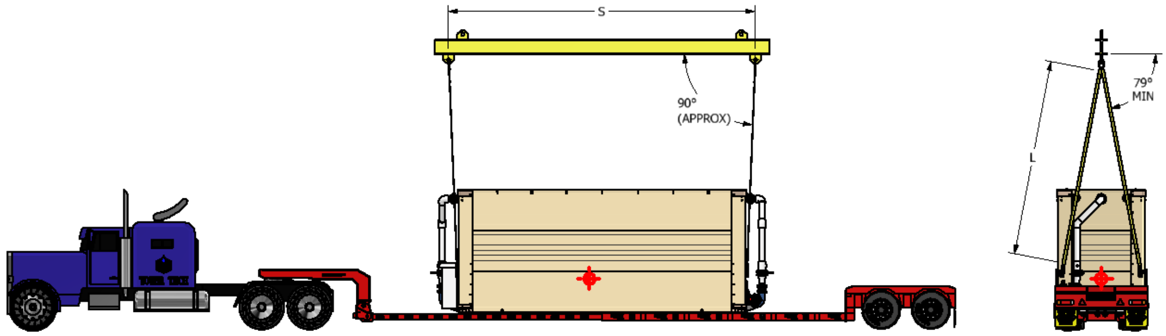


Figure 43 – TTCC-i4xxxx-HC Tower Rigging

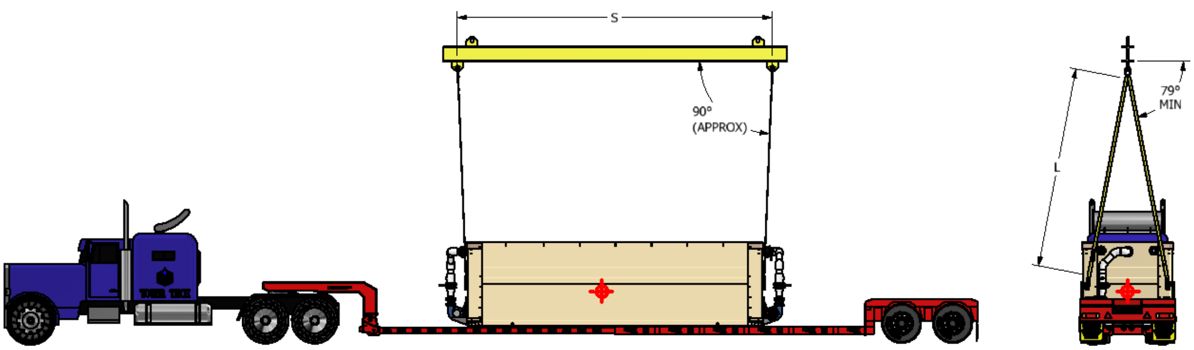


Figure 44 – TTCC-i4xxxx-FC Tower Rigging

TTCC Model	Dry Weight-Lbs * (kg)	S: Sling Length-FT (M)	L: Spreader Beam-FT (M)
i1xxxx-FC	3850 (1746)	20 (6.1)	9' 6" (2.9)
i1xxxx-HC	4441 (2015)	20 (6.1)	9' 6" (2.9)
i2xxxx-FC	5533 (2510)	20 (6.1)	15' 6" (4.7)
i2xxxx-HC	6421 (2913)	20 (6.1)	15' 6" (4.7)
i3xxxx-FC	7580 (3438)	20 (6.1)	21' 6" (6.6)
i3xxxx-HC	8720 (3956)	20 (6.1)	21' 6" (6.6)
i4xxxx-FC	9262 (4202)	20 (6.1)	27' 6" (8.4)
i4xxxx-HC	10699 (4853)	20 (6.1)	27' 6" (8.4)

* Tower weights may vary due to optional equipment, residual water from factory testing, rain, etc. Weights shown are guidelines only and do not include sump, substructure or other accessories not directly attached to the tower module during shipping.

Table 13 – Tower Lifting Data

Chapter Seven: Cooler and Peripherals Installation

7.1 Piping Connections

Standard piping connection locations on a TTCC module are illustrated in Figure 45. Standard dimensions are noted in Table 2 Engineering Data. A description of each connection and its related function follows.

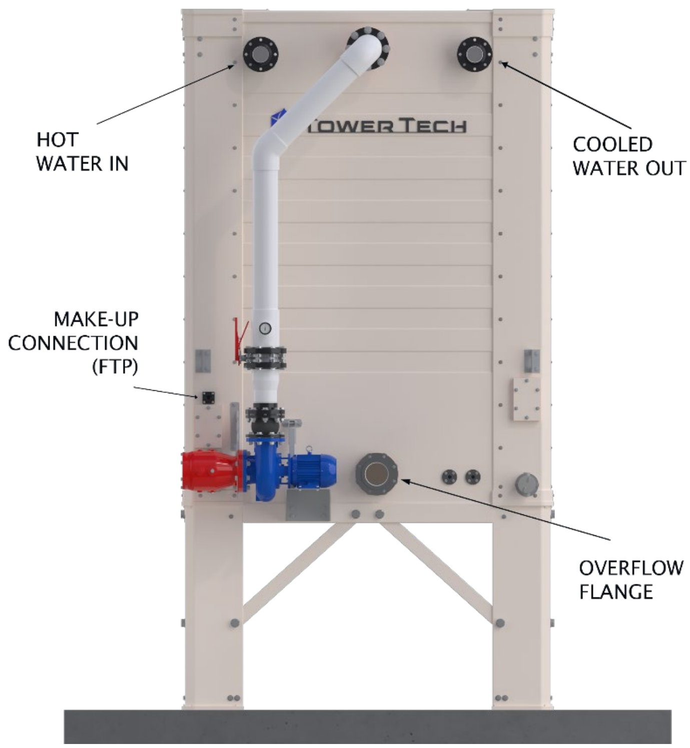


Figure 45 – Standard Piping Connections

⚠ CAUTION Piping should be installed by a licensed plumbing specialist who is familiar with municipal, state and federal regulations.

⚠ CAUTION All piping must be freestanding and not supported by the cooler at any time. It is very important that these instructions are followed to prevent damage to the module due to stress and creep.

⚠ CAUTION Over-tightening bolts may result in damage to flanges.

⚠ CAUTION Heavy duty fender washers should be used on all bolts attaching piping flanges to cooling tower flanges. Adhere to all torque requirements listed in this manual and submittal drawings.

⚠ CAUTION Avoid blocking cooling tower air inlets with piping or other equipment to prevent air restrictions that could diminish tower performance. Avoid installing piping or other equipment underneath the tower that could restrict access to mechanical equipment for service and maintenance.

7.2 Inlet and Discharge Connections

The cooler inlet connection is located at the top of the module's pump end wall to the left of the recirculation piping.

The discharge connection is located at the top of the module's pump end wall to the right of the recirculation piping.

Tower Tech recommends the use of an appropriate flexible flange connection on both inlets to better accommodate minor piping tolerances. Failure to use a flexible flange connection may result in damage to the cooler structure, as well as adjacent piping. Final connections to the cooler module must be field fitted after module installation to prevent pipe stress on the cooler, and a compatible gasket should be used between each flange and flexible flange connector to prevent leakage. It is also recommended that a shut-off valve be installed in each pipe to regulate flow to each module and to provide a means of cooler isolation. Design the header piping to the inlet connection for a maximum water velocity of 10 ft/s. Tighten flange bolts to 30 ft. lbs.

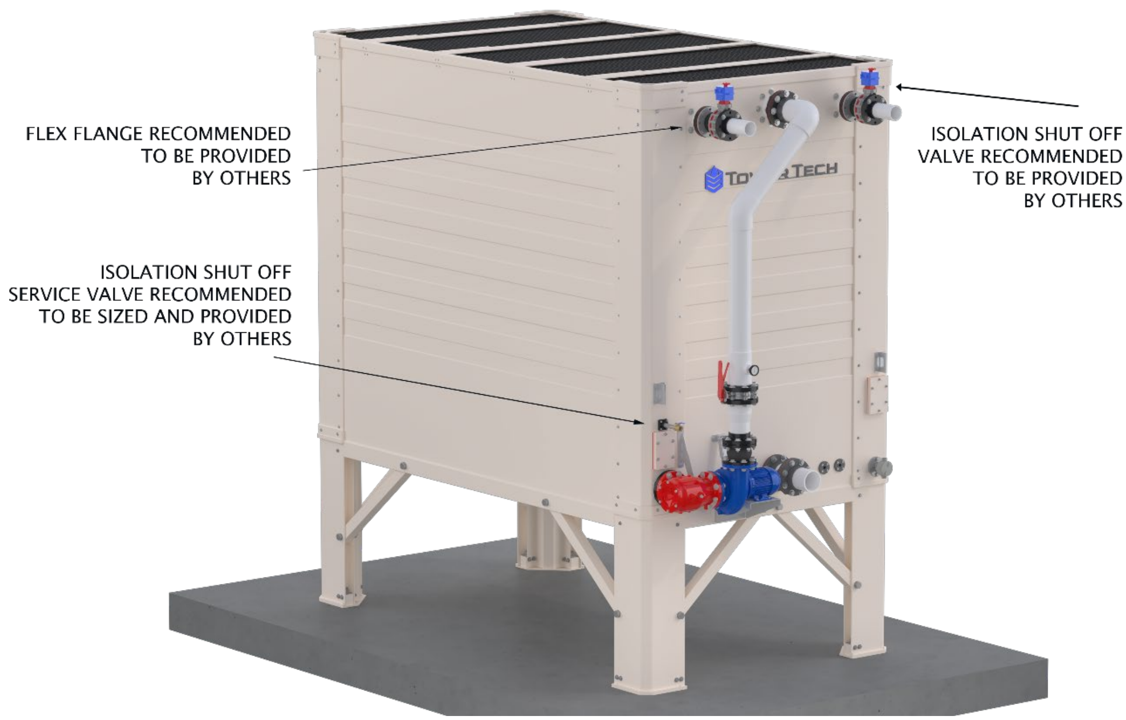


Figure 46 – Connection Flexible Flanges & Flow Control Valves

7.3 External Basket Filter

Tower Tech requires the use of an external basket filter to prevent contaminants such as hair, lint or debris from fouling the heat exchanger tubes. The filter shall be installed by others upstream of the heat exchanger inlet connection at a location suitable for inspection and service. Follow installation instructions per vendor literature.

Vendor literature can be found in the appendix section of this manual and at this address: https://fluidtrol.com/product/sw-basket-strainers/

Figure 47 – External Basket Filter

7.4 Make-Up Connection

The standard make-up connection is located on the pump end of the module in the corner enclosure above the inspection port. Apply Teflon tape to the threads of the make-up piping before inserting it into the connection flange to prevent leakage. When supplied, the make-up valve located inside the module is designed to operate with a maximum inlet pressure of 100 psi. **Install a pressure reducer if local supply pressure exceeds 100 psi.**

7.5 Basin Drain Solenoid Valve

Solenoid valve and pipe fittings ship loose for installation and wiring by others.

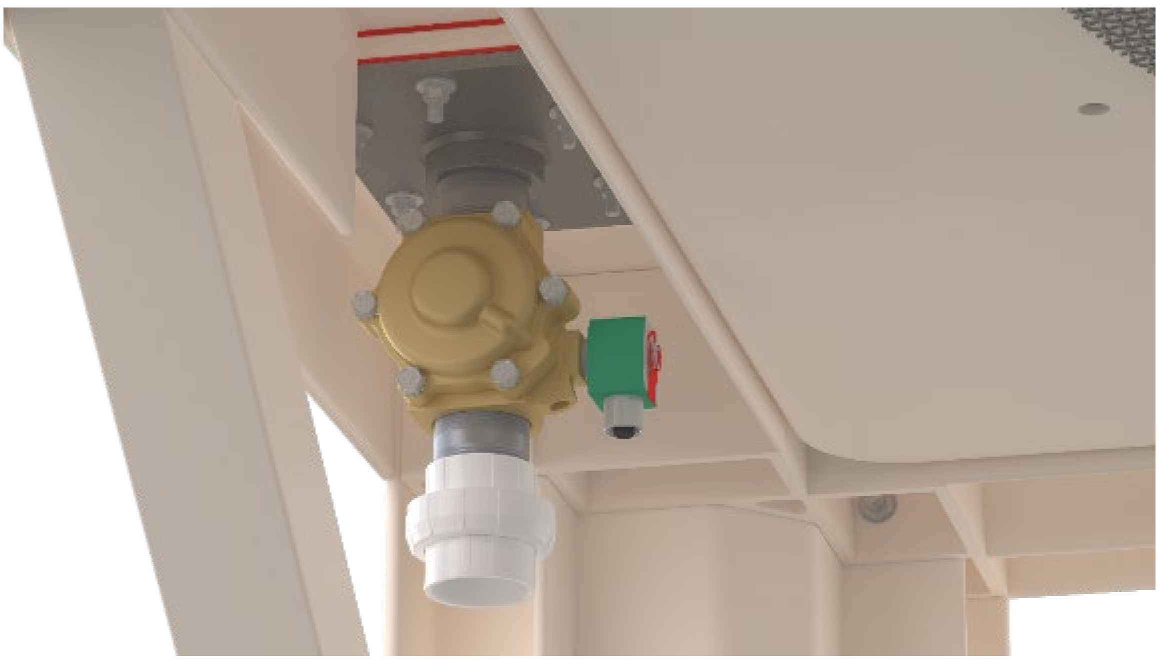


Figure 48 – Basin Drain Solenoid Valve

7.6 Overflow Connection

The 6” overflow connection is located at the bottom of the module’s pump end wall at the middle of the basin. Tower Tech recommends the use of an appropriate flexible flange connection on both inlets to better accommodate minor piping tolerances. Failure to use a flexible flange connection may result in damage to the cooler structure, as well as adjacent piping. Final connections to the cooler module must be field fitted after module installation to prevent pipe stress on the cooler, and a compatible gasket should be used between each flange and flexible flange connector to prevent leakage.

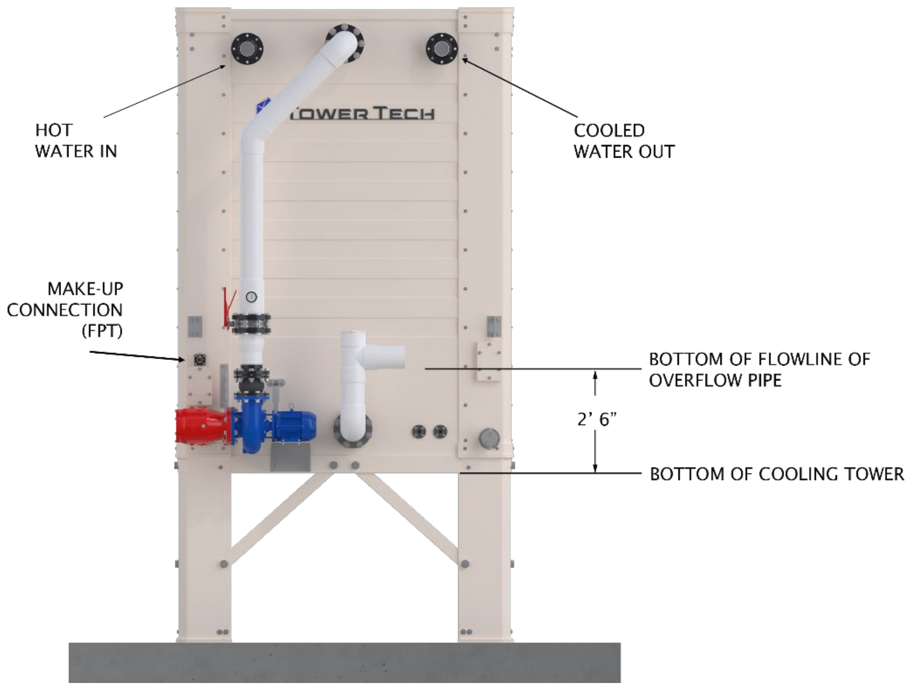


Figure 49 – Typical Overflow Pipe

Chapter Eight: Cooler Start-Up

8.1 Filling XchangeTech System with Process Fluid

Tower Tech recommends using clean water for initial fill and hydrostatic pressure leak testing of the XchangeTech coils, hoses, headers, flanges, drains, vents and other fittings prior to first-time introduction of the glycol process fluid to the cooler. This testing should be performed while the tower is dry and empty to better reveal any leaks or other issues that might have occurred during shipping and installation.

Once pressure and leak testing with clean water is completed, the header vents and coil drains can then be used to test satisfactory operation of the coil drain tubes and drain valve function as required.

1. Remove all drift eliminator media from the top of the cooler. Remove the covers from all inspection ports and observe the basins interior and water collection system is dry. If some water is present, open the basin drain and remove as much water as possible.

2. Open valves on both Hot Water Inlet and Cooled Water Out headers and allow clean water to fill the coils. Use vents on the headers to ensure all air is completely purged. Allow water to flow into the coils until city water pressure is achieved in the coils.

3. Visually check all flanged connections, hose clamps, coil headers and fittings for leaks. Hold pressure for one hour and check the perimeter basin inspection ports for presence of water which would be an indication of a leak somewhere in the system. If a leak is indicated, perform detailed inspection to identify the cause, then contact the factory for instructions prior to performing repairs.

4. When testing is confirmed satisfactory, secure the source of fresh water. Open the header air vents and use the XchangeTech drain valve to allow the test water to fully drain. Close the drain valve when complete.

5. Before introducing glycol process fluid to the cooler, complete all remaining start-up steps in this chapter.

8.2 Filling Recirculating System with Water

1. Close the basin drain solenoid valve and all inspection ports.

2. Bump-start the pump briefly to visually check for proper rotation.

3. Open the riser valve to the spray header.

4. Open make-up valve and allow basins to fill with water to the tower overflow. Note that while the pump is not running, the basin water level will be above the inspection port windows.

5. Check all flanged connections, inspection ports, drain solenoid valve and other pipes and fittings for leaks. Be ready to stop the pump and drain the basin should any leaks be observed during the initial testing.

6. Energize the pump and watch for proper operation as water begins to flow. Watch all basin fittings and inspection ports for leaks. Check all spray nozzles are flowing freely as required. Observe that water spray is adequate and even across all areas of the XchangeTech coils.

7. After one hour, secure the pump, close the makeup water valve and drain the cooler. Remove and clean the suction diffuser screen. Re-fill the cooler and test again until satisfied that the water stream is clear of debris.

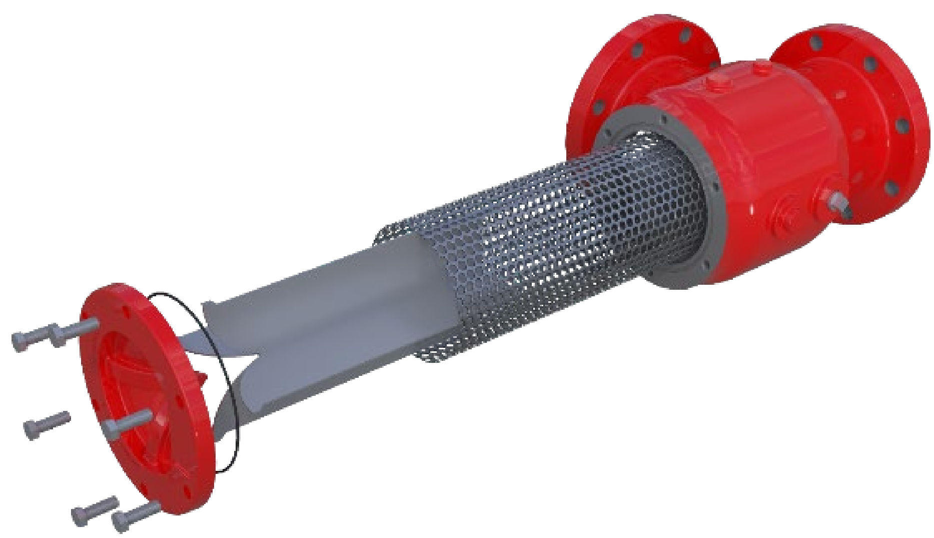


Figure 50 – Suction Diffuser

8.3 Controlling Water Level

The TTCC Closed Circuit Cooler utilizes a mechanically controlled float valve located in the pump end corner enclosure to maintain recirculating water level in the module. Note: Standard mechanical level control is pre-set at factory and should not require modifications to the setting.

Figure 51 – Mechanical Float Valve

Use the following procedure to set the mechanical float valve.

1. Close make-up water valve(s).
2. With recirculating pump OFF, remove inspection port cover below make-up water connection. Check water level. The proper water level should be within the range of the standard operating level at 13-1/2 inches or just below the open inspection port window.
3. Loosen the adjustment screw for the float arm specified in Figure 51. Do not remove the screw.
4. Adjust the arm and stem to desired water level.
5. Tighten adjustment screw.
6. Restore water supply and verify that the water level is at the desired level.

CAUTION Operating with water level below 9” may cause pump surging.

CAUTION Do not exceed recommended maximum operating level or sufficient head space may not be available to accommodate water during shutdown. Note that the water hold-up volume is based on containing the total amount projected to be in the tower’s headers, laterals, XchangeTech coils and fill. Excess water beyond that which can be contained in the basin or evacuated quickly enough via the overflow pipe will empty into the fan shroud, which may cause damage to the fan shroud structure and motor.

Overflow is designed to drain water from the basin when water level rises to within 3-3/8” of the basin top.

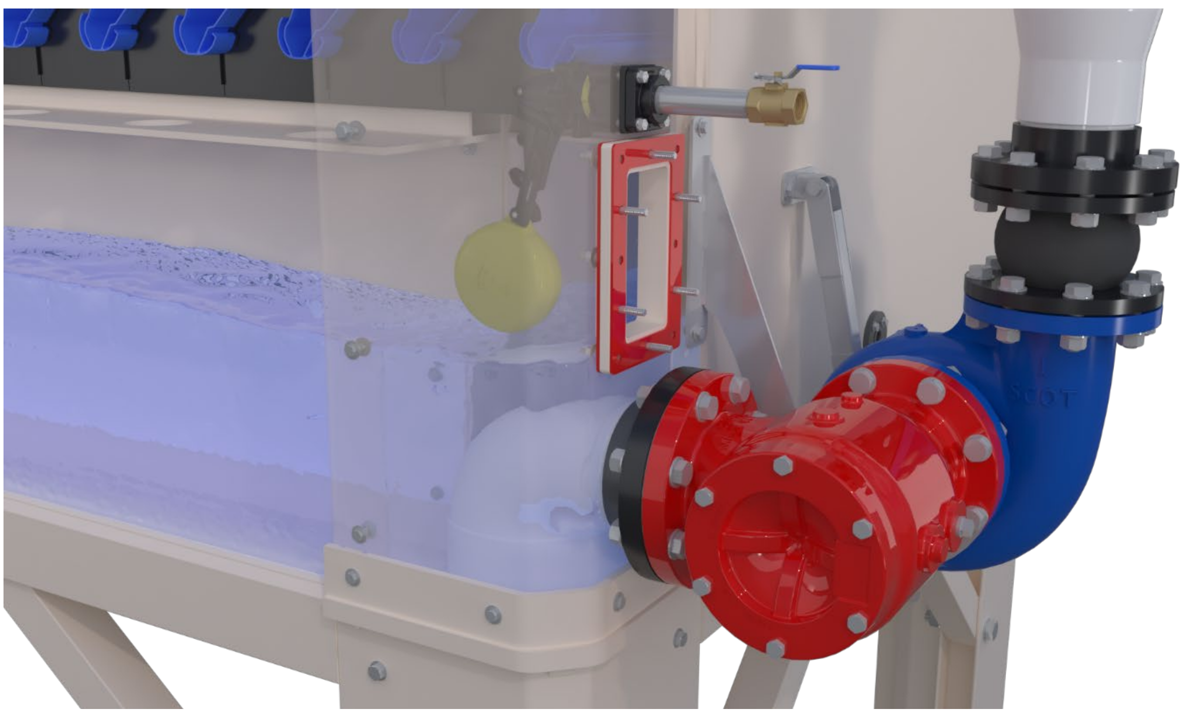


Figure 52 – Setting Water Level

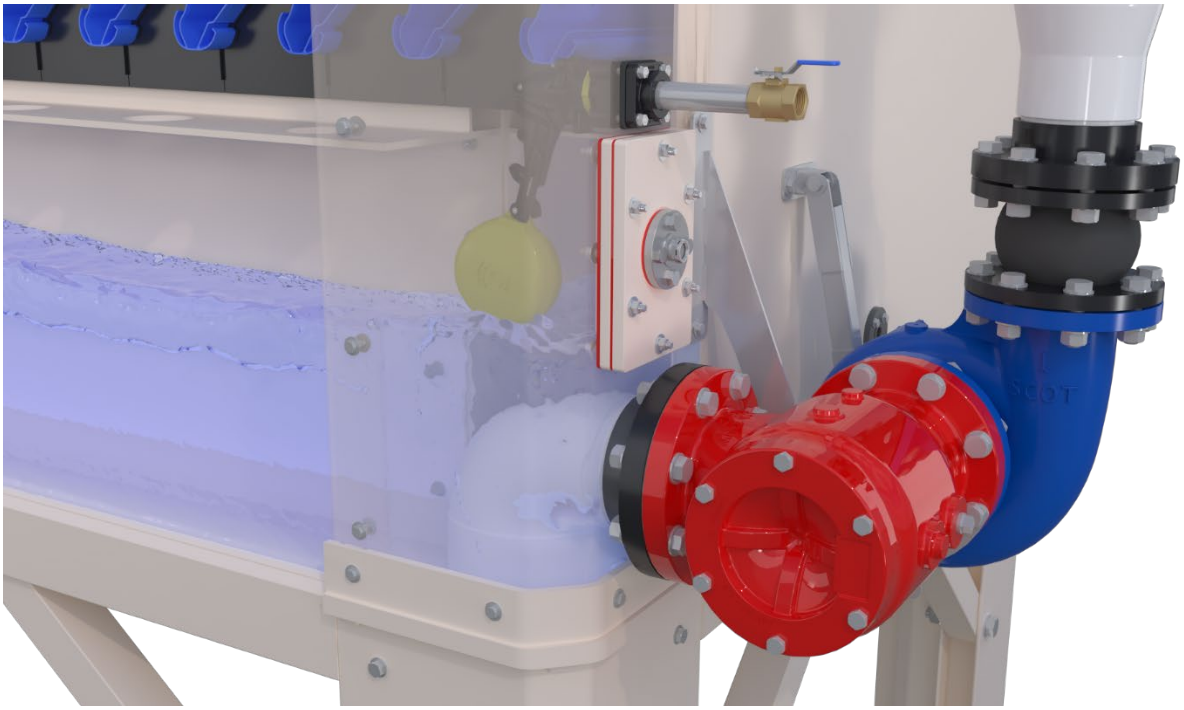


Figure 53 – See Through View During Operation

8.4 Recirculating Spray System Hydraulics

Refer to Table 14 for TTCC Spray Hydraulic Data.

Criterion	TTCC Model			
	i1	i2	i3	i4
Minimum Flow Rate GPM (m^3/hr) **	100 (27.3)	200 (45.4)	300 (68.1)	400 (90.8)
Maximum Flow Rate GPM (m^3/hr) **	300 (81.8)	600 (136.3)	900 (204.4)	1,200 (272.5)
Basin Capacity U.S. Gal (m^3)	316 (86.2)	535 (2.02)	810 (3.07)	1,085 (4.11)

** Spray Nozzle will operate below 40 GPM per nozzle but could result in a smaller spray pattern with reduced tower performance and efficiency. Nozzle operation from 40 GPM to 75 GPM will result in an optimal spray pattern. The rotating turbine will spin freely with flows to approximately 100 GPM however this flow may exceed tower module hydraulic limits (consult Tower Tech engineering manager for specifics). Nozzle operation above 75 GPM may result in uneven wear of nozzle components. Flow rates below 25 GPM and above 100 GPM per nozzle are not allowed.

Table 14 – TTCC Spray Hydraulic Data

8.5 Process Fluid XchangeTech Hydraulics

Refer to Table 15 for TTCC Process Fluid Hydraulic Data.

Criterion	TTCC-FC Model			
	i1	i2	i3	i4
Quantity of coil packs per model per layer	6	12	18	24
Fluid volume per model per layer (coil packs only) Gallons	7.62	15.24	22.86	30.48
Total volume distribution manifold pipe and hoses	12.75	25.48	38.23	50.96

Criterion	TTCC-HC Model			
	i1	i2	i3	i4
Quantity of coil packs per model	12	24	36	48
Fluid volume per model (coil packs only) Gallons	15.24	30.48	45.72	60.96
Total volume per model (including headers and hoses) Gallons	12.75	25.48	38.23	50.96

XchangeTech coil water volume is nominal 1.27 Gallons per coil pack.

Table 15 – Process Fluid XchangeTech Hydraulic Data

8.6 Initial Fan Start-Up

1. Visually inspect each fan for minimum tip clearance of approximately 1/8" (3.175mm) before starting fans for first use. If clearance is insufficient, contact a Tower Tech Representative for further instructions. Although tip clearances are quality checked before releasing a TTCC Closed Circuit Cooler, re-inspect them to ensure there was no movement during shipping.

2. Verify that all fan guards are in place and secure.

3. Check for proper fan rotation by energizing each fan motor. Fans rotate in a counterclockwise direction as viewed from below and push air upwards. If rotation is incorrect, use a qualified electrician to interchange two of the three electrical wires to the motor to correct the rotation.

4. Start each fan in VFD bypass and measure the motor amperage. The amperage should not exceed the motor nameplate rating, with service factor, as given in Table 2.

> ℹ Motor current may run into the service factor in cold weather operating conditions or when the tower does not have water flowing. Motor current should never exceed service factor amps.

5. Check to see that all fans are rotating properly in both VFD and bypass operation.

6. Introduce the heat load after checking all items listed above.

8.7 Spray Flow Balancing

It is often necessary to balance the flow of water entering each cell in multi-cell installations. Tower Tech requires a professional flow balancer to set and certify that flows are balanced and correct for each cooler being started up.

Chapter Nine: Operation

For a detailed description of the Control Panel, see Sec.4.2.

This Manual shows and describes standard power and control wiring and operating procedures only. Tower Tech will supply an appropriate technical supplement for non-standard power and control wiring and operating procedures upon request.

9.1 Cold Weather

In cold weather operation, the process heat load may be rejected with only dry cooling by fan operation through the VFD and the recirculating pump(s) de-energized. Whenever the recirculating pump(s) is de-energized, the basin heater system is energized keeping the basin water from freezing and ready for service if the dry cooling fan system cannot meet process fluid temperature set point and the recirculating pump must be energized.

9.2 Tower Offline During Cold Weather

Any TTCC Closed Circuit Cooler that will not be operated when ambient temperatures are at or below freezing must have **electrical power to all optional basin heaters turned off** and the module cold water basin must be drained. To drain, remove any of the four Inspection Ports located at each cooler module's corners. (Tower modules manufactured after October 2009 also have two Inspection Ports located on the bottom of each Mid-Basin. A cooler module also may contain an optional Basin Drain Kit consisting of a 2" stainless steel threaded coupling with plastic plug installed in each of two Inspection Port Covers located underneath the module in opposite corners of the basin channel. **Refer to Section 9.4.2**.

Tower Tech recommends that a TTCC Closed Circuit Cooler not be expected to produce water cooler than 45°F when the ambient air temperature falls below 25°F
Operations in colder conditions may be possible depending on operational variables including but not limited to entering hot water temperature and water flow rate.

> **⚠ CAUTION** To prevent ice accumulation in the tower, it is necessary to flow a minimum of 50 GPM through each Spin Free Nozzle when the ambient air temperature is below freezing.

9.3 Basin Heater Installation, Testing, Start-up & Operation

Refer to basin heater user's manual for full installation details.

When operating a cooling tower at extremely cold temperatures it is recommended that users specify the use of an electric immersion heater to protect against accidental basin freezing. Tower Tech offers a stainless steel electric immersion heater and control package as optional equipment. The package consists of electric immersion heater element(s), a heater control panel, and a combination temperature/liquid level sensor. This equipment is designed to prevent basin freezing during shutdown or standby conditions.

The electric immersion heaters are sized (kW rating, voltage, phase, and sensor cord immersion length) for the specific tower, basin size, and climate. Both the heater elements and the control panel are in NEMA-4X enclosures suitable for mounting in outdoor locations.

CAUTION The basin heater element(s) and control panel(s) are not designed to prevent icing of the tower components during tower operation.

DANGER **Each heater element contains a fused thermal cutoff device that MUST be wired into the safety circuit as detailed in the installation wiring drawing. This cutoff device is wired in series with any other optional safety devices.**

Immersion basin heaters MUST be deactivated when water is flowing through the cooling tower. Failure to do so will result in overheating of the basin heater element and accidental fire.

– <u>For a cooling tower installation having only one pump</u> it is recommended that the heater control system be interlocked with the tower's circulating water pump, so the heaters are deactivated when the circulating pump is in operation. Doing so provides further protection against overheating of the basin heater element and accidental fire and is also necessary for efficient control of free cooling operations.

– <u>For a cooling tower installation having two or more pumps</u> it is recommended that the heater control system be interfaced to a flow or pressure switch located on the inlet piping to the cooling tower module. Doing so provides further protection against overheating of the basin heater element and accidental fire and is also necessary for efficient control of free cooling operations.

The heater control panel contains the electronic temperature/low liquid level control, control voltage transformer, and the magnetic contactor used to energize and de-energize the heater element(s). The control panel may control more than one heater element, up to its nameplate voltage, phase, and kW rating, provided the elements are in the same tower module basin.

The electronic temperature/low liquid level sensor probe is stainless steel with a 1/2” NPT mounting fitting. It is pre-connected to the control panel with a UL rated outdoor cord.

The sensor has an on/off relay output that de-energizes the heater element(s) whenever the basin liquid temperature is above 45˚F or whenever the sensor probe is not submersed. A low voltage (12 VAC) is connected across the sensor probe and fitting. When the probe is submerged, a 50 milliamp AC current passes through the conductive liquid from the sensor probe to the mounting fitting, completing the circuit. A break in this circuit indicates low liquid level and de-energizes the heater element(s).

⚠ DANGER Use only Tower Tech approved combination temperature/liquid sensor probes. Failure to do so may result in accidental fire. Do not cut or change the length of the sensor cable.

The 24-V transformer in the control panel provides control voltage for the electronic temperature/low liquid level control and the magnetic contactor(s). The magnetic contactor(s) are used to switch the line voltage to the heater element(s). The operating coil of the contactor is energized by the output relay on the electronic temperature/low liquid level control.

Basin heaters are factory preset (non-adjustable) to maintain a basin temperature of 45ºF. Depending on the size of your cooling tower module, multiple immersion heater elements may be required.

The basin heater control panel provides a dry contact on Terminal A1 & A2 as shown in the electrical schematic drawing to indicate if the heater element is on or off. A dry contact is also provided on Terminal A3 and A4 as shown on the electrical schematic drawings. Terminal A3 and A4 are wired to an auxiliary relay to indicate a thermal cut-off fuse failure or if the pump interlock is open. This will allow the BAS to monitor whether the basin heater panel is being prevented from turning on.

9.4 Locating Basin Heater Element(s) and Control Panel Enclosure

⚠ DANGER Use only Tower Tech-approved combination temperature/liquid sensor probes. Failure to do so may result in accidental fire.

1. All tower installations require a minimum of three (3) feet of access space to install and later remove the heater element for inspection or service.

2. The control panel can be safely mounted to the bottom of the tower module's 4.5" high apron, however care must be taken to remain within the boundaries of the tower apron, avoiding any possibility for penetration of the tower's Perimeter Basin or leaks will result. Alternatively, the immersion basin heater control panel may be mounted to a corner leg of the tower module. It is recommended that the panel be bolted to a Unistrut mount which is mounted across the leg brace and the leg. If a remote location from the tower is selected for mounting the control panel bear in mind that the unit ships with a standard 12' probe cord length. Longer lengths are optionally available (up to 100' in length); contact your Tower Tech Sales Representative for details.

2. Heater element must be inserted into the Tower Tech installed stainless steel flange fitting. The heater element is a 6 kW (or optional 9kW) element manufactured with 304 stainless-steel. A NEMA-4X wire junction box is integral to the heater element cap. See Chapter 4.5 and Figure 30 for location of the basin heater element.

Wiring of both the control panel (main input) and of the immersion heater must be completed by a licensed electrician. Only wiring with a temperature rating of 75ºC and rated to carry the quantity of amperage must be used. All wiring must comply with NEC, CEC, as well as local electrical codes. Refer to the basin heater manual entitled "Cooling Tower Basin Heater Control Panel" (shipped inside the control panel) for details regarding Main Power Input Wiring and Heater Power Wiring.

9.5 Immersion Basin Heater: Operating Instructions

Before energizing the main supply disconnect, visually check that the water level is above the sensor probe and that ice has not formed and adjust the make-up water control valve as needed. The combination temperature/low level control is preset at 45ºF, and the system will not energize if the water level is too low or if the water temperature is above 45ºF. Verify all mechanical and electrical systems are working properly. Complete the system test procedure to verify proper operation (also applies to pre-season test when water temperatures exceed 45ºF). Remove all test jumpers before energizing the system.

DANGER **Water Level must be above sensor probe to prevent accidental fire.**

Under normal operating conditions the energized heater control panel will automatically cycle the heater element(s) ON and OFF if the basin liquid temperature is below 45ºF.

DANGER **Disconnect the heater control panel at its source and tag the circuit out for maintenance before performing the following steps.**

9.6 Immersion Basin Heater: Override Operation above 45ºF

a) Disconnect the heater control panel and tag circuit out for maintenance.

b) Remove the heater control panel enclosure cover.

c) Remove the sensor wires connected to terminals T1 and T2 on the combination temperature/low level control and isolate them.

d) Install the 1.5K ohm test resistor supplied with the heater control panel (in bag on inside of cover) across terminals T1 and T2.

e) Install the heater control panel enclosure cover.

f) Energize the system. You should hear the contactor(s) close, energizing the heater(s).

g) After operation, de-energize the circuit, remove the resistor, and place it back into its storage bag. Check all connections, reconnect sensor wires per the wiring diagram to terminals T1 and T2, replace the cover, and place the system back in service.

⚠ CAUTION Do not operate system unattended or for extended periods with the resistor across terminals T1 and T2. Excessive water temperature could damage the cooling tower.

9.7 Basin Heater Operation if Sensor Probe is Encased in Ice

a) De-energize the heater control panel and tag circuit out for maintenance.

b) Remove the heater control panel enclosure cover.

c) Install a jumper wire between terminals G1 and G2 on the combination temperature/low level control circuit board.

d) Install the heater control panel enclosure cover.

e) Energize the system and listen to hear the contactor closing.

f) Operate the system until the ice is melted around the probe.

g) After operation, de-energize the circuit, remove the jumper, check all connections, replace the cover, and place the system back in service.

CAUTION Do not operate the system unattended or for an extended period with the G1-G2 jumper installed. A low liquid level condition could occur, and the system will not shut off. This could result in damage to the heater(s) and cooling tower.

9.8 Immersion Basin Heater: Installation

This section consists of general information, mechanical installation, electrical installation, and start up.

Carefully plan the locations of heaters, control panels, and probes. Measure the factory supplied probe cord length.

⚠ DANGER **Do not attempt to change the supplied probe cord length.**

The heater control panel should be within sight of the heater if a disconnect switch option is selected. Maintain a water level at least 2" over the heaters using the makeup water controls (furnished separately with the equipment or by the user). Low water level may lead to over temperature conditions near the heater. Consider additional safety devices or over temperature protection.

⚠ DANGER **Heater element over temperature can cause a tower fire.**

9.9 Immersion Basin Heater: Control Panel

After selecting the installation site mount the control panel with four 5/16" (field supplied) bolts through the mounting feet on the enclosure. Connect the main incoming power conduit to the main power hub and the heater power conduit to the heater power hubs. If alternative conduit hubs are drilled, or if supplied hubs are not used, replace the plastic protective caps inside the hubs with steel plugs. If leakage or condensation is likely to occur in the conduit leading to the control panel, install a drain at the bottom of the control panel and form a conduit loop.

9.10 Immersion Basin Heater: Temperature/Low Liquid Level Sensor

Mount the combination temperature/low liquid level sensor using the factory installed flange which is installed in the basin wall at least 1" above and at least 6" away horizontally from the stainless steel flange(s) for the heating element(s). Refer to Figures 29 and 30.

DANGER **Do not confine or surround the sensor probe with any type of well, piping, or housing, as it may adversely affect its operation.**

Insert the basin heater sensor probe into the Tower Tech-installed sensor probe flange only. See Figures 29 and 30 for location of the probe flange. The reducing bushing, rubber gasket and lock nut must be used to tighten the heater sensor into the flange of the cooling tower.Tighten the locking nut fully onto the sensor probe. Tighten the reducing bushing into the probe flange. Twist the probe in a counterclockwise movement prior to inserting into the flange so that when the probe is properly seated within the flange its wire rests in a relaxed state rather than twisted state. Tighten the locking nut to keep the sensor probe from rotating in the flange. Sensor probe connections to the heater control panel are made at the factory. No electrical installation is required.

9.11 Immersion Basin Heater: Main Power Input Wiring

The main incoming power hub and the main power termination points are sized for wires based on the total nameplate kW and voltage. The actual load for a particular installation may be less. Either compute the actual load on the heater control panel (the total kW of all the heaters connected to it) or use the nameplate rating in determining the wire size required.

Calculate the amperage as follows:

$$\text{Three Phase Amperage} = \frac{\text{Total kW} \times 1000}{\text{Voltage} \times 1.732}$$

The field supplied branch circuit disconnect switch, and the branch circuit protective devices (fusing or circuit breaker) should be sized to carry at least 100% of the current calculated above.

Wiring with a temperature rating of 75ºC should be used. The wiring should be sized for the quantity of incoming wires in the conduit and the amperage of the branch circuit protective device as directed by the NEC/CEC, or any other local directives.

If non-metallic conduit is used, provide a circuit grounding conductor that meets NEC/CEC requirements. Ground lugs are provided in the heater control panel.

Connect the incoming power wire conduit to the incoming power hub provided on the control panel. Make sure the connection is watertight and secure. Pull the incoming power wire into the control panel enclosure and make the connections per the control panel-wiring diagram.

9.12 Immersion Basin Heater: Element Power Wiring

One heater control panel may control one or more heaters (up to the maximum nameplate kW rating). The power wiring to the heater(s) must have an ampacity equal to the branch circuit over-current protection device rating, or equal to the rating of sub-circuit fusing if installed in the control panel. Some exceptions to this requirement may apply to a specific installation, such as tap rules in the NEC/CEC.

All heater power wiring should have a temperature rating of 75ºC and be rated for the number of wires in the conduit. It must comply with any local codes, NEC, or CEC depending on the installation location. If non-metallic conduit is used, provide a circuit grounding conductor that meets NEC/CEC requirements. Ground lugs are provided in the heater control panel.

Connect the heater power wire conduit(s) to the heater power wire hub(s) provided on the control panel. Make sure the connection is watertight and secure. Pull the heater power wire into the control panel enclosure and make the connections per the control panel-wiring diagram.

Conduit and wiring connections to multiple heaters should be routed so that each individual heater is branched from the run until the conduit terminates at the last heater. Use of "jumpering" from one heater to the next is not recommended.

9.13 Immersion Basin Heater: Element Safety Wiring

Each heater element contains a fused thermal cutoff device that must be wired into the safety circuit. Wire the safety control circuit per Class 2, Article 725 of the N.E.C. and/or Section 16 of C.E.C. unless wiring is routed in the same conduit as the power wire, in which case Class 2 does not apply and the wiring must be Class 1.

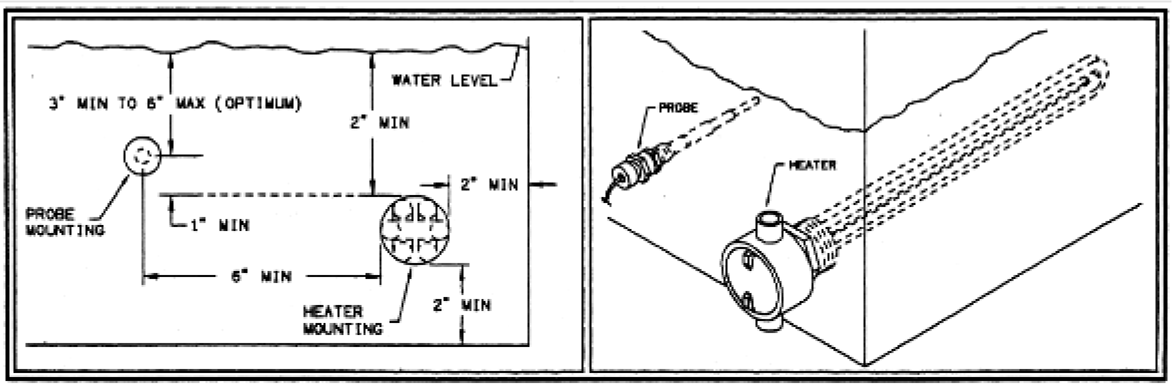


Figure 54 – Location of Basin Heater Probe & Element

Notes:

1. Water level must never fall below 2" above heater elements while heater is energized.
2. Probe must be positioned at least 1" above and 6" horizontally away from heater. For best performance, probe should be placed between 3" and 6" below water level.
3. Heater must be positioned at least 2" above floor of Perimeter Basin Wall and at least 2" from each Perimeter Basin Wall for circulation. For best performance, heater should be placed midway between Perimeter Basin Walls.

9.14 Immersion Basin Heater: Start-Up

Once installation is complete, verify proper operation:

a) Check all mechanical and electrical connections to ensure they are tight.

b) Make sure all other system components are installed and ready to operate.

c) Follow the instructions in the basin heater user's manual.

d) Once proper operation has been verified, ensure all jumpers and/or test resistors are removed and permanent wiring is installed and tightened.

9.15 Immersion Basin Heater: Troubleshooting and Maintenance

DANGER **Possibly dangerous voltages are present in the equipment. Disconnect electrical service at the source and tag circuit out for maintenance before servicing.**

CAUTION Troubleshooting should only be performed by qualified personnel.

a) Perform a visual inspection of the system to verify:

1) Basin has adequate liquid level and is not frozen. If liquid level is low check liquid level controls and add water as required. If basin is frozen, refer to above section entitled "Basin Heater Operation if Sensor Probe is Encased in Ice".

2) All components appear to be undamaged and in sound operating order. If the heater has a thermal cutoff, check for continuity and replace it if open.

b) Check voltage on incoming power lines at the heater control panel. The voltage on all phases should match the nameplate rating. Correct voltage as required.

c) Remove the heater control panel enclosure cover.

d) Disconnect sensor cord and install test resistor across terminals T1 and T2; jumper across terminals G1 and G2.

e) Energize the system:

1) Measure the voltage at terminals "N" and "24/240" on the circuit board. The voltage should be 21-29 volts. If not, the transformer is faulty and should be replaced.

2) Measure the voltage at terminals "N" on the circuit board and NO on the relay. The voltage should be between 21-29 volts. If not, the circuit board is faulty and should be replaced.

3) The green LED light should be ON and the red LED light OFF when the contactor(s) are energized. If not, the contactor(s) are faulty and should be replaced.

4) Remove the test resistor and jumper wire; reconnect the sensor cord.

5) Make sure the liquid level is adequate and at a temperature of 40ºF or below. The green LED light should be ON, the red LED light should be OFF, and the contactor(s) should be energized. If they are not, the cord and sensor are faulty and should be replaced.

f) When the tests are completed and proper operation verified, ensure all jumpers and/or test resistors are removed and permanent wiring is installed and tightened.

g) Replace control panel enclosure cover.

⚠ DANGER Dangerous voltages are present in this equipment. Disconnect electrical service of source and tag circuit out before servicing or replacing components.

9.16 Immersion Basin Heater: Repair

None of the control components are repairable. Remove and replace any failed components.

9.17 Immersion Basin Heater: Maintenance

The system should be inspected annually, just prior to the heating season:

a) Visually inspect the system components for physical damage, overheating, loose connections, leaks, etc. Service as required.

b) Physically check that all wiring insulation is sound and that all wiring connections are tight. Repair and tighten as required.

c) Check operation.

d) Maintain proper water quality according to the recommendations of your water treatment consultant. A high chlorine content and/or deposit build-up on the element tubes may reduce heater life. Correct water quality and clean deposits from element tubes as required.

e) Wipe sensor probe to remove any deposit build up.

Chapter Ten: Water Treatment

DANGER **The use of untreated water in any cooling tower may cause serious health hazards, including the creation of conditions conducive to the development of Legionella bacteria, which is known to cause Legionnaire's disease. A water treatment program to stop biological contamination must be used for all cooling tower installations to reduce such hazards. Do not operate this equipment without a proper water treatment program.**

There are numerous chemical and non-chemical methods currently available for use in treating cooling water. It is beyond the scope of this text to cover the nature and suitability of these methods. However, some general information on what constitutes an effective and complete water treatment program is provided below. In general, a complete program must address the following: 1) scale control; 2) solids control; 3) biological control; and 4) corrosion control (principally for protection of the cooling loop and not the cooling tower).

10.1 Scale Control

Although it is commonly understood that scale accumulation has a tremendous impact on the efficiency of chillers and heat exchangers, it is a lesser known truth that scale accumulation has an adverse effect on closed circuit cooler thermal efficiency. Even minor visible scale accumulation on cooler heat exchanger tubes or fill (the tower's heat exchange medium) can prevent the even distribution of water as a thin film across the heat exchange surface. If scale accumulation is great, it may have a significant impact on static pressures observed within the tower and thus the free and even flow of air through the Water Collection System and heat exchange media. Lastly, significant scale accumulation can impose weight loads upon the tower sufficient to distort walls leading to seal leaks, as well as failures in the water collection system.

Evaporative cooling water in the recirculating water system must be controlled for solids, including both dissolved and undissolved solids. Dissolved solids include the scaling ions (e.g. magnesium (Mg), calcium (Ca), sulfate (SO^4), phosphate (PO^4)) and the non-scaling ions (e.g. chloride (Cl), sodium (Na), etc.) Use a tiered approach to control the concentration and impact of dissolved solids on your TTCC Closed Circuit Cooler : 1) use of scale inhibitor(s) and 2) periodic blowdown or bleed governed by a conductivity or TDS controller. A good rule of thumb for operating Cycles of Concentration is to control the cooler's recirculating water conductivity (TDS) at a level which is 3-4 X that measured in the make-up water (applies to waters of average hardness). Exceptions do exist to this rule of thumb depending on the exact chemical nature of the principal scale ions in the system – see your professional water treater for details.

CAUTION If acid is added to the cooling water loop it must be added using an injection quill positioned at the center of the recirculating pump discharge pipe. Failure to do so may result in damage to cooling tower components which are normally resistant materials.

CAUTION XchangeTech coils, fill media, and drift eliminators can be damaged using some chemicals. Always use cleaning and water treatment chemicals in accordance with recommendations of a water treatment contractor.

The TTCC Closed Circuit Cooler's non-reactive composition allows for most industry accepted scale inhibitors to be used. Scale inhibitor blends typically used are proprietary mixtures of phosphonates (e.g. AMP, HEDP, etc.) and polymers (co and terpolymers, such as polymaleic acid (PMA), phosphinocarboxylic acid (PCA), polycarboxylate copolymer, acrylate polymers) all of which are effective at scale control and have no negative effect on materials used in Tower Tech TTCC Closed Circuit Coolers. For scale control agents to have their best effect it is often necessary to dose the system with acid (e.g. sulfuric acid) to maintain the pH range of 6.5 – 8.5.

In addition to the chemicals described above for scale inhibition and/or modification there are numerous non-chemically based methods available in the market and the list of emerging technologies grows yearly. Oxidation-Reduction (Redox) based alloys (copper-zinc) have had an excellent history of scale control in Tower Tech coolers. Alternative methods such as ozone must be used with stringent control as ozone radicals are known to embrittle PVC components such as fill media.

10.2 Solids Control

Undissolved solids are a measure of the insoluble substances found in suspension in evaporative cooling waters. Undissolved Solids include larger diameter/heavy particles such as bacteria, algae, clam/mussel larvae, leaves/twigs, silt in make-up water, dust in air, migrated corrosion particles (free metal oxides). It may also include colloids or complexes generated by using treatment compounds (e.g. stabilizing agents for scale control and crystal modifiers).

The TTCC Closed Circuit Cooler's absence of side air louvers and open basins dramatically decreases the potential for undissolved solid entry into the recirculating loop as compared with conventional cooler designs

Undissolved solids serve as physical foulants which can plug heat exchangers and fill, thereby damaging them and shell structure by weight imposed as well as reducing heat rejection efficiency. In addition, they can contribute to corrosion by preventing the contact of the CI (Corrosion Inhibitor) to the downstream metal surfaces, as well as promote biofilm formation by shielding microbes from biocides. Controlling these solids is important in allowing lower and more efficient use of treatment chemicals.

An undissolved solids level of 100-150 ppm (particularly those 10 microns or smaller in size) is typically recommended for re-circulating systems. Usually, a physical means is used to remove these solids, e.g. strainers, filters (100 mesh or 150 um particle cut-offs, and cartridge are used.

Solids removal is not a strict requirement for the TTCC Closed Circuit Cooler unless the tower is in a high dust environment.

10.3 Biological Control

Biological control is important both for safety (e.g. *Legionella*), thermal performance (*Pseudomonas* or slime formers can plug heat exchangers and fill), and corrosion control reasons (sulfate reducing bacteria, nitrifying bacteria, and iron reducers can all produce metabolic end products that are damaging to metal surfaces in piping and downstream equipment).

DANGER Closed circuit cooler's recirculating water, as well as other water atomizing devices (such as cooling towers, sprinklers, misters, shower nozzles, etc.), are potential vectors for the spread of *Listeria,* the causative agent of Listeriosis (a type of pneumoniae). It is crucial that the tower be routinely treated with appropriate biocidal control agents specifically designed to control the proliferation of *Listeria*. Experts agree that oxidizing biocides (chlorine, hypochlorites, hydantoins, chlorine dioxide, sodium bromide with chlorine, and ozone) are the most effective control agents and should be used to always maintain a 0.5 ppm minimum residual chlorine level.

CAUTION The cooler should be located well away from and downwind of building air intakes to further reduce the potential for aerosol to enter buildings. Under no circumstance should a cooler be operated without drift eliminators in place and intact.

It is best to combine a non-oxiding and an oxidizing chemical into your cooling water treatment program. Generally, the oxidizing biocide (chlorine or bromine based technologies) is administered continually to maintain a specific system concentration whilst the non-oxidizing chemical (DBNPA, Quats, glutaraldehyde, isothiazolinone) is slug-fed at pre-defined time intervals. Use of both allows for synergisms between their modes of action, as well as assurance that an antimicrobial resistant sub-population will not occur. It is also recommended that a penetrant or bio dispersant (see fouling section) be used in conjunction with the biocide program to enhance the ability of the oxidizing biocide to contact target microbes

10.4 Corrosion Control

Corrosion control is necessary in TTCC cooler systems not for preventing damage to the module itself, but rather to prevent damage to pumps, strainers, and valves within the recirculating system. The recirculating water acts as a delivery mechanism for bringing the corrosion inhibitors to the appropriate metal surfaces.

A discussion of corrosion control is beyond the scope of this document however a few things bear discussion: A good corrosion inhibitor must: 1) protect all metals involved, 2) act at low concentrations, 3) act under variety of water conditions (pH, temp, other chemicals), 4) have minimal adverse environmental impact.

Chapter Eleven: Maintenance

Adequate knowledge of the operation and maintenance of the Tower Tech TTCC Closed Circuit Cooler will ensure efficient and safe operation. Failure to follow these instructions may result in poor cooling performance, and unnecessary equipment failure. The operation, maintenance and repair of this equipment should be undertaken only by qualified personnel. All such personnel should be thoroughly familiar with the equipment, the associated system and controls, and all procedures dealing with the handling, lifting, installation, operation, maintenance, and repair of this equipment to prevent personal injury and/or property damage.

Tower Tech offers the highest quality replacement parts, materials and services to help customers keep their TTCC Closed Circuit Coolers operating at peak performance. For details refer to the *Maintenance & Service Plans* brochure located in the flap inside the front cover of this Manual. The brochure describes our Preventive Maintenance Inspection (PMI), Preventive Maintenance Service (PMS), and Service Inspection (SI).

Figure 55 – Brochure: Maintenance & Service Plans

DANGER **All electrical, mechanical, and rotating machinery constitute a potential hazard, particularly for those not familiar with the design, construction, and operation of same. Accordingly, adequate measures (including the use of a protective enclosure when deemed necessary) should be taken with this equipment, both to safeguard the public from injury and to prevent damage to the equipment and its associated system.**

DANGER **Walking on top of the module is dangerous and could result in serious injury or death. Adequate safety measures must be taken to prevent injury due to falling. See Section 2.11 regarding safety bracket points.**

DANGER **Disconnect any basin heater(s) before draining water from the module's basin. Failure to do so will result in damage to the module, as well as potential for fire to occur.**

11.1 Troubleshooting

The sight glass may be used as a quick check confirmation that the make-up water valve is functioning and that the basin water level is nominal. If water is not visible in the glass during operation or if a sudden drop in cooling capacity is observed, the following list serves as a troubleshooting guide.

1) If basin water level is good, then check the nozzles to make sure they are all functioning properly and are dispersing water with a uniform pattern covering the coils.

2) If the nozzles do not have water or have low water flow, then check and clean the screen in the pump suction diffuser.

3) If the recirculating system checks to be normal, then check the process fluid flow through the coils by checking and cleaning the external filtration basket.

4) If the filtration basket is clean, then blead the process fluid line for possible trapped air.

5) Once all steps are completed and the cooling capacity is still reduced then the coils may need to be inspected or cleaned to remove any fouling or plugged coils.

11.2 Maintenance Schedule

TTCC Closed Circuit Cooler are designed to require minimal maintenance. However, the quality of care they receive will affect their service life. The following schedule is given as a minimum checklist to aid in providing the recommended inspection and maintenance of your unit. Refer to Table 16 for recommended maintenance of TTCC components.

Component	Maintenance Frequency	Action To Be Taken	Reference Section
Shell Surfaces*	12 months	Visual Inspection	2.2, 2.3
Drift Eliminators*	12 months	Visual Inspection	11.2
XchangeTech Coils	12 months	Visual Inspection	2.18
Fill Media	12 months	Visual Inspection	11.3
Spin Free Nozzles	12 months	Visual Inspection	11.4
Fan Guards*	1 month	Visual Inspection	11.5
Fan Blade Clearance*	1 month****	Visual Inspection	11.6, 11.7
Fan Motors**	1 month**	Turn On Briefly	11.10
Fan Motors	12 months ***	Amp/Volt Check	2.12
Fan Motors*	6 months	Visual Inspection	2.11
Mechanical Float Valve*	3 months	Visual Inspection	11.11
Suction Screen*	1 month	Visual Inspection	11.12
Immersion Basin Heater	12 months (prior to cold	Visual Inspection	11.13
Water Collection	6 months	Visual Inspection	11.14
External Basket Filter	1 week	Visual Inspection	11.15

* Items completed during a single walk around & under cooler module, at specified intervals. Inspection time is expected to be completed in less than five minutes per cooler module

** Required only if cooler is not operated regularly for an extended period.

*** Required only if motor has tripped more than 3 times within any 30 day period.

**** After installation of replacement Fan Assembly

Note: Issues observed during Visual Inspections need appropriate Service completed as required.

Table 16 – TTCC Maintenance Schedule

11.3 Drift Eliminators

TTCC Closed Circuit Coolers utilize a low-pressure three pass drift eliminator that is impervious to rot, decay or biological attack. An ultraviolet inhibitor is manufactured into the product to extend life expectancy. Drift eliminators, however, should be inspected once a year (in conjunction with the nozzle inspection). The drift eliminators should be free from any build-up of mud or debris. If cleaning is required, the following procedure should be followed:

1. Remove the drift eliminators. Place gently on an elevated platform or on the ground.

2. Wash the eliminators by spraying with a low-pressure water hose.

3. Turn the eliminators over and spray until remaining debris is removed.

4. Insert the eliminators back into place in the cooler module.

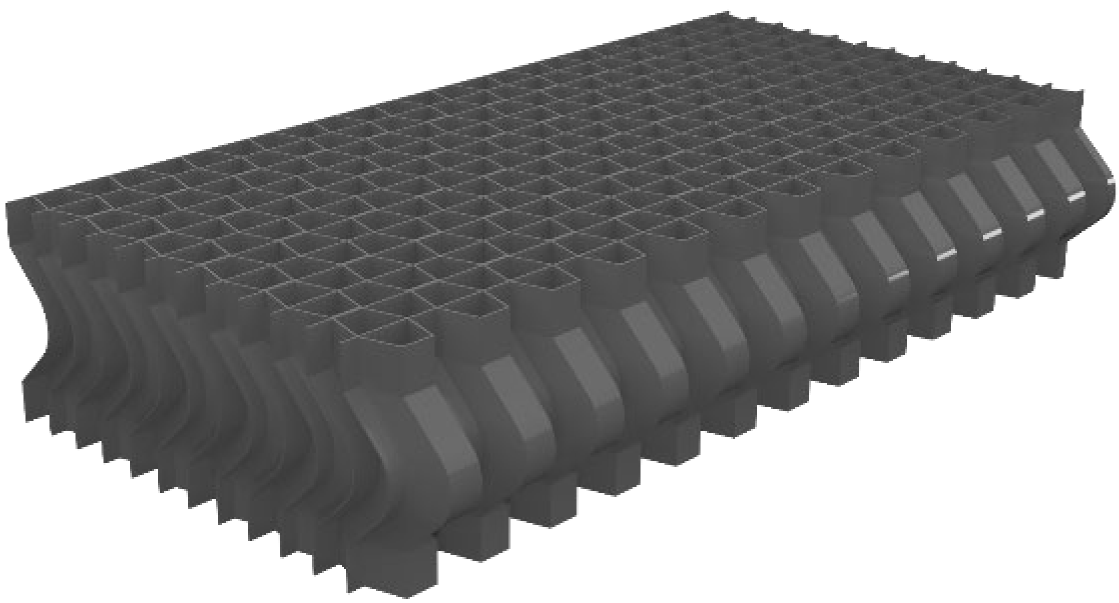


Figure 56 – CF80-MAx Drift Eliminator

11.4 Fill Media

⚠ CAUTION Distribute personnel weight loading on the fill media by placing a flat surface, such as a piece of plywood, atop the fill media to prevent damage to the Fill Media, XchangeTech coils, and Water Collection System while walking on them.

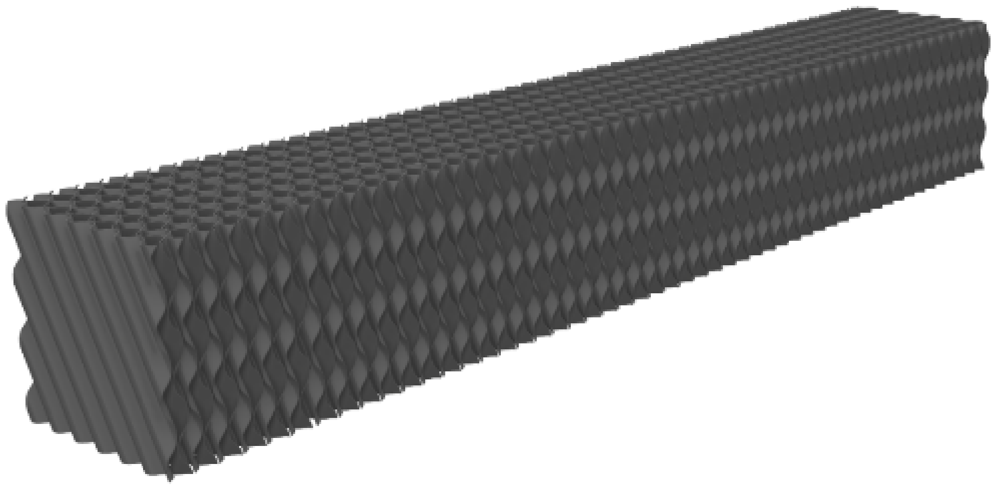


Figure 57 – CF1900 Fill Media 1'w x 1'h x 6'l

Inspect the XchangeTech coils and Fill Media regularly depending on the quality of the water being circulated. A typical inspection includes removal of pieces of fill media from all fill layers (starting from the top). Visually inspect the flute openings on the bottom side of the piece to determine if any build-up of algae, bacterial slime or solids has occurred. Inspect the XchangeTech coils in place. If build-up is significant, it may be necessary to remove the fill media and XchangeTech coil bundles and clean with water and mild detergent as described for the drift eliminators. If algal growth or bacterial slime is detected, please contact your water treatment professional to control the problem. Overzealous cleaning methods may cause damage to cooling tower components.

⚠ CAUTION Bacterial slime can contribute significant weight loads on the cooler beyond that for which it was structurally designed. Damage to cooler internals or shell due to bacterial growth excursion will void the TTCC Closed Circuit Cooler warranty.

11.5 Spray Nozzle

TTCC Closed Circuit Coolers utilize Spin-Free™ spray nozzles. This nozzle has a large two-inch orifice and a rotating turbine that will dislodge nearly all debris commonly seen in cooling towers. While it is unlikely that the nozzle will plug during normal use conditions, bi-annual inspection of the nozzles is recommended.

Inspecting the Spin-Free™ spray nozzle consists of visually inspecting the water distribution pattern. If sticks or large objects are jammed in the nozzle, follow the instructions for removal (refer to Figure 58).

Figure 58 – Rotary Spray Nozzle

DANGER **The Spin-Free™ spray nozzle uses a rotating turbine. Tower Tech sells replacement spray nozzles as complete assemblies only. Disassembly of spray nozzle voids nozzle warranty.**

To remove the Rotary Spray Nozzle:

1. Expose the spray nozzle by removing the drift eliminators that restrict access.
2. Remove the section of fill media directly below the spray nozzle.
3. Remove the small set screw in nozzle head that locks the spray nozzle in place.
4. Using a strap wrench, unscrew the spray nozzle.
5. Individual spray nozzle components are not sold separately. Disassembly of spray nozzle voids nozzle warranty.

Figure 59 – Drift Eliminator Removed

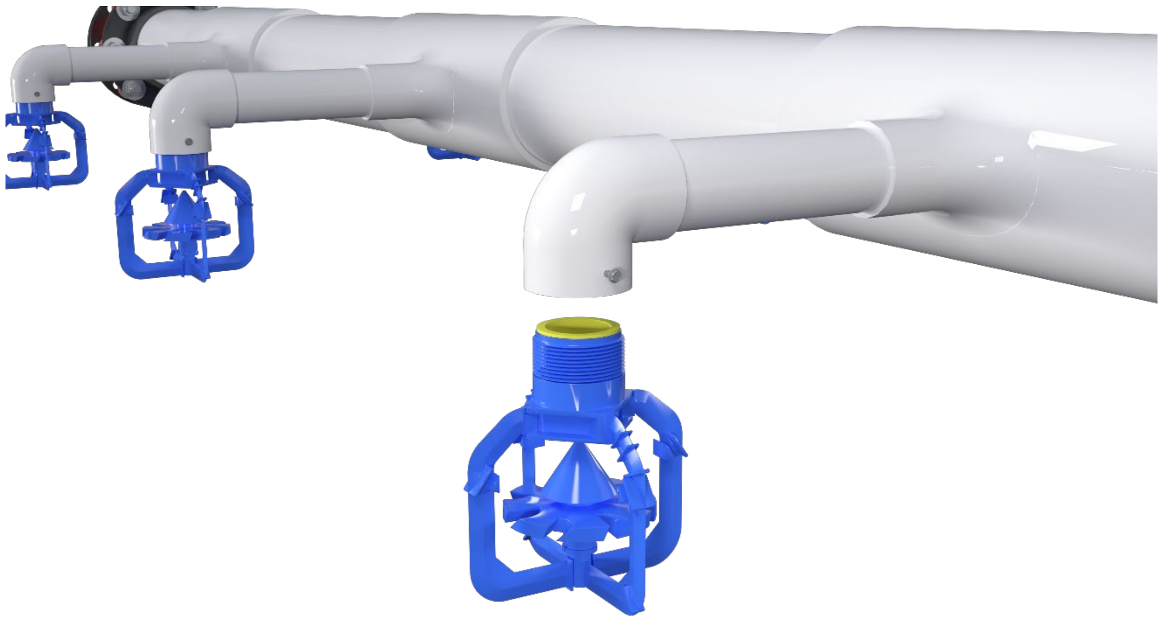


Figure 60 – Rotary Spray Nozzle Removal

11.6 Fan Guards

DANGER When maintenance is required on fan guards, fans or fan motors it is imperative that lock-out, tag-out procedures be strictly adhered to prevent damage to equipment or personnel.

Fan guards are mounted in a frame. Regularly check the guard for large items such as paper or leaves that might be sucked against the guard. It is important to the performance of the cooling tower that any air restrictions be removed.

To remove or replace a fan guard (refer to Figure 61):

1. Turn off fan and lock and tag out power.
2. Remove the four screws securing the fan guard to the fan shroud.
3. Replace fan guard by reattaching with the four mounting screws.

Figure 61 – Fan Screen Closed

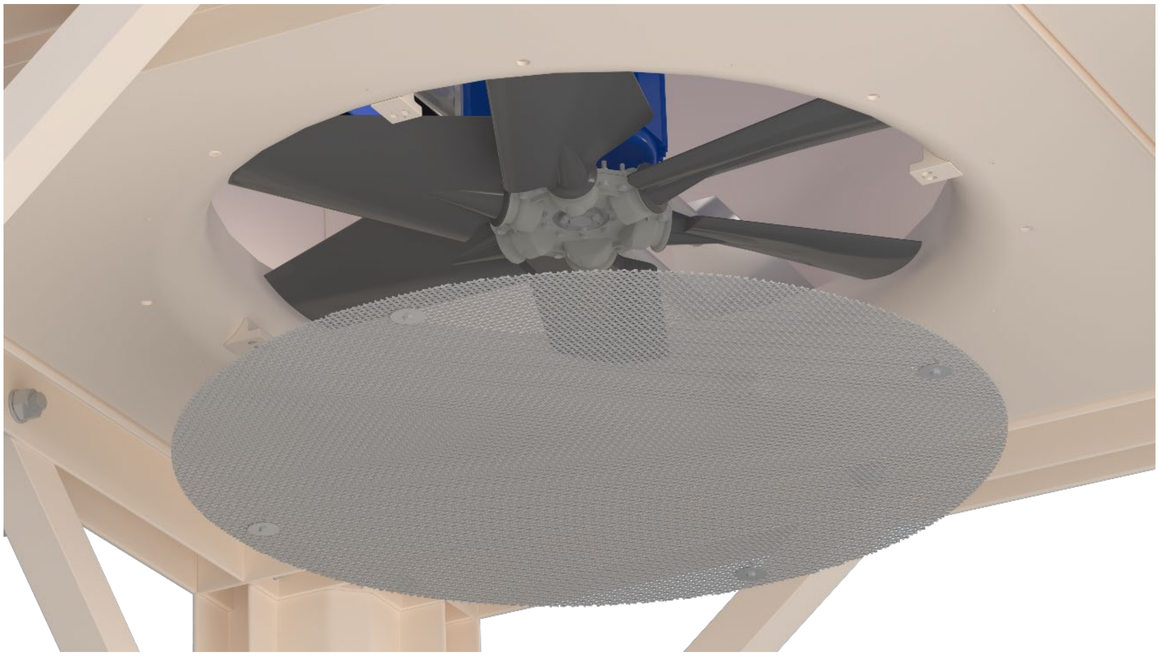


Figure 62 – Fan Screen Open

11.7 Fan Inspection and Removal

DANGER **When maintenance is required on fan guards, fans or fan motors it is imperative that lock-out, tag-out procedures be strictly adhered to prevent damage to equipment or personnel.**

CAUTION Any dirt, ice or other debris on fan blades can affect the balance of the fan. Without proper cleaning and maintenance imbalanced fans can cause damage to the motor bearings.

Fans are pitched and aligned during assembly. Recommended clearance between fan shroud and fan tip is 1/16" minimum and 1/2-inch maximum. Tower Tech sets fan tip clearance at 1/4"to 3/8" in the factory. Fan tip clearance should be checked quarterly.

To remove a fan:

1. Disconnect power from motor, locking-out and tagging-out the motor/fan to be worked on.
2. Remove the fan guard.
3. Support the fan.
4. Remove the bolts from the fan bushing.
5. Thread the bolts back into the threaded holes that are provided in the bushing.
6. Begin tightening the bolts into the bushing evenly until fan is pushed off the bushing. Use a gear-puller if bushing doesn't come off easily.
7. While supporting the fan, tap the bushing gently off the motor shaft.
8. Remove the set key from the motor shaft.
9. Lower the fan to the ground.
10. Mark the fan so that it may be re-installed on the same motor from which it was removed.

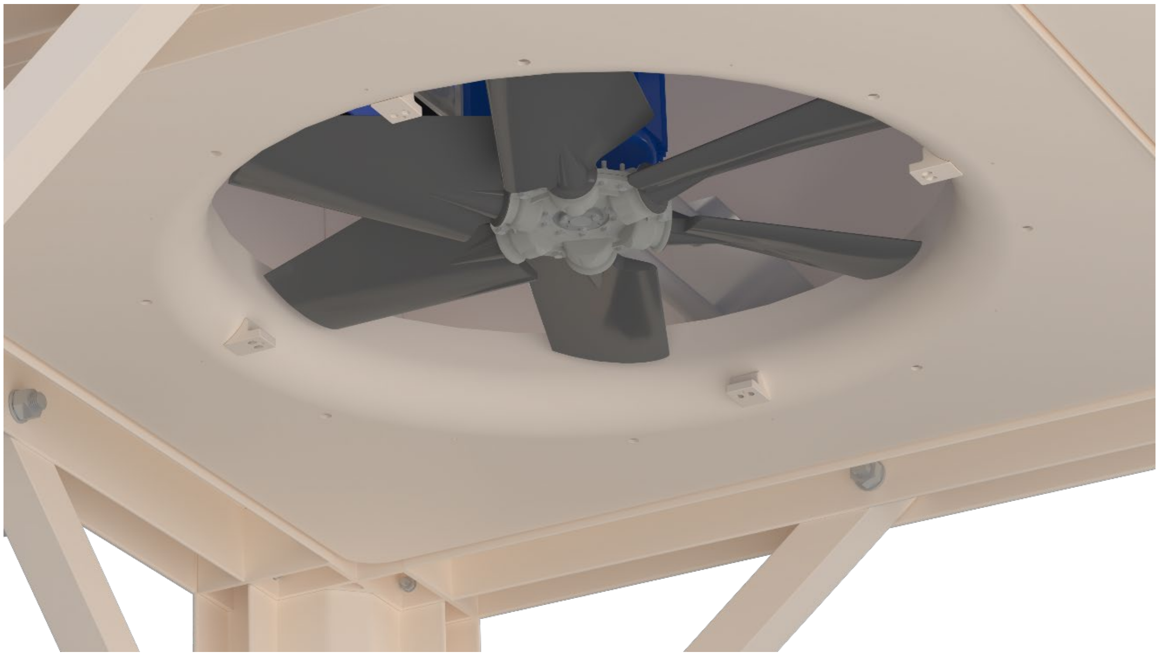


Figure 63 – Fan Assembly

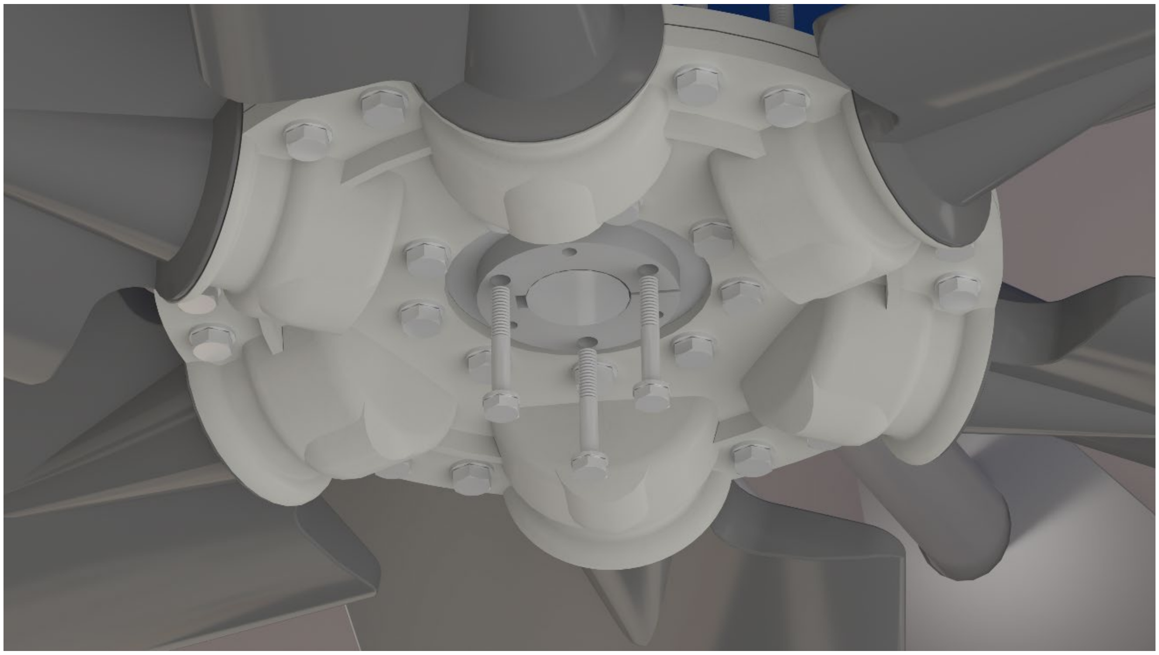


Figure 64 – Taper Lock Bushing Removal

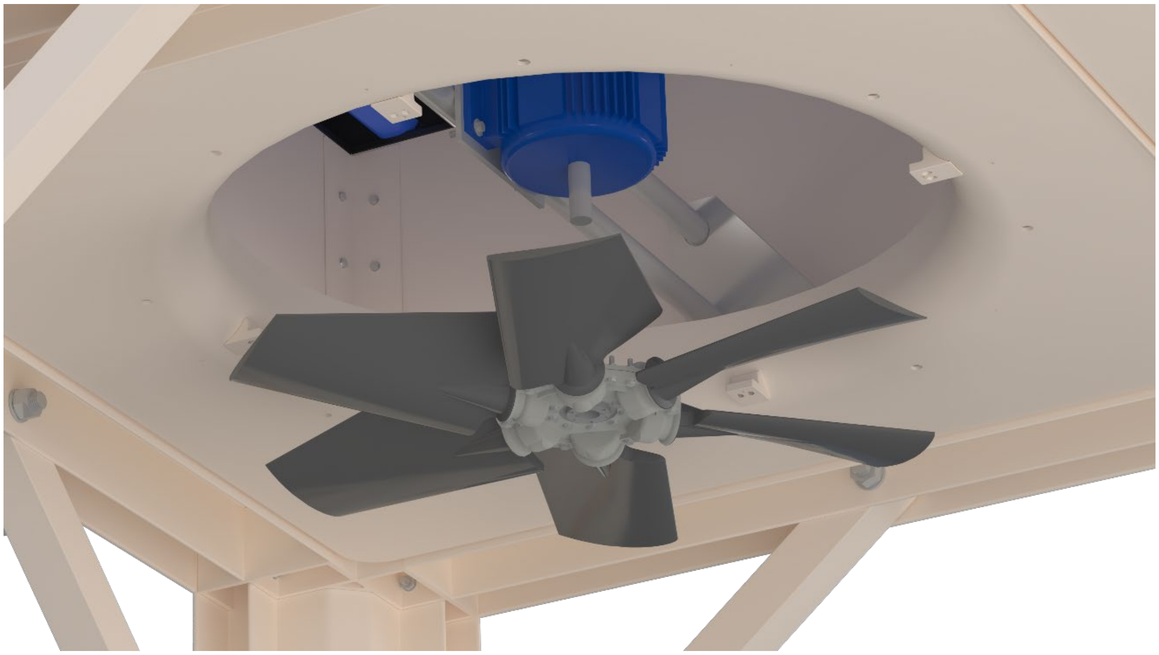


Figure 65 – Fan Removal

11.8 Fan Blade Replacement

Individual fan blades should not be replaced without rebalancing the fan. Replace the fan if damage occurs to the blades.

1. Complete steps 1 through 9 from Checking & Re-Pitching Fan Blades (see Section 10.1.7).

2. Transfer the index tab (key) to replacement fan blade, and place new fan blade into bottom of fan shell half making sure that it is correctly orientated.

3. Proceed with steps 11 through 19 from Checking & Re-Pitching Fan Blades (see Section 10.1.7).

4. Check fan balance and rebalance fan assembly if needed.

11.9 Fan Blade Pitch Adjustment

1. Verify the direction of rotation of the fan with fan operating before removing the fan guard screen.

2. Lock out/tag out the electrical power supply to the fan motors.

3. Remove the fan guard screens from the cells to be worked on.

4. All Tower Tech fan blades for the TTCC Closed Circuit Cooler have a set pitch blade that is fixed by the index tab (key). Pitch should not be adjusted without authorization from the factory. When changing blades, use the same index tab (key) to insure proper pitch.

5. Remove the fan assembly from the motor.

6. Record the location and quantity of all balancing washers and nuts holding the hub shell together along with the individual fan blade location on the hub so that you can return all parts to their original location.

7. Remove the center hub from the fan shell, marking the orientation first.

8. Remove the bolts that hold the fan shell halves together.

9. Carefully separate the fan shell halves by removing the upper half to expose the fan blades.

10. Locate the index tab on the fan blade, exchange with new index tab for the new pitch angle. Fan Pitch is determined by which index tab is installed to achieve the correct setting.

11. Once the pitch is established by installing the correct index tab for all blades of the fan, replace upper fan shell half and tighten the hub bolts to hold the blades firmly in place. Replace center hub and all balancing washers and nuts to their original locations.

12. Recheck the blade pitch after tightening the bolts to ensure that the pitch is correct and record the new pitch setting.

13. Verify that the shell half bolts and hub bolts are torqued to specification below using a torque wrench.

    Manufacturer Specifications:
    5/16"-18 Bolts – Use 14 ft/lbs. of Torque
    3/8"-16 Bolts – Use 19 ft/lbs. of Torque

14. Re-install the fan assembly onto the motor shaft.

15. Check that the fan is not hitting the shroud.

16. Verify that the taper lock bushing bolts to hub are torqued to 12 ft. lbs. using a torque wrench.

17. Replace the Fan Guard Screens.

18. Remove lock-out/tag-out.

19. Check the fan operation for proper rotation to ensure that there are no other problems and return the unit to service.

CAUTION Always use a clean dry cloth to remove any dirt, lubricant or sediment from the bore, the bushing taper and the tapered fan hub. Do not use any lubricant or thread locking compound during installation. The use of such products will cause improper bolt torque and will crack the fan hub. Do not exceed the torque specification listed on the bushing bolt torque chart. Exceeding the recommended torque will crack the fan hub.

11.10 Fan Motors Removal / Installation

DANGER **Use lock-out/tag-out procedures to prevent damage to equipment or personnel when maintenance is required on fan guards, fans, or fan motors.**

To remove a motor:

1. Disconnect power from motor and lock-out/tag-out the motor/fan to be worked on.
2. Remove fan guard.
3. Remove fan.
4. Disconnect electrical conduit and wiring.
5. Support the weight of the motor.
6. Loosen the four bolts that connect the motor to the base plate and remove any shims, making note of their placement.
7. Remove the connecting bolts while holding the motor steady.
8. Slowly lower the motor to the ground.
9. To install a motor, reverse the above procedure.

CAUTION If any of the wire supplied with a fan motor, junction box or safety disconnect requires replacement, use replacement wire of the same gauge and type.

11.10 Fan Motor Lubrication

Standard motors on TTCC Closed Circuit Cooler have sealed bearings. If the tower is not operated regularly for an extended period, the motors should be turned on briefly once each month. Refer to Table 15.

11.12 Mechanical Float Valve

To remove the float valve:

1. Remove the inspection port door below the make-up water connection.
2. Remove ball and stem assembly from the valve body.
3. Using proper sized wrench, unscrew the valve from the threaded flange.

To install the float valve:

1. Attach valve to threaded flange.
2. Valve outlet must be pointed straight down.
3. Attach float and stem to valve body.
4. Adjust float for desired water level (refer to Section 8.3 for details).

Figure 66 – Mechanical Float Valve

11.13 Pump Suction Diffuser Screen

It is important to visually inspect, and document contents retrieved from the suction diffuser screen as it can provide valuable information regarding potential damaging contaminants and preventing their future re-entry into the system. Use a construction start-up screen for extra protection anytime fill media is removed from and reinstalled in the cooling tower.

To remove the suction diffuser screen:

1. Shut off pump(s).
2. Remove cap from suction diffuser.
3. Pull screen out of suction diffuser.
4. Empty contents of screen.

To install the screen, reverse steps 1 through 3.

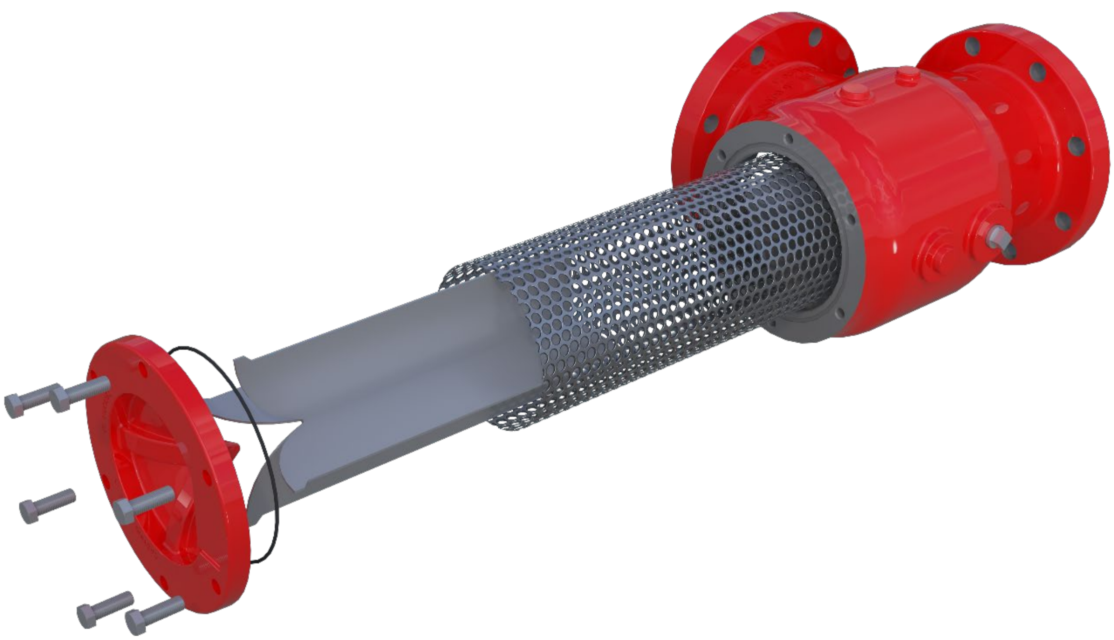


Figure 67 – Suction Diffuser

11.14 Immersion Basin Heater

Check the system annually, just prior to the start of the winter operating season, as well as anytime the tower is drained.

1. Visually inspect probe, panel, and heater for physical damage, evidence of overheating, loose connections, leaks, etc.

2. Make sure that the conduit plugs are in place for unused connection ports in the heater element wire box.

3. Visually inspect all wiring insulation for integrity and connections for tightness.

4. Wipe sensor probe to remove any build-up.

5. Verify that tower water quality is being properly maintained. Specific attention should be paid to excessive chlorine levels that may shorten heater lifespan.

6. Refer to Section 9.4.3 for details on test procedure to verify that the immersion basin heater energizes properly.

⚠ DANGER Exercise caution when servicing or troubleshooting the immersion basin heater. Always refer to the basin heater user's manual before starting work. Only qualified personnel should perform maintenance on the immersion basin heater.

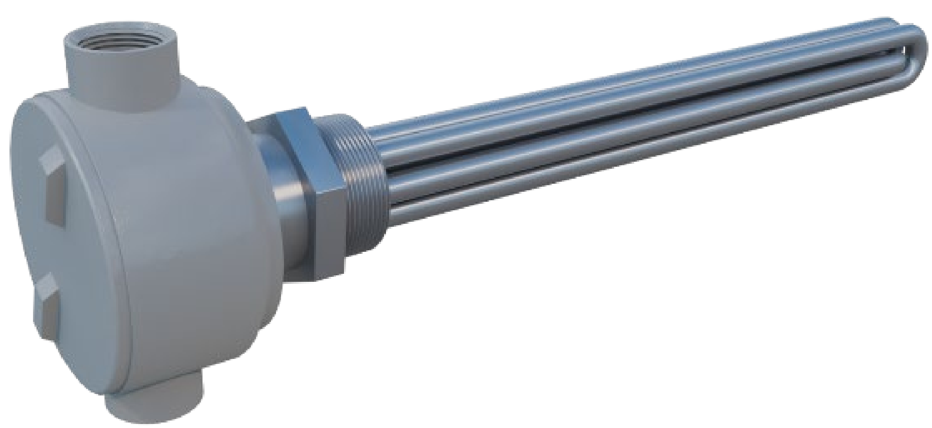


Figure 68 – Immersion Basin Heater

11.15 Water Collection System

The TTCC Series Fluid Cooler Water Collection System is an effective air-water separator that will operate trouble-free for extended time periods if it is periodically inspected and maintained as prescribed herein. The Water Collection System also supports the weight of the Xchange Tech coils and fill media and the design water load.

CAUTION The WCS is permanently installed in the tower module with hardware and caulking materials. Non-Tower Tech factory personnel should never attempt to lift or move the Water Collection System as doing so can permanently damage the tower and void the tower warranty.

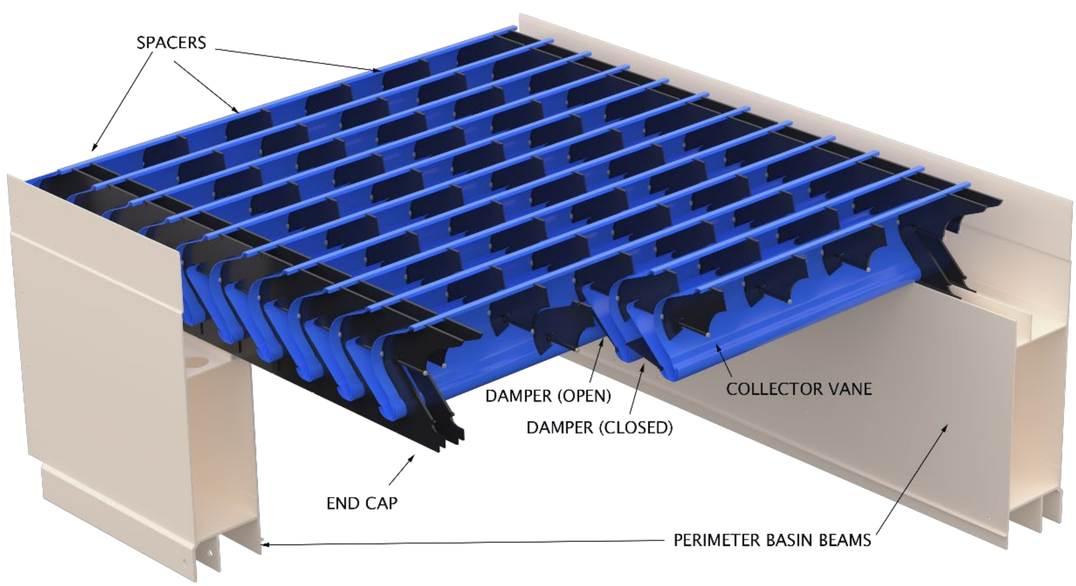


Figure 69 – Water Collection System

The main components of the Water Collection System include:

- Collector Vanes: Each collector vane is approximately 8” wide and 14” high and is installed transversally in the tower module. Collector vanes are a series of overlapping chevron-shaped troughs that capture cooled water falling from the XchangeTech coils and channel it into the perimeter basin beams.

- Spacers installed ~15” apart along the entire length of each collector vane fasten the Water Collection System together.

- End Caps help hold the collector vanes together and secure the Water Collection System to the Perimeter Basin Wall to prevent leaks. End caps are installed in pairs (~2.5” apart) at the end of each collector vane.

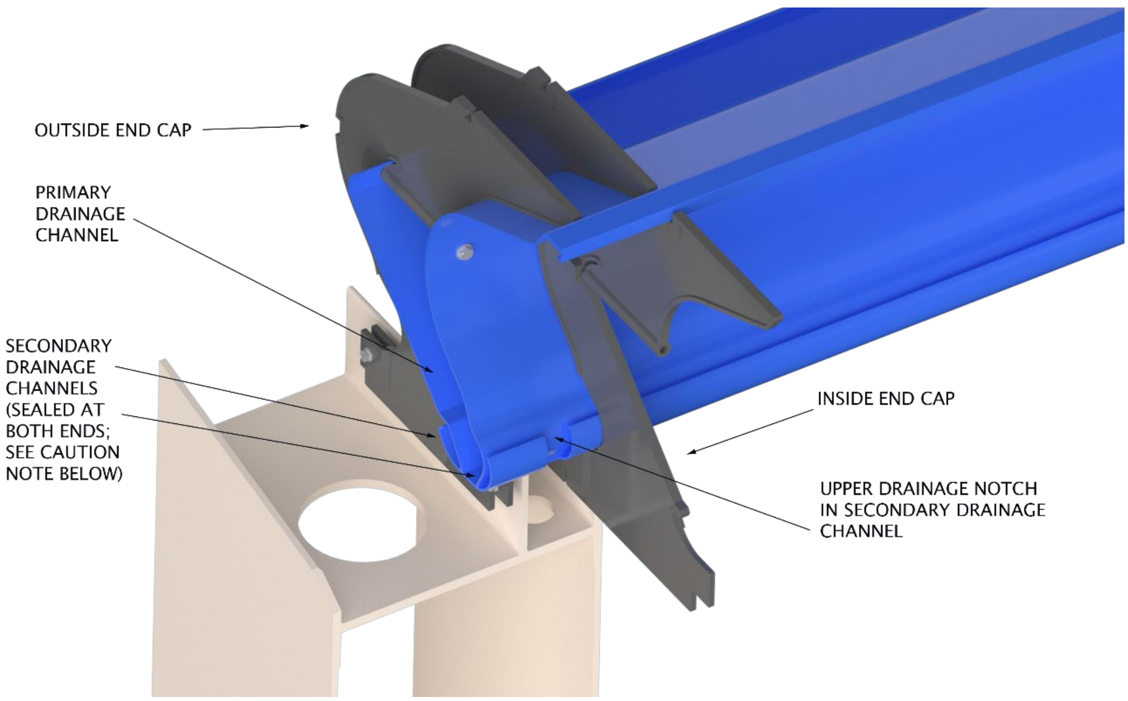


Figure 70 – Close-Up View: Water Collection System

- Secondary Drainage Channels: Located at the bottommost section of a collector vane, secondary channels are designed to capture water drops adhering to the exterior surfaces of a collector vane. If a secondary drainage channel becomes clogged with scale, dirt or debris, it is possible that some water may escape containment. Secondary drainage channels should be inspected periodically, both visually and by feel, to ensure they are free of scale, dirt and debris.

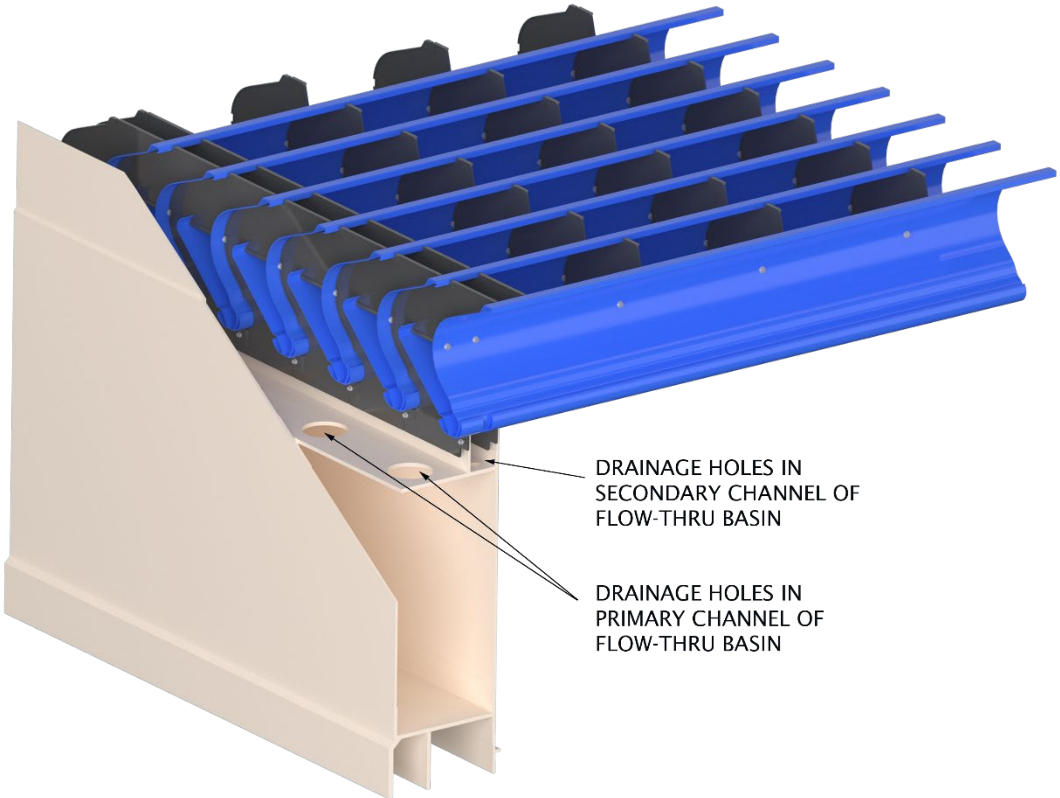


Figure 71 – Flow-Thru Basin Drainage (Perimeter Basin Wall)

- Secondary Drainage Channel Drainage Holes. Each end of a secondary drainage channel has a drainage hole (or notch) located between each pair of end caps. The drainage hole allows any water flowing in a secondary channel to escape into the perimeter basin beam. These holes are hidden from view and can only be felt by hand. If a secondary channel's hole or notch becomes plugged by scale, dirt or debris, water may overflow the secondary channel into the fan area.

⚠ CAUTION The ends of Secondary Drainage Channels have been plugged with caulking material at the factory to prevent water leaks. If the caulk is removed, air moving rapidly within the Perimeter Basin Wall can force water flowing in the Perimeter Basin Wall to flow into the Secondary Drainage Channels, quickly filling them to capacity and causing them to overflow. Use care when cleaning Secondary Drainage Channels and Drainage Holes. Do not attempt to force "debris" from the ends of a Secondary Drainage Channel, as doing so may inadvertently dislodge caulking material which helps prevent leaks.

- Dampers. Installed between collector vanes on the bottom of the Water Collection System, dampers are designed to open automatically when the fan beneath it is turned ON, and to close automatically when the fan beneath it is turned OFF. Dampers thereby help contain airborne water drops inside the Water Collection System. Dampers require periodic visual inspection to ensure they are opening and closing fully and freely.

- Flow-Thru Basin Primary Drainage Holes in the Perimeter Basin Wall allow cooled water from the Water Collection System to flow into the Flow-Thru Basin.

To access and perform service on the bottom section of the Water Collection System:

1. Disconnect the power to the fan by locking out and tagging out the appropriate motor.

2. Remove fan screen. Remove fan from motor shaft if necessary.

3. If a Damper does not fit properly or is sticking, remove the damper from the secondary channel. Each Damper is held in place by an F-shaped side that hinges loosely on the top of the secondary channel. Always remove all dampers prior to cleaning secondary drainage channels and reinstall once cleaning is completed.

4. Clean the bottom side of the Water Collection System with a power washer. Clean both sides of the collector vanes all the way up to the bottom of the fill media.

5. If necessary to remove additional scale, dirt and debris, use a straight tool (tilt the tool at a ~70-80° angle to the direction of the collector vane) by sliding the tool down the entire length of the secondary drainage channel and carefully guiding the tool through the end cap. Locate the notch at the end of the secondary drainage channel by moving the tool gently along the bottom of the secondary drainage channel, then gently dislodge any scale, dirt and debris by pulling toward you and removing it, or by pushing it gently through the notch located near the end of the secondary drainage channel. The end of the secondary drainage channel has been sealed with caulking material at the factory; removal of this material during the cleaning process will damage the Water Collection System and result in leaks.

CAUTION Do not attempt to push or otherwise force the factory-applied caulking material out of the end of the secondary channel. Doing so will damage the Water Collection System and result in leaks.

6. Use care to avoid cracking or otherwise damaging a damper or collector vane when removing or installing a damper. After installing a damper, make sure it opens and closes fully and freely.

7. Re-seal all end caps and areas where sealant may have been removed during your work, to prevent leakage. Note that during the cleaning process the membranes of sealants and caulks may be breached and may contain small holes that are not easily seen. Always use factory-approved sealants and caulking materials.

8. Reinstall the fan (if it was removed) and fan screens in their correct operating positions.

9. Remove your lock/tag from the control panel or cooling tower.

10. Check for proper operation of each fan and motor and visually observe each damper for correct operation.

To access and perform service on the upper section of the Water Collection System:

1. Shut off water to and from tower module.

2. Access to the interior of the tower module is through the top of the module. Remove the drift eliminators over the area of the Water Collection System to be accessed.

DANGER **Do not walk on drift eliminators, as they are not designed to safely support the weight of personnel.**

CAUTION The Water Collection System and fill media will support the live load of personnel at 200 lbs./ft2, to a maximum of 450 lbs. per cooling tower module. Tower Tech recommends avoiding walking on the fill media or Water Collection System unless pieces of 1' x 2' plywood are used for load distribution, to minimize the possibility of damaging fill media and Water Collection System.

3. Take note of how the fill media sections are stacked in the tower module.

4. Remove the sections of fill media around the area of the XchangeTech coils that you wish to access and inspect each log for scale, dirt and debris. Any fill pieces that are heavily contaminated by scale, dirt or other debris should be removed from the tower module and power washed. Any fill pieces not contaminated by scale, dirt and other debris can be stacked temporarily on top of other fill elsewhere in the tower module. If necessary, additional drift eliminator sections may be removed to make room to stack clean fill pieces elsewhere in the tower module. Clean fill media may also be placed temporarily on top of installed drift eliminators, provided that no more than one layer of clean fill is placed on top of installed drift eliminators.

5. Remove XchangeTech coil sections (Refer to Section 11.15 XchangeTech Coil Removal/Replacement) by disconnecting the inlet and outlet tubing from each section to be removed, then tilt the coil section upward at one end and direct it out the top of the module.

6. Inspect the coil pack and make note of where any fouling has occurred. Clean the coil pack as necessary.

> **CAUTION** When removing fill media, note the location of scale, dirt and debris within the fill media, from top to bottom, i.e. "The top layers of fill contained showed no sign of scaling, but the bottom layer had a slight scale residue." Such information may be helpful as you discuss your cooler with a water treater or with Tower Tech's customer service staff.

7. Inspect the top section of the Water Collection System for scale, dirt and debris and remove any scale, dirt and debris by power washing.

8. Reinstall clean XchangeTech coil packs and fill media in the cooler module in the same way it was installed by the factory. It is important to orient the coil pack so that the inlet is on the bottom of the coil header and the outlet is on the top. Reversal may trap air in the coil header and bind the process water flow.

9. Reinstall drift eliminators.

10. Turn on the water to and from the cooler module and check for leaks.

11.16 XchangeTech Coil Removal/Replacement

Coil removal will require draining the glycol fluid in a safe and appropriate manner. The coil drain valve is located on the rear of the TTCC cooler.

Figure 72 – XchangeTech Coil Drain Valve

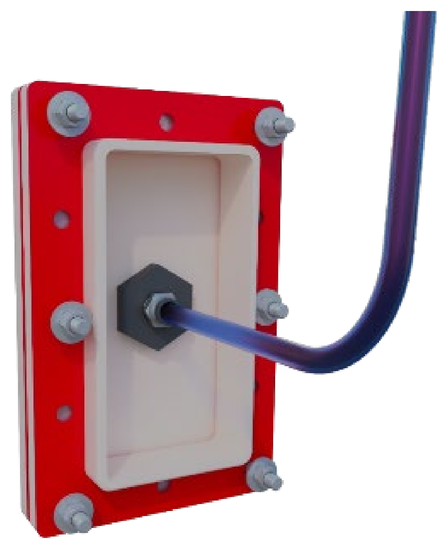


Figure 73 – XchangeTech Coil Drain Valve Rear

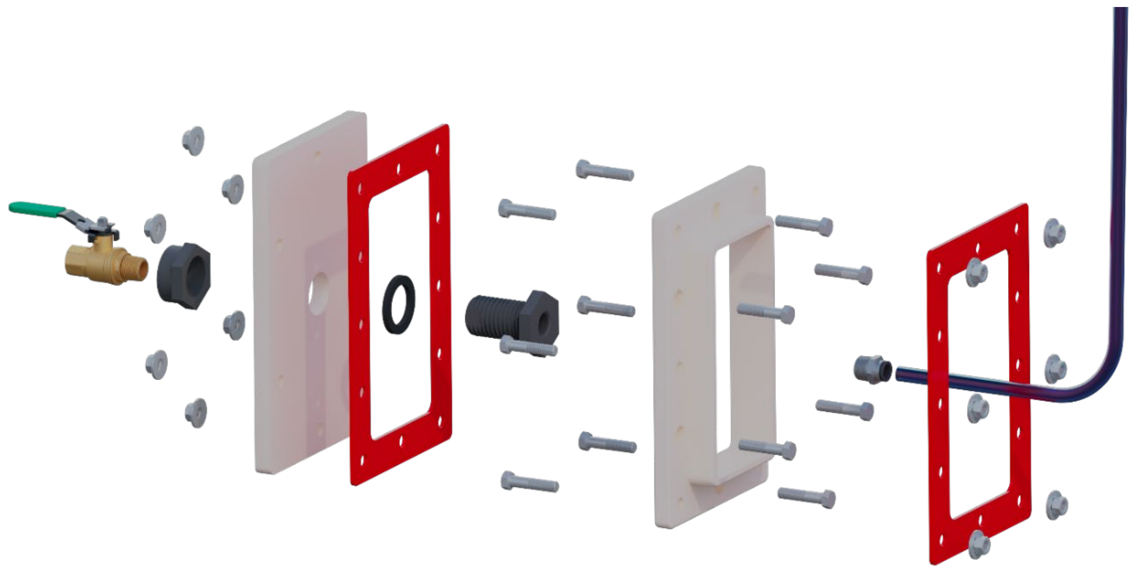


Figure 74 – XchangeTech Coil Drain Valve Exploded View

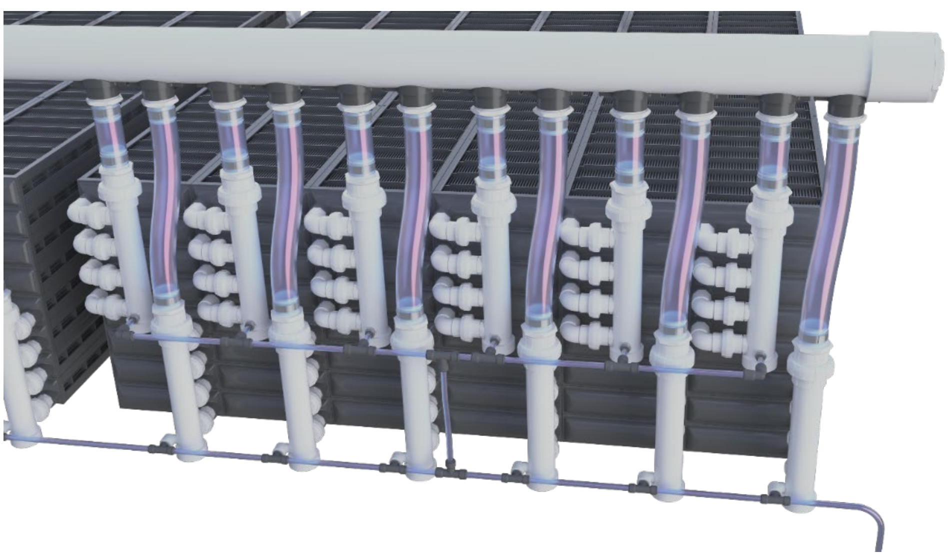


Figure 75 – XchangeTech Coil Drain Tubes

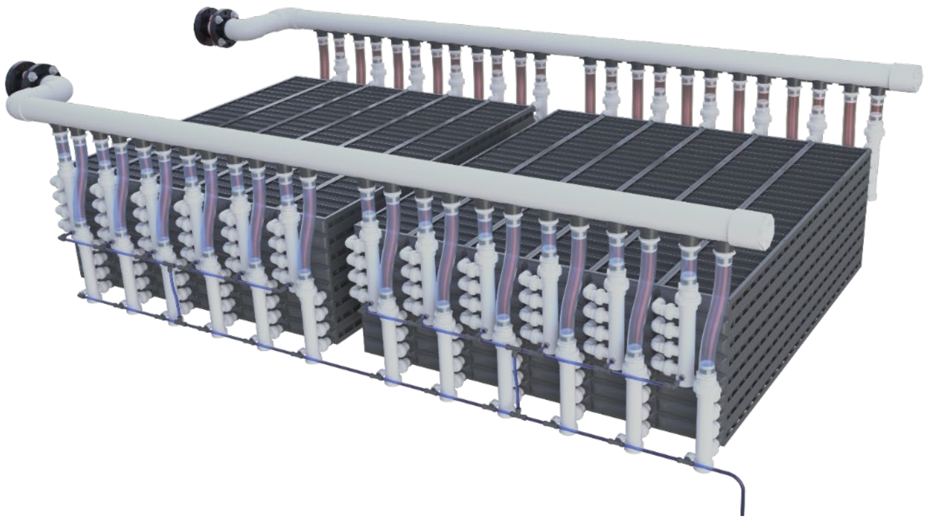


Figure 76 – XchangeTech Coil Drain Tubes

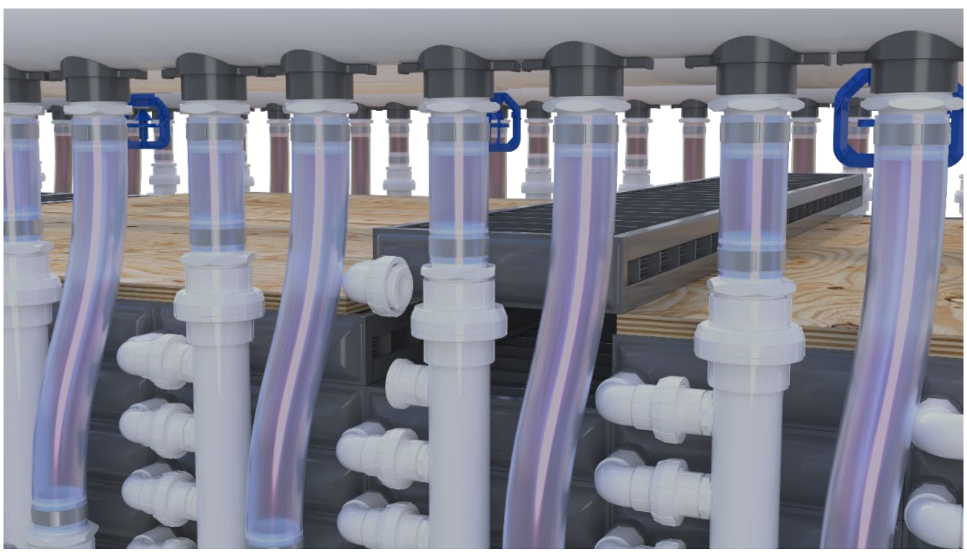


Figure 77 – XchangeTech Coil Removal

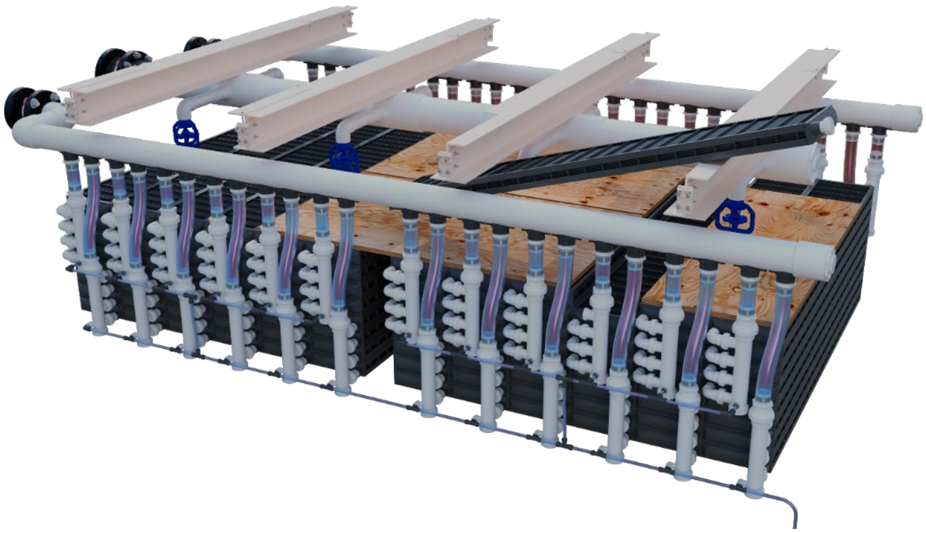


Figure 78 – XchangeTech Coil Removal

11.17 External Basket Filter

Maintaining efficient operation of XchangeTech heat exchanger coils is improved using an external basket filter. We recommend weekly visual inspection of the basket filter and cleaning only as necessary.

Vendor literature can be found in the appendix section of this manual and at this address:

https://fluidtrol.com/product/sw-basket-strainers/

Spare parts for the basket strainer can be found at this address:

https://fluidtrol.com/product/clear-acrylic-covers-side-vent/

Figure 79 – External Basket Strainer Cleaning

11.18 Spare Parts

The reliability of the TTCC direct-drive fan design assures customers that cooler performance and efficiency will not be impaired by a fan drive failure. This reliability, and Tower Tech's stock of readily available parts, enable most customers to avoid stocking spare parts. We recommend the following for customers that prefer to maintain a small spare parts inventory:

Part Description	Single Module Installation	Multiple Module Installation
Fans	1	1
Motors	1	1
Spin Free™ Nozzle	1	1

Table 17 – Recommended Spare Parts Inventory

The customer is responsible for selecting, purchasing, and maintaining a parts inventory consistent with its own needs. Tower Tech stocks most tower parts for immediate shipment. For further information contact a Tower Tech Customer Service Representative at (405) 979-2123 or Service@TowerTechUSA.com.

Chapter Twelve: Appendix

12.1 Index of Figures

12.2 Index of Tables