TOWER TECH™

Installation, Operation and Maintenance Manual

TTXR Series
Modular Cooling Tower™

Version MK1100-2 rev.4
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Sustainable Efficiency ™

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Chapter One: About This Manual

1.1 Scope

Information described herein pertains directly to the installation, operation and maintenance of the Tower Tech TTXR Series Modular Cooling Tower. The TTXR Series is a forced-draft, counter-flow design that allows modules to be arranged in a variety of configurations. The design also enables modules to be interconnected to accommodate virtually any cooling load. The design allows for the easy addition of new modules to a set of existing modules if the demand for cooling increases.

1.2 Use

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 installer 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: TTXR Series Features

2.1 Model Nomenclature

TTXR – **XX** **YY** **ZZ**

TTXR: **Model Series**

Model Designation - (XX)

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
04 = 4 Fans, 2 x 2 Configuration
i5 = 5 Fans, 1 x 5 Configuration
i6 = 6 Fans, 1 x 6 Configuration
06 = 6 Fans, 2 x 3 Configuration
08 = 8 Fans, 2 x 4 Configuration
10 = 10 Fans, 2 x 5 Configuration
12 = 12 Fans, 2 x 6 Configuration

Fill Media Type - (YY)

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 - (ZZ)

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 Modular Design

Cooling towers come in a variety of configurations. These configurations can vary according to the type of airflow encountered, the type of draft used, the tower erection site, and the materials of construction. These characteristics and myriad other design factors are what distinguish one cooling tower design from another.

The Tower Tech TTXR Series Modular Cooling Tower is characterized as a forced-draft, counter-flow cooling tower. A 3-D section view displaying the internal components of a TTXR Series tower is depicted in Figure 1.

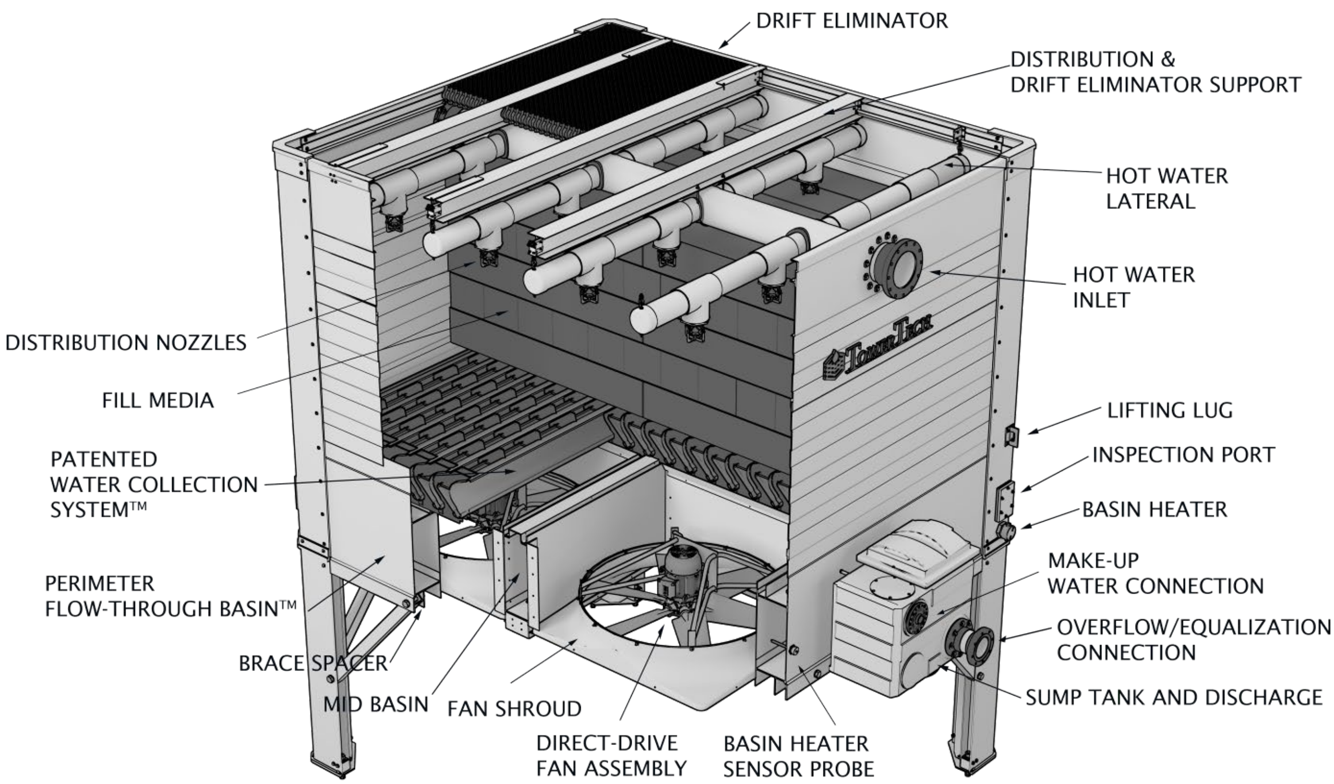


Figure 1 - TTXR 3-D Cut-Away View

The TTXR Series Modular Cooling was designed for the purpose of increased performance, smaller footprint and reduced horsepower. The TTXR model is technically identical to the TTXL model with the same installation and operational benefits providing the lowest life-cycle cost of any cooling tower. The performance enhancements of the TTXR model are achieved by optimization of the water distribution system through controlled turn down utilization. The TTXR models are available in the same familiar modular sizes of the TTXL series with modular plug and play interconnectivity to achieve any project size cooling requirements. The modular cooling tower design quickly accommodates future expansion of the cooling tower capacity.

A counter-flow cooling tower, as opposed to a cross-flow cooling tower, is distinguished by the airflow and water flow moving in opposite directions (in relationship to one another) inside the tower. In a cross-flow tower, the air and water flow move perpendicular to one another. Figure 2 shows the layout of a Tower Tech counter-flow cooling tower compared to a typical cross-flow tower.

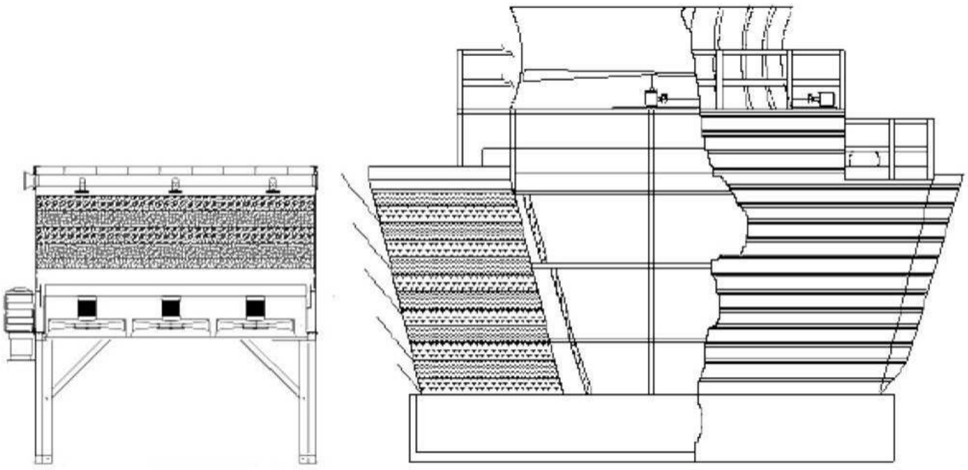


Figure 2 – TTXR versus Conventional Induced-Draft Cross-Flow Tower

The Tower Tech TTXR Series Modular Cooling Tower is characterized as a mechanical forced-draft cooling tower. Mechanical fans are used to provide a known volume of air through the tower. Forced-draft towers have the fan located in the cool, dry, ambient air stream on the entrance face of the tower, pushing air through the tower. Induced-draft towers have the fan located in the hot, moist air stream on the exit face of the tower, drawing air upwards through the tower. Neither the fans nor the motors on a forced-draft cooling tower are subjected to the harsh environment encountered in an induced-draft cooling tower. Figure 3 shows the layout of a Tower Tech mechanical forced-draft cooling tower compared to an induced-draft counter-flow cooling tower.

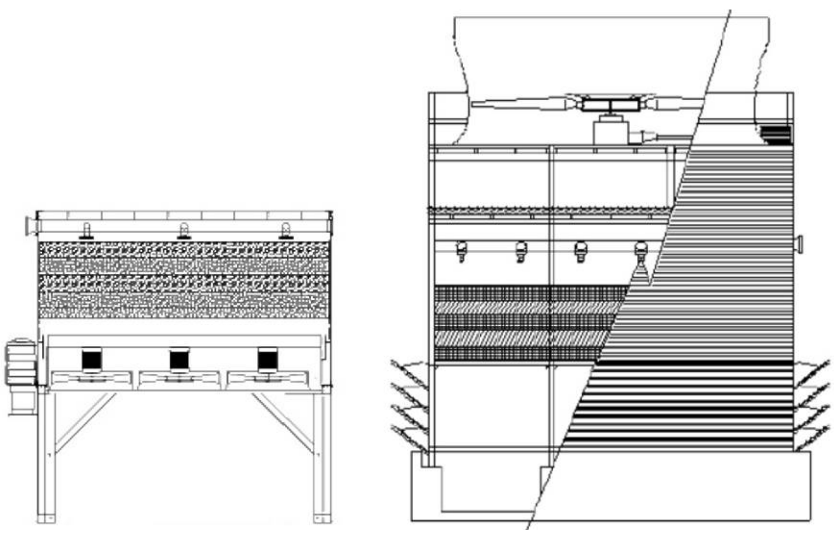
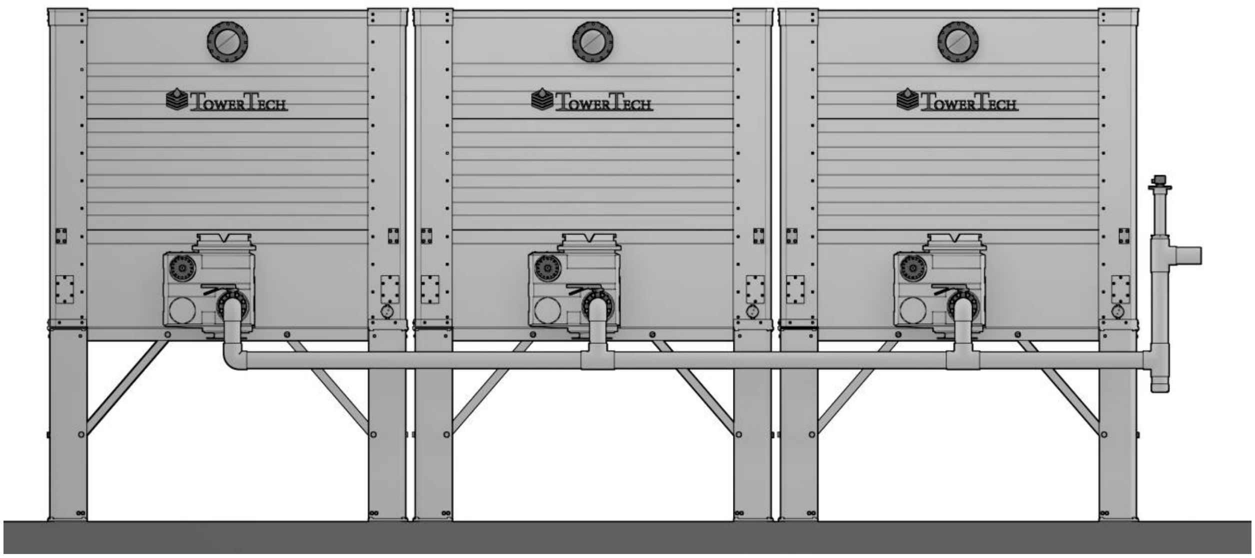


Figure 3 – TTXR versus Conventional Induced-Draft Counter-Flow Tower

The Tower Tech TTXR Series Modular Cooling Tower is also distinguished by its modular design, as shown in Figure 4. This enables the individual modules to be interconnected in numerous configurations to accommodate virtually any cooling capacity. This design is also quickly adaptable to accommodate future expansion of cooling tower capacity.



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

Figure 4 – TTXR Series Modular Cooling Tower Installation

Flow-Thru Basin and Water Collection System

The cold-water basin in the TTXR Series Modular Cooling Tower is comprised of a unique, patented Flow-Thru Basin™ consisting of four perimeter box beams (Perimeter Basin Walls) interconnected to one or more transversal box beams (Mid-Basins). This structure forms the base of each tower module. A unique, patented Water Collection System™ located above the fan motors serves as an air-water separator, capturing cooled water falling from the fill media. The WCS channels the cooled water into the Flow-Thru Basin and is discharged into a sump 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 cooling tower designs.

Figure 5 shows the placement of the WCS, Flow-Thru Basin, motors, and fans within a Tower Tech TTXR Series Modular Cooling Tower.

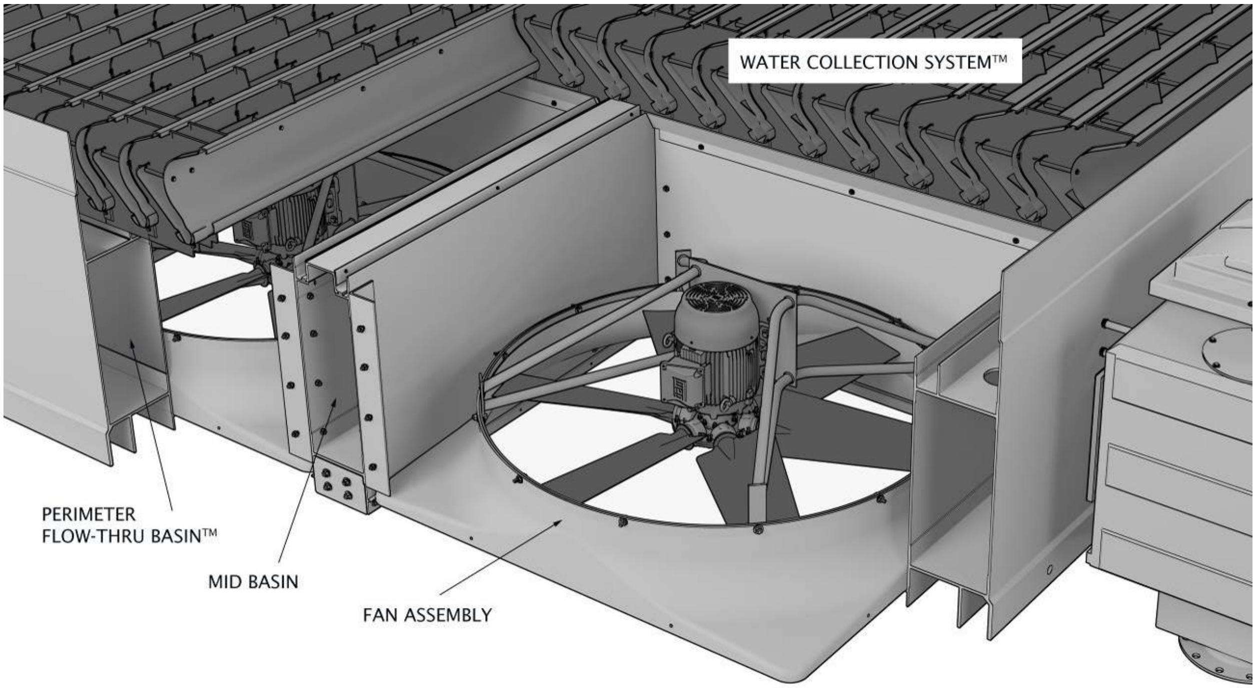


Figure 5 – Water Collection System, Flow-Thru Basin, Mid Basin, Motors, Fans

2.3 Sump Design

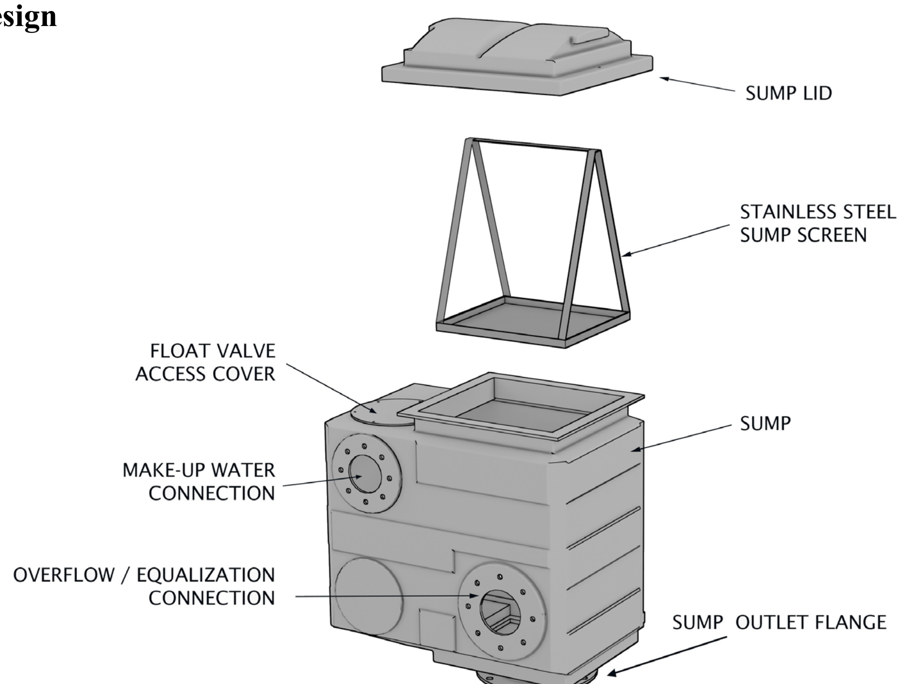


Figure 6 – Sump Layout

Each Tower Tech module is equipped with a terminally mounted outlet sump (shown in Figure 6) that is flanged for easy hook-up. Standard equipment for each sump includes a threaded make-up water connection, a mechanical float valve, a flanged overflow/ equalization connection, and a sump screen to collect large pieces of debris that may have entered the system.

Sump flange sizes vary depending upon the cooling tower model selected. Table 10 lists typical connection sizes for TTXR Series Modular Cooling Towers.

2.4 Make-Up Connection / Float Valve

The TTXR Series Modular Cooling Tower can be supplied with either a one- or two-inch brass float valve (see Figure 7) or; no mechanical make up assembly when using an electronic level control or remote sump application. The fitting is Female National Pipe Thread (FNPT). All valve components are made of brass or stainless steel. The connection flange is made from high quality plastic to eliminate corrosion. The maximum rated operating pressure for the valve is 25 psi (1.76 kgf/cm^2). **<u>You must install a pressure reducer valve if operating pressure exceeds 25 psi (1.76 kgf/cm^2)</u>**. The make-up water piping should contain an anti-siphon/breaker device before the sump connection: Refer to local codes for details.

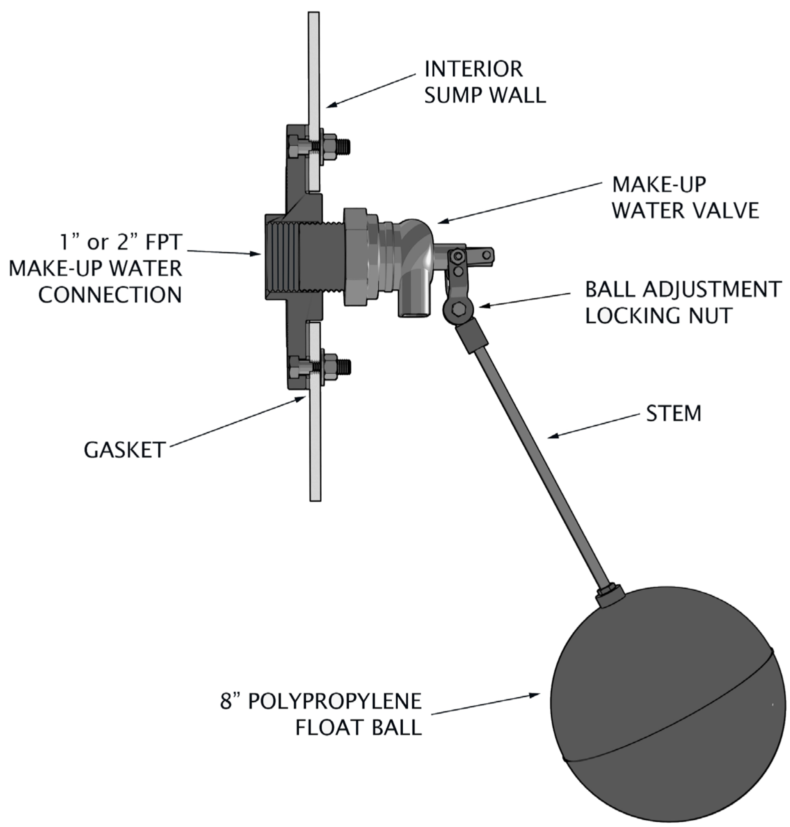


Figure 7 – Mechanical Float Valve

2.5 Spray Nozzle

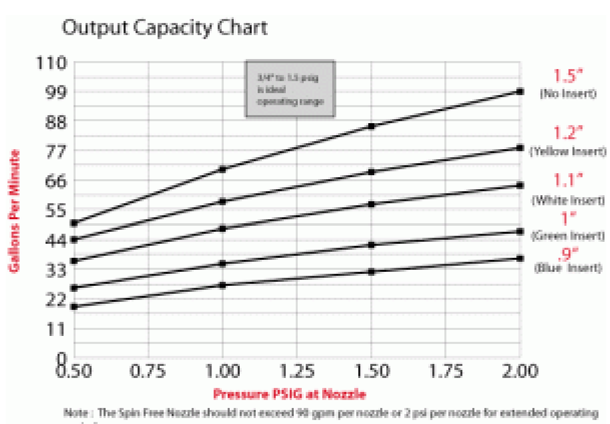
The TTXR Series towers contain Spin-Free™ spray nozzles that disperse hot water from the water distribution piping to the fill media. The nozzle requires less pressure to operate than a conventional nozzle, is virtually maintenance free, and improves tower performance. The nozzle design provides a uniform water loading achieved by a square distribution pattern. The TTXR spray nozzle was specifically designed for projects that need to achieve maximum efficiency with limited load variables.

The spray nozzle requires less pressure head to operate than a conventional nozzle by combining a low-profile spray pattern with a low-pressure orifice. Use of a lateral spray pattern allows the nozzle to be positioned as close as one inch above the surface of the fill material, saving several feet of pump head. In addition, the use of a turbine in the nozzle to atomize 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/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 tower performance and reduces the likelihood of scaling due to the occurrence of dry regions within the fill. This flexible capability is not present in fixed orifice spray nozzles; they must remain very near design flow to provide the required spray coverage.

By eliminating the extreme pressure increases associated with increased flow rates, the spray nozzle is able to produce a much more consistent spray pattern as flow rates vary. Graph 1 illustrates the change in tower piping head pressure observed at varying flow rates when employing the spray nozzle.



Graph 1 – Tower Pressure versus Flow

As can be seen from the graphs above, the operating parameters of the spray nozzle pattern is most optimal between 40 GPM and 75 GPM (2.5 – 4.7 LPS), which is the approximate upper limit established by tower module hydraulics. The Spin-Free spray nozzle can perform from 25 GPM to 75 GPM. Spin-Free™ spray nozzles provide a 3-1 turn down from the maximum allowed flow rate. (Refer to Section 9.4.2 "Cold Weather Operations" for important additional information about cold weather operations with a TTXR Series Modular Cooling Tower.)

Variable Flow Advantages

Conventional water distribution in cooling towers sacrifices valuable energy saving opportunities. This fact is even more pronounced in today's water filming style heat transfer media. The efficiency of evaporative heat transfer is affected by the air-to-water contact area and the mass flow liquid-to-gas ratio. In general, for a given heat load and water mass flow rate, the more surface area involved, the less required air velocity over the water surface, and consequently the less air-moving fan horsepower. If lower kW/ton is desired, one must purchase more air-to-water contact surface area.

Film media, such as the popular PVC cross-fluted corrugated film block, provided a breakthrough in cooling tower design. It greatly increased the contact surface area without increasing the size of the tower box. Adversely, it suffers quickly from scaling and biomass fouling in very compact air channels that negatively impact the flow of air.

Precise water treatment is required to prevent bio growth fouling and the fill must remain wetted to avoid evaporative scaling. Conventional water distribution uses fixed orifice spray nozzles that produce a round pattern above a rectangular fill pack. The nozzles are placed in a rectangular overlapping pattern to assure full wetting of the fill at the design water flow rate. Water flow rates below the design point will not produce a full spray pattern and void areas will start to appear. Any fill's best efficiency is achieved when the liquid-to-gas ratio is evenly balanced throughout the fill media. Short patterns and overlapping patterns cannot accomplish it. When a conventional cooling tower system is faced with a variable water flow rate (i.e. multiple pump cycling or variable speed pumping) these pattern problems force the operator to isolate whole cooling tower cells to maintain proper water distribution under reduced load in the remaining on-line cells. If this is not done, the tower efficiency will suffer and the fill media will quickly foul. Isolating cells takes away air-to-water contact surface.

What is needed is a cooling tower water distribution system that is able to respond to variable flow rates and keep all of the fill media evenly wetted and in service. This requires a nozzle that responds to flow changes to keep a constant pattern. A square pattern that avoids overlap would be best. Putting such a system on a three-cell tower with three matched pumps would yield the following opportunities: A typical tower would operate at 0.06 kW/ton for the tower alone at full load, 0.06 kW/ton at 2/3 load (two cells operating at 100%), and 0.06 kW/ton at 1/3 load (one cell operating at 100%). Under the same conditions, a constant pattern, variable spray system with variable speed drives on the fan motors would operate at 0.06 kW/ton at full load, 0.024 kW/ton at 2/3 load (all cells operating at 2/3 load), and 0.005 kW/ton at 1/3 load (all cells operating at 1/3 load). These energy savings can only be achieved through use of the constant pattern, variable flow distribution system found only in patented Tower Tech Modular Cooling Towers.

2.6 Motors

TTXR Series Modular Cooling Towers shipped after October 2010 are equipped with Baldor brand motors that are direct-drive, totally enclosed air over (TEAO), 8-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 TTXR Modular Cooling Towers shipped after October 2014 also meet IP55 and NEMA MG-1 Parts 30 and 31 requirements. Standard available motor types:

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

60Hz 50°C. Available in 3.0 HP, 5.0 HP or 7.5 HP. Available at 190V, 230V, 380V or 460V.

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

50Hz 50°C. Available in 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 Figure 8 for a view of motor mounted to fan shroud. Refer to Table 1 for motor data.

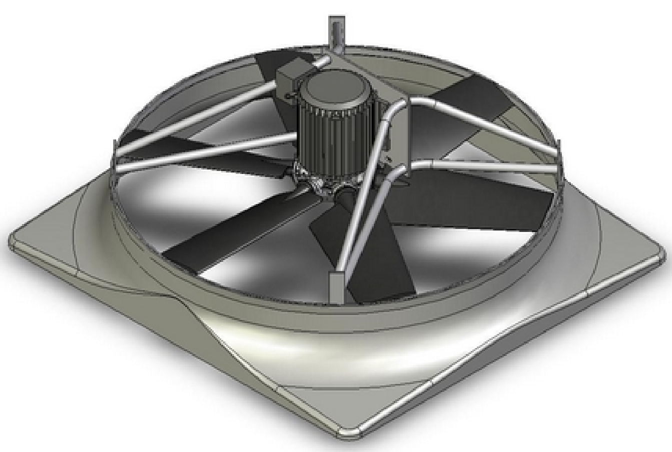


Figure 8 – Motor, Motor Support, Fan, Fan Shroud

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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]			
TTXR	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.
i11930	1	2.2	2.2	3.0	3.0	200	12.1	12.1	13.9	13.9	84.0%	865	1.15	4" (100mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						230	10.6	10.6	12.2	12.2	84.0%						
						460	5.3	5.3	6.1	6.1	84.0%						
						575	4.4	4.4	5.1	5.1	84.0%						
i11950		3.7	3.7	5.0	5.0	200	18.7	18.7	21.5	21.5	85.5%	855					
						230	17.0	17.0	19.6	19.6	84.0%						
						460	8.5	8.5	9.8	9.8	84.0%						
						575	6.6	6.6	7.6	7.6	84.0%						
i11975		5.6	5.6	7.5	7.5	200	26.6	26.6	30.6	30.6	81.5%	850					
						230	24.4	24.4	28.1	28.1	81.5%						
						460	12.2	12.2	14.0	14.0	81.5%						
						575	10.0	10.0	11.5	11.5	82.5%						
i21930	2	2.2	4.4	3.0	6.0	200	12.1	24.2	13.9	27.8	84.0%	865	1.15	8" (150mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						230	10.6	21.2	12.2	24.4	84.0%						
						460	5.3	10.6	6.1	12.2	84.0%						
						575	4.4	8.8	5.1	10.1	84.0%						
i21950		3.7	7.4	5.0	10.0	200	18.7	37.4	21.5	43.0	85.5%	855					
						230	17.0	34	19.6	39.1	84.0%						
						460	8.5	17	9.8	19.6	84.0%						
						575	6.6	13.2	7.6	15.2	84.0%						
i21975		5.6	11.2	7.5	15.0	200	26.6	53.2	30.6	61.2	81.5%	850					
						230	24.4	48.8	28.1	56.1	81.5%						
						460	12.2	24.4	14.0	28.1	81.5%						
						575	10.0	20	11.5	23.0	82.5%						
i31930	3	2.2	6.6	3.0	9.0	200	12.1	36.3	13.9	41.7	84.0%	865	1.15	8" (200mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						230	10.6	31.8	12.2	36.6	84.0%						
						460	5.3	15.9	6.1	18.3	84.0%						
						575	4.4	13.2	5.1	15.2	84.0%						
i31950		3.7	11.1	5.0	15.0	200	18.7	56.1	21.5	64.5	85.5%	855					
						230	17.0	51	19.6	58.7	84.0%						
						460	8.5	25.5	9.8	29.3	84.0%						
						575	6.6	19.8	7.6	22.8	84.0%						
i31975		5.6	16.8	7.5	22.5	200	26.6	79.8	30.6	91.8	81.5%	850					
						230	24.4	73.2	28.1	84.2	81.5%						
						460	12.2	36.6	14.0	42.1	81.5%						
						575	10.0	30	11.5	34.5	82.5%						
i41930	4	2.2	8.8	3.0	12.0	200	12.1	48.4	13.9	55.7	84.0%	865	1.15	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	42.4	12.2	48.8	84.0%						
						460	5.3	21.2	6.1	24.4	84.0%						
						575	4.4	17.6	5.1	20.2	84.0%						
i41950		3.7	14.8	5.0	20.0	200	18.7	74.8	21.5	86.0	85.5%	855					
						230	17.0	68	19.6	78.2	84.0%						
						460	8.5	34	9.8	39.1	84.0%						
						575	6.6	26.4	7.6	30.4	84.0%						
i41975		5.6	22.4	7.5	30.0	200	26.6	106.4	30.6	122.4	81.5%	850					
						230	24.4	97.6	28.1	112.2	81.5%						
						460	12.2	48.8	14.0	56.1	81.5%						
						575	10.0	40	11.5	46.0	82.5%						
041930	4	2.2	8.8	3.0	12.0	200	12.1	48.4	13.9	55.7	84.0%	865	1.15	10" (250mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	42.4	12.2	48.8	84.0%						
						460	5.3	21.2	6.1	24.4	84.0%						
						575	4.4	17.6	5.1	20.2	84.0%						
041950		3.7	14.8	5.0	20.0	200	18.7	74.8	21.5	86.0	85.5%	855					
						230	17.0	68	19.6	78.2	84.0%						
						460	8.5	34	9.8	39.1	84.0%						
						575	6.6	26.4	7.6	30.4	84.0%						
041975		5.6	22.4	7.5	30.0	200	26.6	106.4	30.6	122.4	81.5%	850					
						230	24.4	97.6	28.1	112.2	81.5%						
						460	12.2	48.8	14.0	56.1	81.5%						
						575	10.0	40	11.5	46.0	82.5%						
i51930	5	2.2	11	3.0	15.0	200	12.1	60.5	13.9	69.6	84.0%	865	1.15	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	53	12.2	61.0	84.0%						
						460	5.3	26.5	6.1	30.5	84.0%						
						575	4.4	22	5.1	25.3	84.0%						
i51950		3.7	18.5	5.0	25.0	200	18.7	93.5	21.5	107.5	85.5%	855					
						230	17.0	85	19.6	97.8	84.0%						
						460	8.5	42.5	9.8	48.9	84.0%						
						575	6.6	33	7.6	38.0	84.0%						
i51975		5.6	28	7.5	37.5	200	26.6	133	30.6	153.0	81.5%	850					
						230	24.4	122	28.1	140.3	81.5%						
						460	12.2	61	14.0	70.2	81.5%						
						575	10.0	50	11.5	57.5	82.5%						

Engineering Data

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

Model TTXR	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.
	Fan Motors 3 Phase, 60 Hz, 40° C., 200V, 230V, 460V or 575V													Connections [c]			
i61930	6	2.2	13.2	3.0	18.0	200	12.1	72.6	13.9	83.5	84.0%	865	1.15	8" (200mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	63.6	12.2	73.1	84.0%						
						460	5.3	31.8	6.1	36.6	84.0%						
						575	4.4	26.4	5.1	30.4	84.0%						
i61950		3.7	22.2	5.0	30.0	200	18.7	112.2	21.5	129.0	85.5%	855					
						230	17.0	102	19.6	117.3	84.0%						
						460	8.5	51	9.8	58.7	84.0%						
						575	6.6	39.6	7.6	45.5	84.0%						
i61975		5.6	33.6	7.5	45.0	200	26.6	159.6	30.6	183.5	81.5%	850					
						230	24.4	146.4	28.1	168.4	81.5%						
						460	12.2	73.2	14.0	84.2	81.5%						
						575	10.0	60	11.5	69.0	82.5%						
061930	6	2.2	13.2	3.0	18.0	200	12.1	72.6	13.9	83.5	84.0%	865	1.15	10" (250mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	63.6	12.2	73.1	84.0%						
						460	5.3	31.8	6.1	36.6	84.0%						
						575	4.4	26.4	5.1	30.4	84.0%						
061950		3.7	22.2	5.0	30.0	200	18.7	112.2	21.5	129.0	85.5%	855					
						230	17.0	102	19.6	117.3	84.0%						
						460	8.5	51	9.8	58.7	84.0%						
						575	6.6	39.6	7.6	45.5	84.0%						
061975		5.6	33.6	7.5	45.0	200	26.6	159.6	30.6	183.5	81.5%	850					
						230	24.4	146.4	28.1	168.4	81.5%						
						460	12.2	73.2	14.0	84.2	81.5%						
						575	10.0	60	11.5	69.0	82.5%						
081930	8	2.2	17.6	3.0	24.0	200	12.1	96.8	13.9	111.3	84.0%	865	1.15	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	84.8	12.2	97.5	84.0%						
						460	5.3	42.4	6.1	48.8	84.0%						
						575	4.4	35.2	5.1	40.5	84.0%						
081950		3.7	29.6	5.0	40.0	200	18.7	149.6	21.5	172.0	85.5%	855					
						230	17.0	136	19.6	156.4	84.0%						
						460	8.5	68	9.8	78.2	84.0%						
						575	6.6	52.8	7.6	60.7	84.0%						
081975		5.6	44.8	7.5	60.0	200	26.6	212.8	30.6	244.7	81.5%	850					
						230	24.4	195.2	28.1	224.5	81.5%						
						460	12.2	97.6	14.0	112.2	81.5%						
						575	10.0	80	11.5	92.0	82.5%						
101930	10	2.2	22	3.0	30.0	200	12.1	121	13.9	139.2	84.0%	865	1.15	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						230	10.6	106	12.2	121.9	84.0%						
						460	5.3	53	6.1	61.0	84.0%						
						575	4.4	44	5.1	50.6	84.0%						
101950		3.7	37	5.0	50.0	200	18.7	187	21.5	215.1	85.5%	855					
						230	17.0	170	19.6	195.5	84.0%						
						460	8.5	85	9.8	97.8	84.0%						
						575	6.6	66	7.6	75.9	84.0%						
101975		5.6	56	7.5	75.0	200	26.6	266	30.6	305.9	81.5%	850					
						230	24.4	244	28.1	280.6	81.5%						
						460	12.2	122	14.0	140.3	81.5%						
						575	10.0	100	11.5	115.0	82.5%						
121930	12	2.2	26.4	3.0	36.0	200	12.1	145.2	13.9	167.0	84.0%	865	1.15	12" (300mm)	12" x 2 [d] (300mm x 2)	2" FNPT (50mm)	6" (150mm)
						230	10.6	127.2	12.2	146.3	84.0%						
						460	5.3	63.6	6.1	73.1	84.0%						
						575	4.4	52.8	5.1	60.7	84.0%						
121950		3.7	44.4	5.0	60.0	200	18.7	224.4	21.5	258.1	85.5%	855					
						230	17.0	204	19.6	234.6	84.0%						
						460	8.5	102	9.8	117.3	84.0%						
						575	6.6	79.2	7.6	91.1	84.0%						
121975		5.6	67.2	7.5	90.0	200	26.6	319.2	30.6	367.1	81.5%	850					
						230	24.4	292.8	28.1	336.7	81.5%						
						460	12.2	146.4	14.0	168.4	81.5%						
						575	10.0	120	11.5	138.0	82.5%						

[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.

[d] Flow rates above 2,700 gpm require engineering review and may require two sump containers.

[e] TTXR-12 requires two sump containers. See TTXR-12 drawings for details.

Engineering Data

60 Hz, 50° C., 190V, 230V, 380V or 460V

Model TTXR	Fan Motors: No. Fans	kW / Fan	kW / Module	HP / Fan	HP / Module	3 Phase, 60 Hz, 50° C., 190V, 230V, 380V or 460V: 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.
i11930	1	2.2	2.2	3.0	3.0	230	10.6	10.6	12.2	12.2	84.0%	865	1.15	4" (100mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380	6.7	6.7	7.7	7.7	84.0%						
						460	5.3	5.3	6.1	6.1	84.0%						
i11950		3.7	3.7	5.0	5.0	230	17	17	19.6	19.6	85.5%	855					
						380	10.1	10.1	11.6	11.6	84.0%						
						460	8.5	8.5	9.8	9.8	84.0%						
i11975		5.6	5.6	7.5	7.5	230	24.6	24.6	28.3	28.3	81.5%	850					
						380	15.0	15.0	17.3	17.3	81.5%						
						460	12.3	12.3	14.1	14.1	81.5%						
i21930	2	2.2	4.4	3.0	6.0	230	10.6	21.2	11.7	23.3	84.0%	865	1.1	8" (150mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380	6.7	13.4	7.4	14.7							
						460	5.3	10.6	5.8	11.7							
i21950		3.7	7.4	5.0	10.0	230	17	34	18.7	37.4	84.0%	855					
						380	10.1	20.2	11.1	22.2							
						460	8.5	17	9.4	18.7							
i21975		5.6	11.2	7.5	15.0	230	24.6	49.2	27.1	54.1	81.5%	850					
						380	15.0	30	16.5	33.0							
						460	12.3	24.6	13.5	27.1							
i31930	3	2.2	6.6	3.0	9.0	230	10.6	31.8	11.7	35.0	84.0%	865	1.1	8" (200mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380	6.7	20.1	7.4	22.1							
						460	5.3	15.9	5.8	17.5							
i31950		3.7	11.1	5.0	15.0	230	17	51	18.7	56.1	84.0%	855					
						380	10.1	30.3	11.1	33.3							
						460	8.5	25.5	9.4	28.1							
i31975		5.6	16.8	7.5	22.5	230	24.6	73.8	27.1	81.2	81.5%	850					
						380	15.0	45	16.5	49.5							
						460	12.3	36.9	13.5	40.6							
i41930	4	2.2	8.8	3.0	12.0	230	10.6	42.4	11.7	46.6	84.0%	865	1.1	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380	6.7	26.8	7.4	29.5							
						460	5.3	21.2	5.8	23.3							
i41950		3.7	14.8	5.0	20.0	230	17	68	18.7	74.8	84.0%	855					
						380	10.1	40.4	11.1	44.4							
						460	8.5	34	9.4	37.4							
i419575		5.6	22.4	7.5	30.0	230	24.6	98.4	27.1	108.2	81.5%	850					
						380	15.0	60	16.5	66.0							
						460	12.3	49.2	13.5	54.1							
041930	4	2.2	8.8	3.0	12.0	230	13.4	53.6	14.7	59.0	84.0%	865	1.1	10" (250mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380	6.7	26.8	7.4	29.5							
						460	5.3	21.2	5.8	23.3							
041950		3.7	14.8	5.0	20.0	230	17	68	18.7	74.8	84.0%	855					
						380	10.1	40.4	11.1	44.4							
						460	8.5	34	9.4	37.4							
041975		5.6	22.4	7.5	30.0	230	24.6	98.4	27.1	108.2	81.5%	850					
						380	15.0	60	16.5	66.0							
						460	12.3	49.2	13.5	54.1							
i51930	5	2.2	11.0	3.0	15.0	230	10.6	53	11.7	58.3	84.0%	865	1.1	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380	6.7	33.5	7.4	36.9							
						460	5.3	26.5	5.8	29.2							
i51950		3.7	18.5	5.0	25.0	230	17	85	18.7	93.5	84.0%	855					
						380	10.1	50.5	11.1	55.6							
						460	8.5	42.5	9.4	46.8							
i51975		5.6	28.0	7.5	37.5	230	24.6	123	27.1	135.3	81.5%	850					
						380	15.0	75	16.5	82.5							
						460	12.3	61.5	13.5	67.7							
i61930	6	2.2	13.2	3.0	18.0	230	10.6	63.6	11.7	70.0	84.0%	865	1.1	8" (200mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						380	6.7	40.2	7.4	44.2							
						460	5.3	31.8	5.8	35.0							
i61950		3.7	22.2	5.0	30.0	230	17	102	18.7	112.2	84.0%	855					
						380	10.1	60.6	11.1	66.7							
						460	8.5	51	9.4	56.1							
i61975		5.6	33.6	7.5	45.0	230	24.6	147.6	27.1	162.4	81.5%	850					
						380	15.0	90	16.5	99.0							
						460	12.3	73.8	13.5	81.2							

Engineering Data

60 Hz, 50° C., 190V, 230V, 380V or 460V

Model	Fan Motors	3 Phase, 60 Hz, 50° C., 190V, 230V, 380V or 460V												Connections [c]			
TTXR	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.
						230	10.6	63.6	11.7	70.0							
061930		2.2	13.2	3.0	18.0	380	6.7	40.2	7.4	44.2	84.0%	865					
						460	5.3	31.8	5.8	35.0							
						230	17	102	18.7	112.2							
061950	6	3.7	22.2	5.0	30.0	380	10.1	60.6	11.1	66.7	84.0%	855	1.1	10" (250mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						460	8.5	51	9.4	56.1							
						230	24.6	147.6	27.1	162.4							
061975		5.6	33.6	7.5	45.0	380	15.0	90	16.5	99.0	81.5%	850					
						460	12.3	73.8	13.5	81.2							
						230	10.6	84.8	11.7	93.3							
081930		2.2	17.6	3.0	24.0	380	6.7	53.6	7.4	59.0	84.0%	865					
						460	5.3	42.4	5.8	46.6							
						230	17	136	18.7	149.6							
081950	8	3.7	29.6	5.0	40.0	380	10.1	80.8	11.1	88.9	84.0%	855	1.1	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						460	8.5	68	9.4	74.8							
						230	24.6	196.8	27.1	216.5							
081975		5.6	44.8	7.5	60.0	380	15.0	120	16.5	132.0	81.5%	850					
						460	12.3	98.4	13.5	108.2							
						230	10.6	106	11.7	116.6							
101930		2.2	22.0	3.0	30.0	380	6.7	67	7.4	73.7	84.0%	865					
						460	5.3	53	5.8	58.3							
						230	17	170	18.7	187.0							
101950	10	3.7	37.0	5.0	50.0	380	10.1	101	11.1	111.1	84.0%	855	1.1	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						460	8.5	85	9.4	93.5							
						230	24.6	246	27.1	270.6							
101975		5.6	56.0	7.5	75.0	380	15.0	150	16.5	165.0	81.5%	850					
						460	12.3	123	13.5	135.3							
						230	10.6	127.2	11.7	139.9							
121930		2.2	26.4	3.0	36.0	380	6.7	80.4	7.4	88.4	84.0%	865					
						460	5.3	63.6	5.8	70.0							
						230	17	204	18.7	224.4							
121950	12	3.7	44.4	5.0	60.0	380	10.1	121.2	11.1	133.3	84.0%	855	1.1	12" (300mm)	12" x 2 [d] (300mm x 2)	2" FNPT (50mm)	6" (150mm)
						460	8.5	102	9.4	112.2							
						230	24.6	295.2	27.1	324.7							
121975		5.6	67.2	7.5	90.0	380	15.0	180	16.5	198.0	81.5%	850					
						460	12.3	147.6	13.5	162.4							

[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.

[d] Flow rates above 2,700 gpm require engineering review and may require two sump containers.

[e] TTXR-12 requires two sump containers. See TTXR-12 drawings for details.

Engineering Data

50 Hz, 40° C., 190V-208V, 220V, 380V-415V, 440V

Model TTXR	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.
	Fan Motors-3 Phase, 50 Hz, 40° C., 190V-208V, 220V, 380V-415V, 440V													Connections [c]			
i11930	1	2.2	2.2	3.0	3.0	190	12.4	12.4	14.3	14.3	84.0%	865	1.15	4" (100mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						220	11.0	11.0	12.7	12.7	84.0%						
						380	6.4	6.4	7.4	7.4	84.0%						
						440	5.5	5.5	6.3	6.3	84.0%						
i11950		3.7	3.7	5.0	5.0	190	18.8	18.8	21.6	21.6	85.5%	855					
						220	17.6	17.6	20.2	20.2	84.0%						
						380	10.2	10.2	11.7	11.7	84.0%						
						440	8.8	8.8	10.1	10.1	84.0%						
i11975		5.6	5.6	7.5	7.5	190	28.6	28.6	32.9	32.9	81.5%	850					
						220	24.6	24.6	28.3	28.3	81.5%						
						380	14.3	14.3	16.4	16.4	81.5%						
						440	12.3	12.3	14.1	14.1	82.5%						
i21922	2	2.2	4.4	3.0	6.0	190	12.4	24.8	14.3	28.5	82.5%	720	1.15	8" (150mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						220	11.0	22.0	12.7	25.3	84.0%						
						380	6.4	12.8	7.4	14.7	84.0%						
						440	5.5	11.0	6.3	12.7	84.0%						
i21937		3.7	7.4	5.0	10.0	190	18.8	37.6	21.6	43.2	82.5%	700					
						220	17.6	35.2	20.2	40.5	81.5%						
						380	10.2	20.4	11.7	23.5	81.5%						
						440	8.8	17.6	10.1	20.2	81.5%						
i21956		5.6	11.2	7.5	15.0	190	28.6	57.2	32.9	65.8	80.0%	700					
						220	24.6	49.2	28.3	56.6	81.5%						
						380	14.3	28.6	16.4	32.9	81.5%						
						440	12.3	24.6	14.1	28.3	81.5%						
i31922	3	2.2	6.6	3.0	9.0	190	12.4	37.2	14.3	42.8	82.5%	720	1.15	8" (200mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						220	11.0	33.0	12.7	38.0	84.0%						
						380	6.4	19.2	7.4	22.1	84.0%						
						440	5.5	16.5	6.3	19.0	84.0%						
i31937		3.7	11.1	5.0	15.0	190	18.8	56.4	21.6	64.9	82.5%	700					
						220	17.6	52.8	20.2	60.7	81.5%						
						380	10.2	30.6	11.7	35.2	81.5%						
						440	8.8	26.4	10.1	30.4	81.5%						
i31956		5.6	16.8	7.5	22.5	190	28.6	85.8	32.9	98.7	80.0%	700					
						220	24.6	73.8	28.3	84.9	81.5%						
						380	14.3	42.9	16.4	49.3	81.5%						
						440	12.3	36.9	14.1	42.4	81.5%						
i41922	4	2.2	8.8	3.0	12.0	190	12.4	49.6	14.3	57.0	82.5%	720	1.15	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	44.0	12.7	50.6	84.0%						
						380	6.4	25.6	7.4	29.4	84.0%						
						440	5.5	22.0	6.3	25.3	84.0%						
i41937		3.7	14.8	5.0	20.0	190	18.8	75.2	21.6	86.5	82.5%	700					
						220	17.6	70.4	20.2	81.0	81.5%						
						380	10.2	40.8	11.7	46.9	81.5%						
						440	8.8	35.2	10.1	40.5	81.5%						
i41956		5.6	22.4	7.5	30.0	190	28.6	114.4	32.9	131.6	80.0%	700					
						220	24.6	98.4	28.3	113.2	81.5%						
						380	14.3	57.2	16.4	65.8	81.5%						
						440	12.3	49.2	14.1	56.6	81.5%						
041922	4	2.2	8.8	3.0	12.0	190	12.4	49.6	14.3	57.0	82.5%	720	1.15	10" (250mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	44.0	12.7	50.6	84.0%						
						380	6.4	25.6	7.4	29.4	84.0%						
						440	5.5	22.0	6.3	25.3	84.0%						
041937		3.7	14.8	5.0	20.0	190	18.8	75.2	21.6	86.5	82.5%	700					
						220	17.6	70.4	20.2	81.0	81.5%						
						380	10.2	40.8	11.7	46.9	81.5%						
						440	8.8	35.2	10.1	40.5	81.5%						
041956		5.6	22.4	7.5	30.0	190	28.6	114.4	32.9	131.6	80.0%	700					
						220	24.6	98.4	28.3	113.2	81.5%						
						380	14.3	57.2	16.4	65.8	81.5%						
						440	12.3	49.2	14.1	56.6	81.5%						

TOWER TECH
Sustainable Efficiency ™

Engineering Data

50 Hz, 40° C., 190V-208V, 220V, 380V-415V, 440V

Model	Fan Motors-3 Phase, 50 Hz, 40° C., 190V-208V, 220V, 380V-415V, 440V													Connections [c]			
TTXR	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.
i51922	5	2.2	11.0	3.0	15.0	190	12.4	62.0	14.3	71.3	82.5%	720	1.15	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	55.0	12.7	63.3	84.0%						
						380	6.4	32.0	7.4	36.8	84.0%						
						440	5.5	27.5	6.3	31.6	84.0%						
i51937		3.7	18.5	5.0	25.0	190	18.8	94.0	21.6	108.1	82.5%	700					
						220	17.6	88.0	20.2	101.2	81.5%						
						380	10.2	51.0	11.7	58.7	81.5%						
						440	8.8	44.0	10.1	50.6	81.5%						
i51956		5.6	28.0	7.5	37.5	190	28.6	143.0	32.9	164.5	80.0%	700					
						220	24.6	123.0	28.3	141.5	81.5%						
						380	14.3	71.5	16.4	82.2	81.5%						
						440	12.3	61.5	14.1	70.7	81.5%						
i61922	6	2.2	13.2	3.0	18.0	190	12.4	74.4	14.3	85.6	82.5%	720	1.15	8" (200mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	66.0	12.7	75.9	84.0%						
						380	6.4	38.4	7.4	44.2	84.0%						
						440	5.5	33.0	6.3	38.0	84.0%						
i61937		3.7	22.2	5.0	30.0	190	18.8	112.8	21.6	129.7	82.5%	700					
						220	17.6	105.6	20.2	121.4	81.5%						
						380	10.2	61.2	11.7	70.4	81.5%						
						440	8.8	52.8	10.1	60.7	81.5%						
i61956		5.6	33.6	7.5	45.0	190	28.6	171.6	32.9	197.3	80.0%	700					
						220	24.6	147.6	28.3	169.7	81.5%						
						380	14.3	85.8	16.4	98.7	81.5%						
						440	12.3	73.8	14.1	84.9	81.5%						
061922	6	2.2	13.2	3.0	18.0	190	12.4	74.4	14.3	85.6	82.5%	720	1.15	10" (250mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	66.0	12.7	75.9	84.0%						
						380	6.4	38.4	7.4	44.2	84.0%						
						440	5.5	33.0	6.3	38.0	84.0%						
061937		3.7	22.2	5.0	30.0	190	18.8	112.8	21.6	129.7	82.5%	700					
						220	17.6	105.6	20.2	121.4	81.5%						
						380	10.2	61.2	11.7	70.4	81.5%						
						440	8.8	52.8	10.1	60.7	81.5%						
061956		5.6	33.6	7.5	45.0	190	28.6	171.6	32.9	197.3	80.0%	700					
						220	24.6	147.6	28.3	169.7	81.5%						
						380	14.3	85.8	16.4	98.7	81.5%						
						440	12.3	73.8	14.1	84.9	81.5%						
081922	8	2.2	17.6	3.0	24.0	190	12.4	99.2	14.3	114.1	82.5%	720	1.15	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						220	11.0	88.0	12.7	101.2	84.0%						
						380	6.4	51.2	7.4	58.9	84.0%						
						440	5.5	44.0	6.3	50.6	84.0%						
081937		3.7	29.6	5.0	40.0	190	18.8	150.4	21.6	173.0	82.5%	700					
						220	17.6	140.8	20.2	161.9	81.5%						
						380	10.2	81.6	11.7	93.8	81.5%						
						440	8.8	70.4	10.1	81.0	81.5%						
081956		5.6	44.8	7.5	60.0	190	28.6	228.8	32.9	263.1	80.0%	700					
						220	24.6	196.8	28.3	226.3	81.5%						
						380	14.3	114.4	16.4	131.6	81.5%						
						440	12.3	98.4	14.1	113.2	81.5%						

Engineering Data

50 Hz, 50° C., 190V-208V or 380V-415V

Model TTXR	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. [c]	Outlet Dia. [c]	Makeup Dia. [c]	Overflow Dia. [c]
	Fan Motors - 3 Phase, 50 Hz, 40° C., 190V-208V or 380V-415V													Connections [c]			
i11929	1	2.9	5.8	4.0	8.0	190/208	16.4 / 17.5	16.4 / 17.5	18 / 19.3	18 / 19.3	84.0%	710	1.1	4" (150mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380/415	8.1 / 8.6	8.1 / 8.6	8.9 / 9.5	8.9 / 9.5							
i11945		4.5	9.0	6.0	12.0	190/208	24 / 25.6	24 / 25.6	26.4 / 28.2	26.4 / 28.2	81.5%	715					
						380/415	12 / 12.8	12 / 12.8	13.6 / 14	13.6 / 14							
i21929	2	2.9	5.8	4.0	8.0	190/208	16.4 / 17.5	32.8 / 35	18 / 19.3	36/38.6	84.0%	710	1.1	8" (150mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380/415	8.1 / 8.6	16.2 / 17.2	8.9 / 9.5	17.8/19							
i21945		4.5	9.0	6.0	12.0	190/208	24 / 25.6	48 / 51.2	26.4 / 28.2	52 / 56.4	81.5%	715					
						380/415	12 / 12.8	24 / 25.6	13.6 / 14	27.2 / 28							
i31929	3	2.9	8.7	4.0	12.0	190 / 208	16.4 / 17.5	49.2 / 52.5	18 / 19.3	54 / 87.9	84.0%	710	1.1	8" (200mm)	8" (200mm)	1" FNPT (25mm)	4" (100mm)
						380 / 415	8.1 / 8.6	24.3 / 25.8	8.9 / 9.5	26.7 / 77.4							
i31945		4.5	13.5	6.0	18.0	190 / 208	24 / 25.6	72 / 76.8	26.4 / 28.2	79.2 / 84.6	81.5%	715					
						380 / 415	12 / 12.8	36 / 38.4	13.2 / 15.4	39.6 / 46.2							
i41929	4	2.9	11.6	4.0	16.0	190 / 208	16.4 / 17.5	65.6 / 70	18 / 19.3	71.2 / 77.2	84.0%	710	1.1	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	32.4 / 34.4	8.9 / 9.5	35.6 / 38							
i41945		4.5	18.0	6.0	24.0	190 / 208	24 / 25.6	96 / 102.4	26.4 / 28.2	105.6 / 112.8	81.5%	715					
						380 / 415	12 / 12.8	48 / 51.2	13.6 / 14	53.6 / 56							
041929	4	2.9	11.6	4.0	16.0	190 / 208	16.4 / 17.5	65.6 / 70	18 / 19.3	71.2 / 77.2	84.0%	710	1.1	10" (250mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	32.4 / 34.4	8.9 / 9.5	35.6 / 38							
041945		4.5	18.0	6.0	24.0	190 / 208	24 / 25.6	96 / 102.4	26.4 / 28.2	105.6 / 112.8	81.5%	715					
						380 / 415	12 / 12.8	48 / 51.2	13.2 / 15.4	53.6 / 56							
i51929	5	2.9	14.5	4.0	20.0	190 / 208	16.4 / 17.5	82 / 87.5	18 / 19.3	89.0	84.0%	710	1.1	8" (200mm)	10" (250mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	40.5 / 43	8.9 / 9.5	44.5 / 47.5							
i51945		4.5	22.5	6.0	30.0	190 / 208	24 / 25.6	120 / 128	26.4 / 28.2	132 / 141	81.5%	715					
						380 / 415	12 / 12.8	60 / 64	13.6 / 14	68 / 70							
i61929	6	2.9	17.4	4.0	24.0	190 / 208	16.4 / 17.5	98.4 / 105	18 / 19.3	108 / 115.8	84.0%	710	1.1	8" (200mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	48.6 / 51.6	8.9 / 9.5	53.4 / 57							
i61945		4.5	27.0	6.0	36.0	190 / 208	24 / 25.6	144 / 153.6	26.4 / 28.2	158.4 / 169.2	81.5%	715					
						380 / 415	12 / 12.8	72 / 76.8	13.2 / 15.4	79.2 / 92.4							
061929	6	2.9	17.4	4.0	24.0	190 / 208	16.4 / 17.5	98.4 / 105	18 / 19.3	108 / 115.8	84.0%	710	1.1	10" (250mm)	12" (300mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	48.6 / 51.6	8.9 / 9.5	53.4 / 57							
061945		4.5	27.0	6.0	36.0	190 / 208	24 / 25.6	144 / 153.6	26.4 / 28.2	158.4 / 169.2	81.5%	715					
						380 / 415	12 / 12.8	72 / 76.8	13.2 / 15.4	79.2 / 92.4							
081929	8	2.9	23.2	4.0	32.0	190 / 208	16.4 / 17.5	131.2 / 140	18 / 19.3	144 / 154.4	84.0%	710	1.1	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	64.8 / 68.8	8.9 / 9.5	71.2 / 76							
081945		4.5	36.0	6.0	48.0	190 / 208	24 / 25.6	192 / 204.8	26.4 / 28.2	211.2 / 225.6	81.5%	715					
						380 / 415	12 / 12.8	96 / 102.4	13.2 / 15.4	105.6 / 123.2							
101929	10	2.9	29.0	4.0	40.0	190 / 208	16.4 / 17.5	164 / 170.5	18 / 19.3	180 / 193	84.0%	710	1.1	12" (300mm)	14" (350mm)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	81 / 86	8.9 / 9.5	89 / 95							
101945		4.5	45.0	6.0	60.0	190 / 208	24 / 25.6	240 / 256	26.4 / 28.2	264 / 282	81.5%	715					
						380 / 415	12 / 12.8	120 / 128	13.6 / 14	136 / 140							
121929	12	2.9	34.8	4.0	48.0	190 / 208	16.4 / 17.5	196.8 / 210	18 / 19.3	216 / 231.6	84.0%	710	1.1	12" (300mm)	12" x 2 [d] (300mm x 2)	2" FNPT (50mm)	6" (150mm)
						380 / 415	8.1 / 8.6	97.2 / 103.2	8.9 / 9.5	106.8 / 114							
121945		4.5	54.0	6.0	72.0	190 / 208	24 / 25.6	288 / 307.2	26.4 / 28.2	316.8 / 338.4	81.5%	715					
						380 / 415	12 / 12.8	144 / 153.6	13.2 / 15.4	158.4 / 184.8							

[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.

[d] Flow rates above 2,700 gpm require engineering review and may require two sump containers.

Table 1 –Motor Data (6 Pages)

2.7 Fans

Figure 9 – Typical -bladed 7WR Fan

High efficiency axial fans with a unique airfoil design are used on all TTXR Series Modular Cooling Towers (refer to Figure 9).

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 TTXR Series and vary based on motor selection (refer to Table 2).

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 2 – Fan Data for Motors

2.8 Fan Shroud

Figure 10 – Fan Shroud

The fan shroud used on the TTXR 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 (refer to figure 10) provides a smooth transition for the air entering the fan, maximizing fan efficiency and thereby reducing energy costs. Because of the fiberglass construction, the shroud is very lightweight, strong, and resists corrosion indefinitely.

2.9 Fill Media

The most important component of a cooling tower may be the heat transfer surface or fill. The fill's efficiency is a function of its ability to promote contact between the air and water with a minimum resistance/impedance to airflow. The fill used by Tower Tech meets the rigorous standards of the Cooling Technology Institute (STD-136[88]) by having uniform thickness and hole, air bubble, and foreign matter-free and free of other manufacturing defects which may adversely affect performance.

The standard TTXR Series Modular Cooling Tower contains PVC film fill media stacked to a depth of five feet. The selection of the type of fill media used will vary from one installation to another due to variances in water quality and/or performance requirements.

- Comfort Cooling, Utility, and Industrial Applications:

  Generally clean to medium quality water applications would benefit from the use of a cross-corrugated fill media with a 19mm standard flute size to minimize the potential for plugging while maintaining performance efficiency. (Refer to Table 3 for data on 19mm cross corrugated fill media.) Generally, the selection of CF-1900 is most suitable when:

  1. Total suspended solids (TSS) are <25 PPM (TSS <100 PPM where bacterial activity is very low).

  2. Make-up water is from uncontaminated sources.

  3. Biological and scale control is good.

  4. Cycles of concentration are low.

  5. Airborne dust is minimal.

  6. Oils and grease are not present in the recirculating water.

- Pulp, Paper and Steel Mills:

  Applications with generally poorer water quality may specify vertical-flute fill media to minimize the potential for fill plugging. Such applications may have higher levels of TSS (>500 PPM with no upper limit, 1000 PPM if oil or grease are present or if there is no biological control), make-up water is from surface waters, biological or scale control is poor, and/or oils or grease may be present (up to 25 PPM) in recirculating water. (Refer to Table 3 for data on 38mm vertical flute fill).

- Entering Water Temperatures:

  PVC fill media is recommended for applications in which the temperature of tower entering hot water does not exceed 140°F in continuous operation. HPVC fill media is required for applications in which the temperature of tower entering hot water ranges up to 150°F in continuous operation. PVC and HPVC fill media can tolerate temperature excursions of up to 15°F for up to two hours, if the excursion is supported by the fill media manufacturer's recommendations.

CAUTION The fill bearing capacity can be affected by the accumulation of silt, dirt, process leaks, and debris. 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. Occasional inspection of the fill surface area to assess fouling is recommended to assure that this bearing capacity is not exceeded.

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 3 – Fill Media Data

2.10 Drift Eliminators

The TTXR Series Modular Cooling Tower utilizes a low-pressure sinusoidal-shaped drift eliminator that provides three distinct changes in flow direction to enhance the drift capturing capability of the drift eliminator. 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 4 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 4 – Drift Eliminator Data

2.11 Safety Point Brackets

The Tower Tech Modular Cooling Tower was designed to reduce maintenance requirements and for 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 6ft of the ground. When service personnel have to enter the Tower Tech cooling tower, the modular walls served as a fall restraint for the personnel working inside the cooling tower. Even with safety being a top consideration in the design of the TTXR Modular Cooling Tower, certain service applications required the service technician to adhere to strict fall restraint requirements when accessing the top of the modular cooling tower.

TTXR modular cooling towers built after October 1, 2013 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.

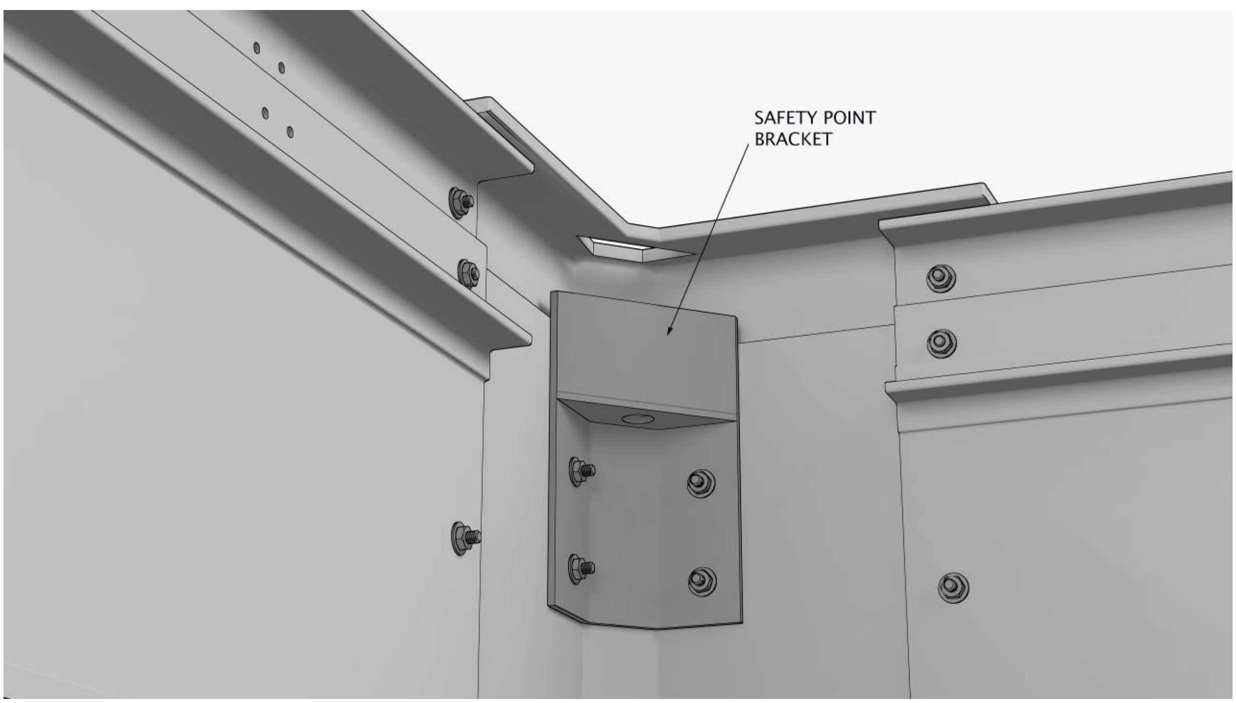


Figure 11 – Safety Point Bracket

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.

2.12 Power and Control Wiring

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 separate 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.

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.

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

Each motor is factory pre-wired to a junction box located on the end of the tower module (as illustrated in Figure 13A). Optional rotary-type lockout disconnect switches may be specified (as illustrated in Figure 13B). 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. A typical illustration of optional pre-wiring layout is shown in Figure 12. Optional pre-wiring of motors to pigtails may be specified (as illustrated in Figure 13C). Tower Tech also offers an optional pre-wiring of the motors to a motor protection panel (as described and illustrated in Section 4.3).

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.

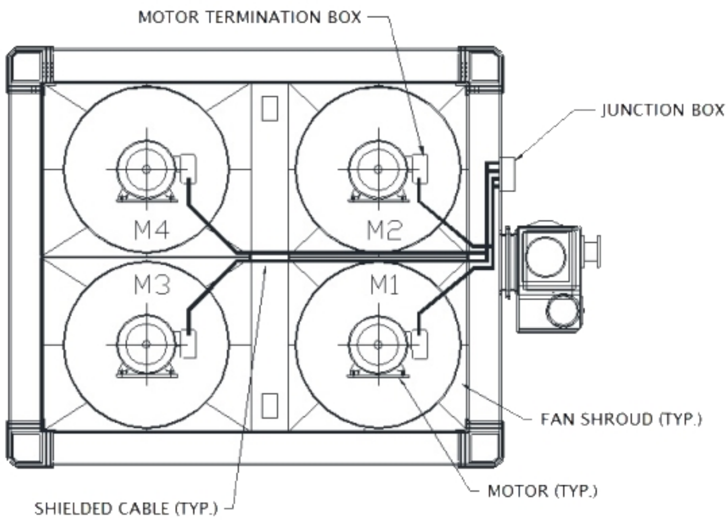


Figure 12 – Typical Wiring Layout

(Refer to Table 1 for amperage requirements at various motor power levels.)

⚠ CAUTION Waterproof-type connectors <u>MUST</u> 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.

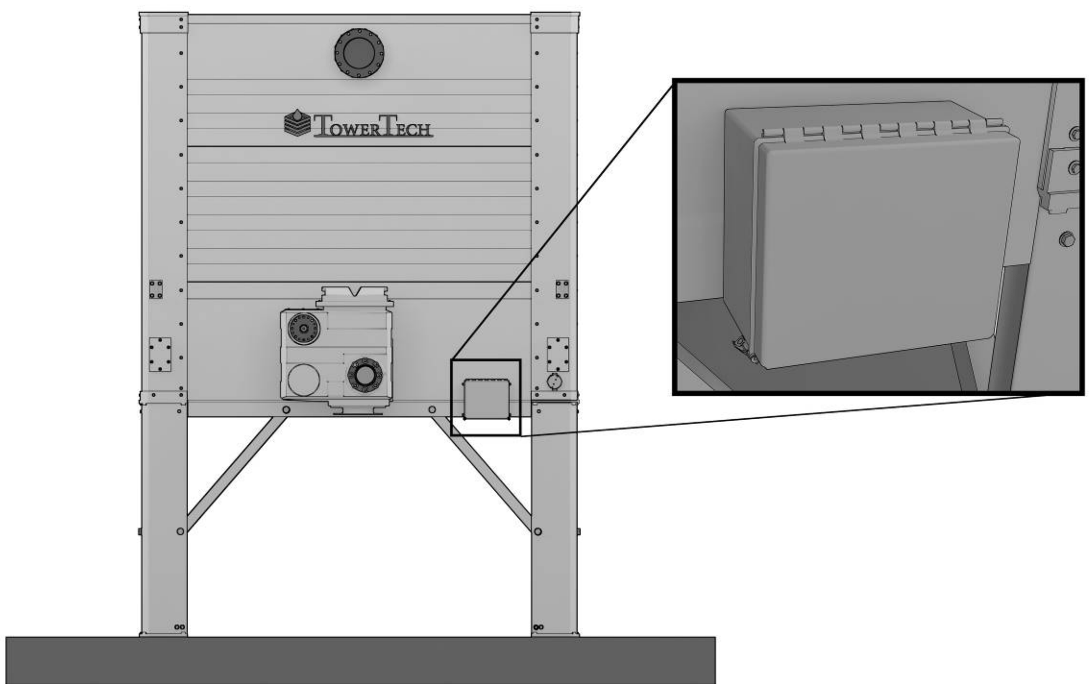


Figure 13A – Standard NEMA-4X Junction Box

Optionally available are rotary disconnect switches comprised of NEMA-4X enclosures with an NO/NC auxiliary contact for remote monitoring (refer to Figure 13B).

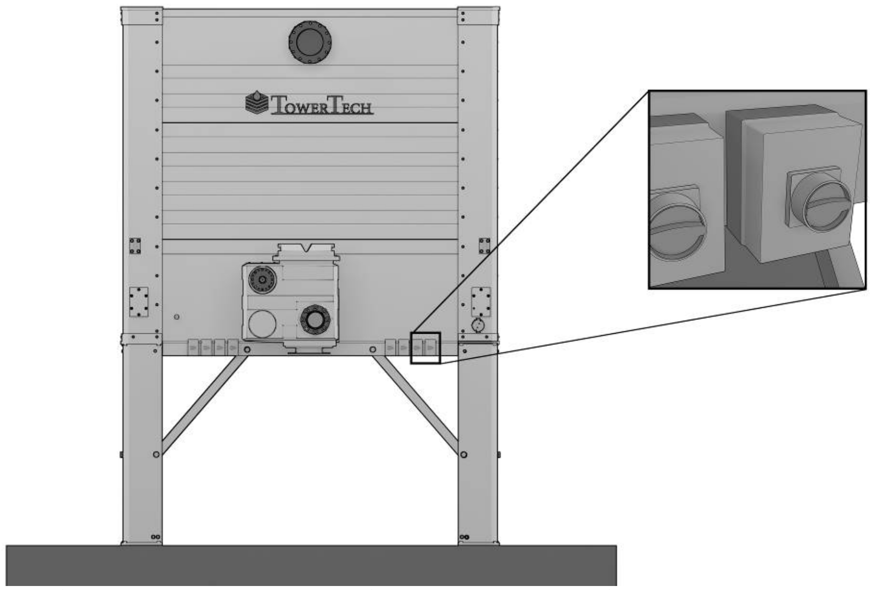


Figure 13B – Optional Rotary-Type NEMA 4X Lockout Disconnect Switches

It is important to follow the pre-wire sequence of the motors to the rotary disconnects as defined in tower submittal drawings. The order of each motor wiring is critical when connecting to motor starters to insure proper sequence and operation of the motors.

The Tower module can be pre-wired to pigtails (length to be specified) for onsite connection by others to electrical equipment (refer to Figure 13C).

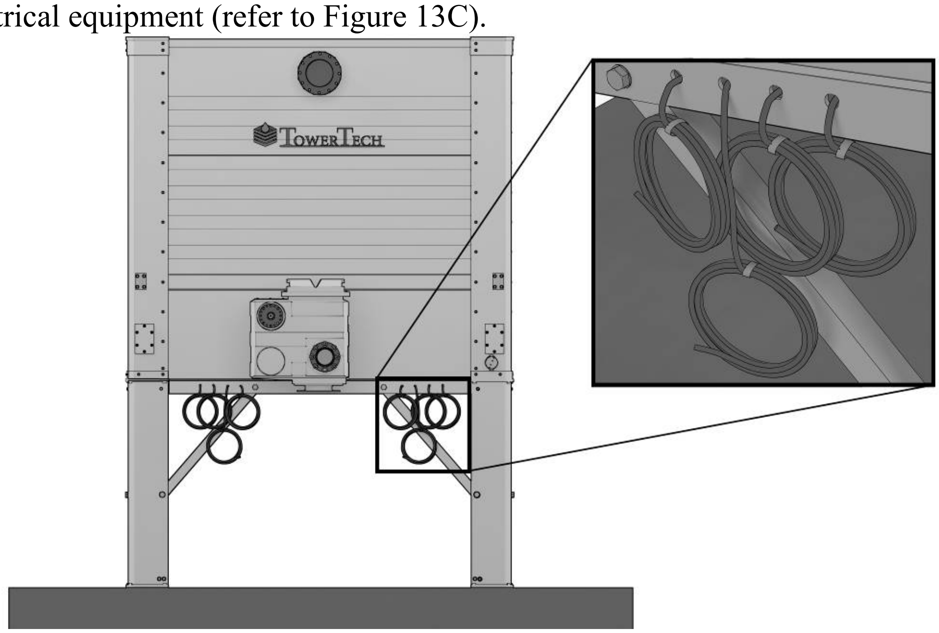


Figure 13C – Pre-wire to Pigtails

Chapter Three: Materials of Construction

3.1 Background

The Tower Tech TTXR Series Modular Cooling Tower is factory pre-assembled. All walls, structural members, and internal components in wetted areas are non-corrosive fiberglass, various plastics (PVC is used exclusively in the hot water distribution system and in other non-structural members), and stainless steel hardware. Non-corrosive materials of construction provide long service life in the hostile chemical environments inherent to cooling towers.

Galvanized metal support systems (located in the hot moist air stream) and chemical wood treatments are major contributors to environmental and maintenance problems associated with conventional cooling towers. Galvanized metals can molecularly break down in the water due to high concentrations of acids and alkalis. Conventional wooden towers are often treated with potentially hazardous chemicals to prolong their life. These substances also leach into the cooling water.

The TTXR Series Modular Cooling Tower minimizes these environmental problems by eliminating galvanized metal and treated wood from the wet areas of the cooling tower design. (The TTXR Series uses impervious plastic/pvc-coated steel fan guard screens; however, the fan guard screens are located in the non-wetted area below the tower module.)

3.2 Tower Walls

The tower walls provide a perimeter shell around the tower fill media and other internal components. The three sections that comprise the walls, the Perimeter Basin Wall, the Mid-Wall, and the Top-Wall 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 areas where water hold-up occurs. Refer to Table 5 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 5 – Wall Data

3.3 Fan Shroud

The fan shroud used on TTXR Series Modular Cooling Towers (refer to Figure 10) is made using a hand lay-up process utilizing fiberglass mat and chopped fiberglass strands, or a resin transfer molding process utilizing fiberglass mat. Its unique design radius provides a smooth transition for the air entering the fan thus maximizing the fan efficiency and energy savings and likewise reducing extraneous noise. Due to the use of fiberglass mat, the shroud is very lightweight yet strong and will resist corrosion indefinitely.

3.4 Fan Motor Support

Fan motor supports are bolted to the fiberglass shrouds (refer to Figure 8), thus allowing the motor, motor support and shroud to interconnect with a minimum of vibration and a minimum of fan tip tolerance. 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.

3.5 Tower Internals

⚠ CAUTION The standard TTXR Series hot water distribution system and fill media are designed for a maximum tower entering hot water temperature of 140°F (60°C) in continuous operation. Excessive tower entering water temperatures will damage the tower's hot water distribution system and fill media. For applications having tower entering hot water temperatures ranging up to 150°F (65.5°C) degrees, CPVC hot water distribution system piping and HPVC fill media are optionally available. PVC fill media can tolerate temperature excursions of up to 15°F (9.4°C) for up to two hours, if the excursion is supported by the fill media manufacturer's recommendations.

TTXR Series internal components are described in Table 6.

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)		Sump Box	PP (Rotationally Molded)
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 6 – Materials of Construction; Internal Components

Chapter Four: Optional Equipment

4.1 Sub-Structure (Leg) Kit

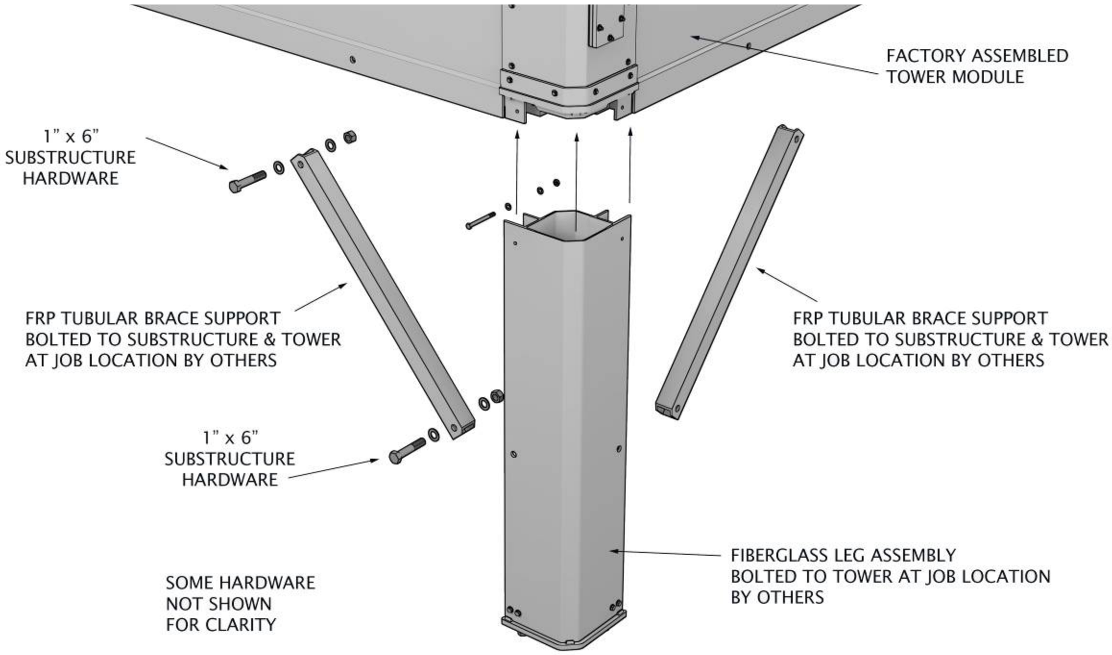


Figure 14 – Tower Sub-Structure

Tower Tech offers a pultruded fiberglass substructure connected to each corner of the tower module. Refer to Figure 14. When installed on Tower Tech 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 and has received California OSHPD pre-approval for seismic loads. 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 general 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 6-foot (182.9 cm) and 8-foot (243.8 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)
- Footpad
- FRP tubular braces – Not required for 1 foot (30.5 cm) legs
- Assembly hardware (folding leg bracket optional)

4.2 T9900 Motor Control Panel

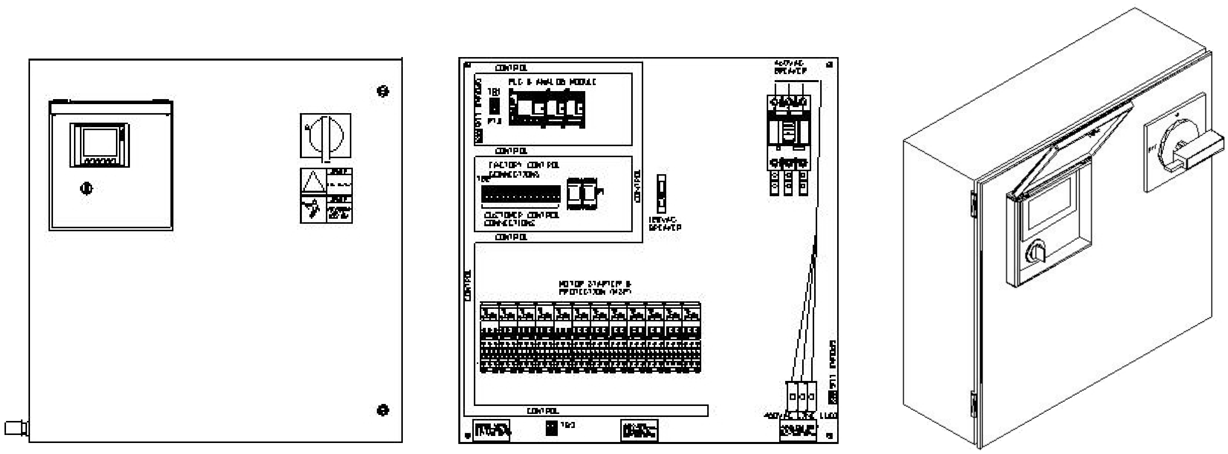


Figure 15 – Typical Motor Control Panel for 10-Fan Cooling Tower Module. (VIEWSCREEN ® touch screen standard on all Tower Tech T9900 control panels ordered after August 31, 2011.)

Tower Tech offers a complete line of T9900 optional motor control accessories designed for the TTXR Series Modular Cooling Tower. Tower Tech's optional motor control panels come complete and ready for immediate installation. Panels require main power feed to the main disconnect switch, and a separate 120V control power feed. Panels also require connections to the standard pre-wired junction box, optional individual motor disconnects or pre-wired pigtails.

The T9900 series motor control panels are equipped with a cover mounted lockable main disconnect and individual HAND-OFF-AUTO controls for each fan motor. Each internally mounted combination motor starter/adjustable overload protector has an integral lockable circuit breaker to enable individual motor isolation with lock out/tag out capability. The control panel comes completely pre-wired. Terminal blocks are provided for the main power feed and the individual fan motor connections, and any externally mounted control input and outputs. The standard enclosure for the optional motor control panel is a NEMA-4 rated, powder coated hinged steel box with full back plate and gasket door.

The T9900 series panels have a preprogrammed PLC and temperature input device to control fan cycling and/or a remote variable-frequency drive. Each motor overload protector is equipped with an auxiliary relay. Should a motor overload trip a dry contact signal can be wired in series or parallel back to a Building Management System or Building Automation System (BAS) for notification.

Refer to Figure 15 for a typical motor control panel layout. VIEWSCREEN® touch screen is standard on all Tower Tech T9900 control panels ordered after August 31, 2011. The HMI touch screen comes equipped with a protective panel door that is lockable. Door is hinged at the top to provide shade from the sunlight, thereby making it easier to view the screen.

⚠ CAUTION **Do not mount motor control panels on the tower module's basin walls or casing walls as this will cause basin leakage or wall component failure. Never mount or attach the control panel to plumbing or piping equipment as vibration could cause damage to internal components.**

⚠ 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 MOTOR WIRING MUST BE PROPERLY GROUNDED ON BOTH ENDS. ALL COMMUNICATION WIRE TO BE SHIELDED TWISTED PAIR CONDUCTOR AND PROPERLY GROUNDED ON ONE END ONLY.**

The optional T9900 control panel is available with a Programmable Logic Controller (PLC) that is programmed to cycle the cooling tower fans to maintain the desired cold water temperature set point entered by an operator through the cover-mounted interface LCD panel. The PLC can supply an intermittent 4-20 milliamp signal to control an external variable-frequency drive (VFD).

ℹ The PI(D) Loop being used by the PLC or VFD should be fined tuned to maintain tight control to the cold water temperature set point. Fans cycling or ramping constantly up and down indicate oscillation of the control loop or hunting that can damage motors and potentially void the motor warranty. Once the PLC is fine-tuned the control loop should maintain a consistent output with tight control to the cold water temperature set point with small variations for a stable rapid response.

When a VFD is used with this control panel, jumper J21-J24, located on Terminal Block #2 (TB2), must be replaced with a dry contact connection (in the VFD) that indicates the operational status of the VFD to the PLC. The dry contact must be normally open (N.O.) when the VFD is operational (active) and normally closed (N.C.) when the drive is in by-pass mode, or when failed. When the VFD is online the dry contact must be N.O. which tells the control panel PLC to energize all motor starter coils, allowing the VFD to maintain the desired cold water temperature set point entered through the control panel without fan cycling from the PLC. When the VFD is in by-pass mode, or when failed, the dry contact must be N.C. which tells the control panel PLC to de-energize the starter coils, and the PLC will maintain the desired cold water temperature set point entered by an operator through the door-mounted LCD interface panel through fan cycling control.

A separate 120V circuit must be provided for control power within the panel. All 4-20 milliamp or 0-10VDC signal wiring must be shielded twisted pair wiring with the shield properly grounded on one end only. The PLC provides an optional safety enable connection to the VFD to insure when the T9900 panels main breaker is turned off the VFD won't try and operate against no load.

An owner can control the cooling tower through a BAS by connecting to the T9900 series panel without a gateway module. It is recommended that the BAS send a remote temperature set point to the PLC by an intermittent 4-20mA analog signal that is calibrated for 45°F-200°F respectively connected to TB2 terminals J63-J64. The PLC will then send a speed reference signal to the VFD to maintain temperature set point. The BAS can also control the VFD directly by sending a remote speed reference signal by an intermittent 4-20mA or 0-10VDC analog signal connected directly to the VFD. The PLC has the capability for remote enable/disable control through connection to TB2 by replacing jumper J22-J25 with a dry contact signal. The dry contact connection from the VFD to the tower PLC will activate the motor starters and initiate VFD control. Any VFD (with auto bypass feature) shutdown will put the PLC into fan cycling control as in the previous sequence. This provides redundant control of the cooling tower should the VFD fail, while still allowing the BAS to control the desired tower exiting water temperature.

The T9900 series panel can be equipped with a gateway module for building automation control interfacing. Tower Tech's optional gateway module for communication protocol interfacing with Building Automation System provides an access point to gateway data mapping that is pre-programmed in the PLC while all other setup, interfacing and programming for communication with the BAS to be provided by others. Optional gateway modules are available for the following communication protocols:

BACnet/IP or BACnet/MSTP (RS485)
LonWorks/IP or LonWork/MSTP (RS485)
Modbus TCP/IP or Modbus RTU (RS485)

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 towers is Alpha brand, VFD compatible, quantum-shielded, liquid tight, oil resistant, flexible cable.

4.3 T2100 Motor Protection Panel

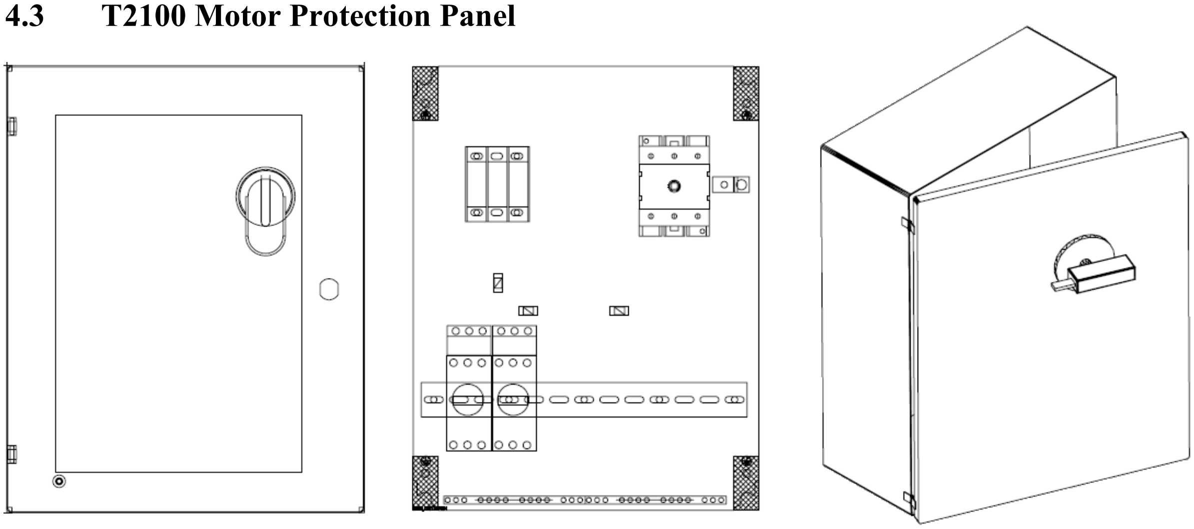


Fig. 16 – T2100 MPP

Should Tower Tech’s optional T9900 motor control panel not be used, then individual motor protection is required. Tower Tech offers an optional T2100 Motor Protection Panel (refer to Figure 16). The Motor Protection Panel (MPP) is a UL-Rated NEMA 4X (FRP) and is designed for single point connection. The NEMA 4X panel has individual manual motor protectors to protect each motor against short circuit or thermal overload. The manual motor protectors provide overload trip switches for lock out/tag out capability of each individual motor. Each manual motor protector has an auxiliary relay to monitor the fault status of each motor. The NEMA 4X panel also provides a main non-fused disconnect with through the door operator handle. An auxiliary safety relay is provided for safety interlock with a VFD. The MPP is pre-wired to the motors and pre-mounted on the cooling tower.

When a VFD is used with the T2100 MPP a temperature input device (RTD) can be provided that should be installed within 15 feet of the cooling tower outlet flange. The RTD should be wired back to the proper terminal in the VFD for the internal PI(D) closed loop controller to maintain a cold water temperature set point. Tower Tech recommends the VFD be equipped with auto bypass to allow across the line voltage to all motors should the VFD trip or fail.

⚠ CAUTION **When tower module is more than 6 feet above standing level consideration should be given to service access to the T2100 MPP. Options are available for shipping the MPP for field installation to comply with any applicable local, state, and national codes including, but not limited to building, electrical, and mechanical codes. ALL MOTOR WIRING MUST BE PROPERLY GROUNDED ON BOTH ENDS.**

4.4 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) and mechanical motor protection starters provide 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 temperature. Consult the VFD manufacturer's user manual for details on programming the VFD unit for use and installation.

Customers are responsible for programming out harmonic and electronic frequencies, and for locating appropriate connection points for variable-frequency drives not supplied by Tower Tech. Tower Tech drawings are typical only. All control wiring is to be Belden equivalent, shielded twisted-pair cable, properly grounded on one end only.

(Refer to Section 2.5 for the advantages of using VFD with variable flow water distribution.)

⚠ CAUTION All VFD's must have a dv/dt Filter. VFD rated cable must be used for load cable from the VFD to the motors. Failure to meet these requirements will void the motor warranty.

⚠ CAUTION The VFD must be sized to meet the Full Load current demand at 60hz for all motors connected to the drive. If individual motors will be turned on/off during VFD operation, the Locked Rotor Amperage must be included in the total amperage sizing of the VFD.

⚠ CAUTION Load cable from the VFD to the motors should always be as short as practical. The load cable from the VFD to the motors should never exceed 150ft. (50m) without factory approval.

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

4.5 Immersion Basin Heater

Tower Tech offers an optional pre-engineered basin heater package for TTXR Series Modular Cooling Towers. Each package includes:

- Standard stainless steel electric immersion heater
- UL listed control panel in NEMA-4X enclosure
- Water level and temperature sensor/probe
- Wiring diagram
- Installation and operating instructions
- Required flange fittings for probe and heater pre-installed into tower

⚠ CAUTION The immersion basin heater is intended to prevent icing of only the basin water when the tower is not in operation.

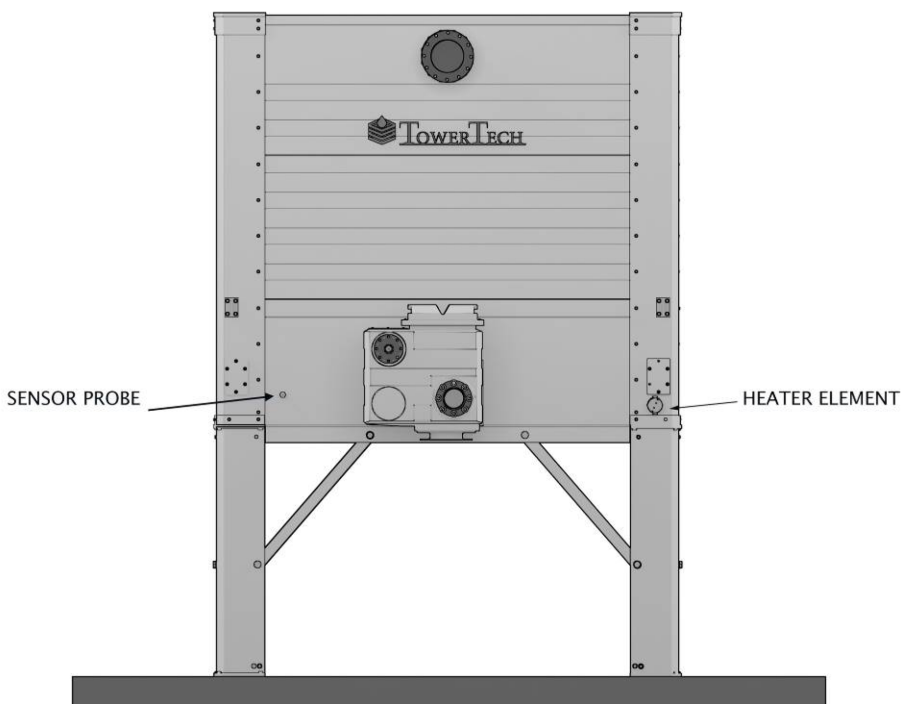


Figure 17 – Immersion Basin Heater and Sensor Probe Location

For winter shut down operation, Tower Tech offers an optional immersion basin heater with a corrosion- and liquid-proof enclosure. The control unit 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(s). The control panel is UL rated NEMA-4X and can control up to four heating units, however, the heater elements must be located within the same water basin as the temperature-sensing probe to prevent the possibility of fire. Each heater element contains a fused thermal cut-off device to prevent over heating of the element. Refer to location of immersion basin heater and probe in Figure 17.

INDEECO - 6KW Heater Voltage And Amp Draw					
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 480 Volts / 3 Phase			Enclosure Dimensions
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 7A – Indeeco 6kW Amp Chart

INDEECO - 9KW Heater Voltage And Amp Draw					
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 Volts / 3 Phase			Enclosure Dimensions
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 7B – Indeeco 9kW Amp Chart

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.

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 could 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.

Tower Tech recommends the electrical contractor installing the basin heater element use a flex loop with additional wiring connected to the element so it can be removed for quick inspection without having to disconnect the wiring. Heater element is 22" in length.

4.6 Vibration Control

Tower Tech does not require vibration switches for the TTXR Series Module Cooling Tower because of the small motor size, inherent structural stability of the modular tower, and using adhesive vibration dampening sealants for many structural connections. Vibration isolators are not required or recommended on TTXR Series Modular Cooling Towers for the same reasons.

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 a 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 TTXR Series Modular Tower. 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 of the substructure legs attach on top of or vibration pads can be used directly below the substructure legs.

4.7 Ultrasonic Liquid Level Sensor

As an alternative to Tower Tech's standard mechanical float valve, you may select the optional ultrasonic liquid level sensor. The mechanical float valve can be installed as a back up to the electronic level controller. The liquid level sensor/transmitter should be mounted in a quiescent zone, such as a standpipe extension located off of the tower equalization line, for most accurate measurement. The recommended installation and piping arrangement is shown in Figure 18A. The liquid level sensor/transmitter is factory calibrated to send a 4-20mA signal for accurate monitoring of the tower module water level (see Figure 18B for calibration settings). Tower Tech offers an optional continuous relay controller (remote unit) for proper operation and signal detection. The relay controller will provide a signal to a solenoid valve (provided and installed by others) to provide adequate make-up water for maintaining the required operating water level. If the optional relay controller is not used the liquid level sensor/transmitter must be wired to a building automation system that controls the solenoid valve (provided and installed by others) for proper make-up water.

⚠ 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.

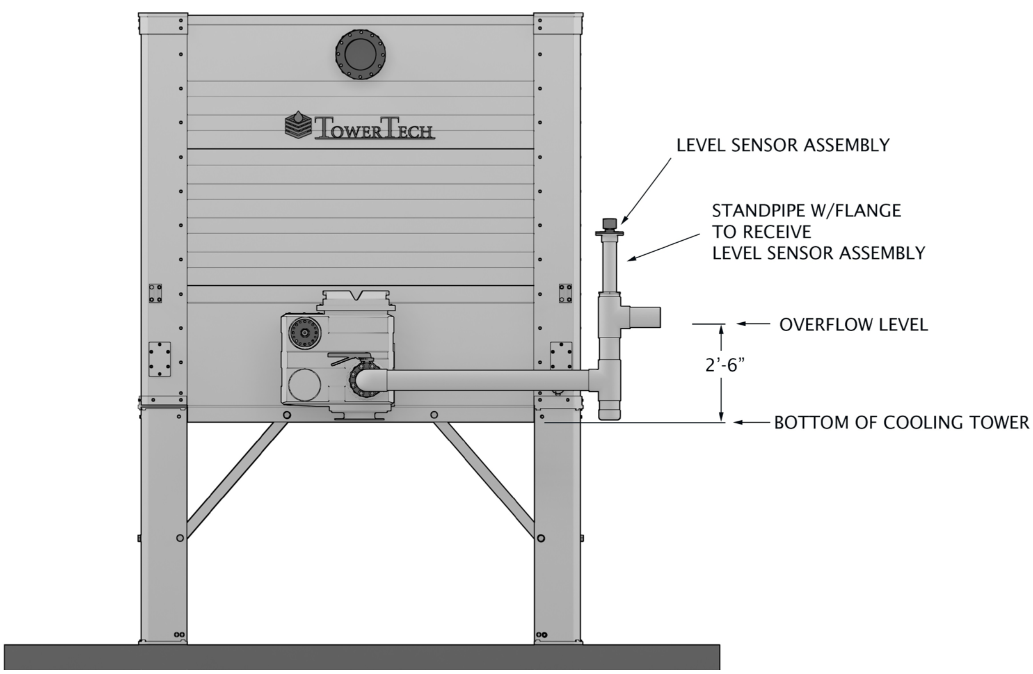
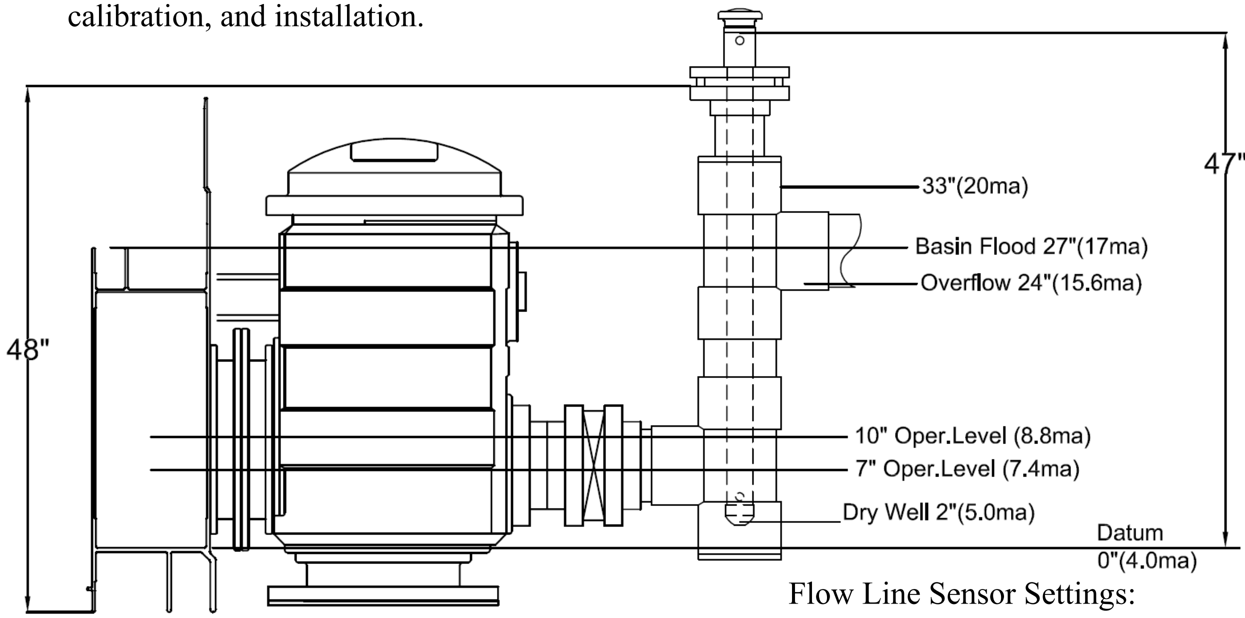


Figure 18A – Ultrasonic Liquid Level Sensor Location

Consult the ultrasonic liquid level sensor manufacturer’s user manual for details on set-up, calibration, and installation.



Flow Line Sensor Settings:
Bottom Of Sensor To Bottom Of Tank = 47”
4mA = 0”
20mA = 33”

Figure 18B – Sump Detail With Ultrasonic Liquid Level Sensor

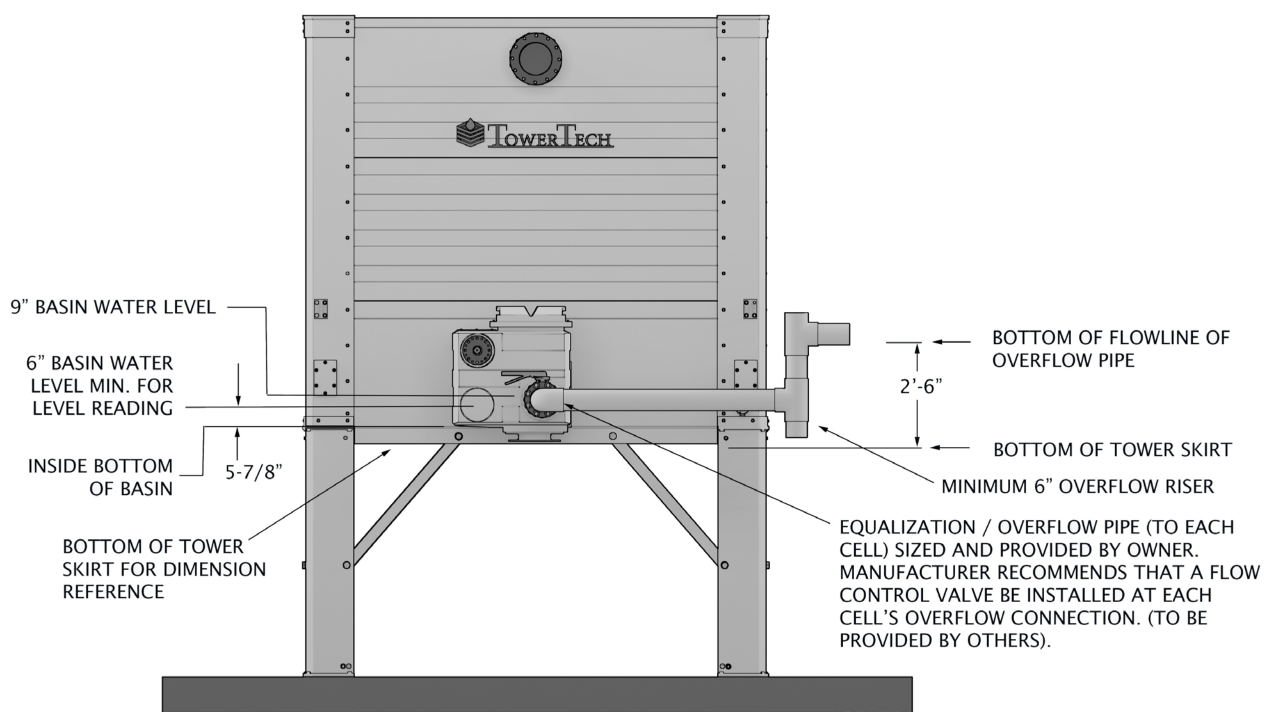


Figure 19A – Equalization/OverflowPipe Detail (No Ultrasonic Level Sensor)

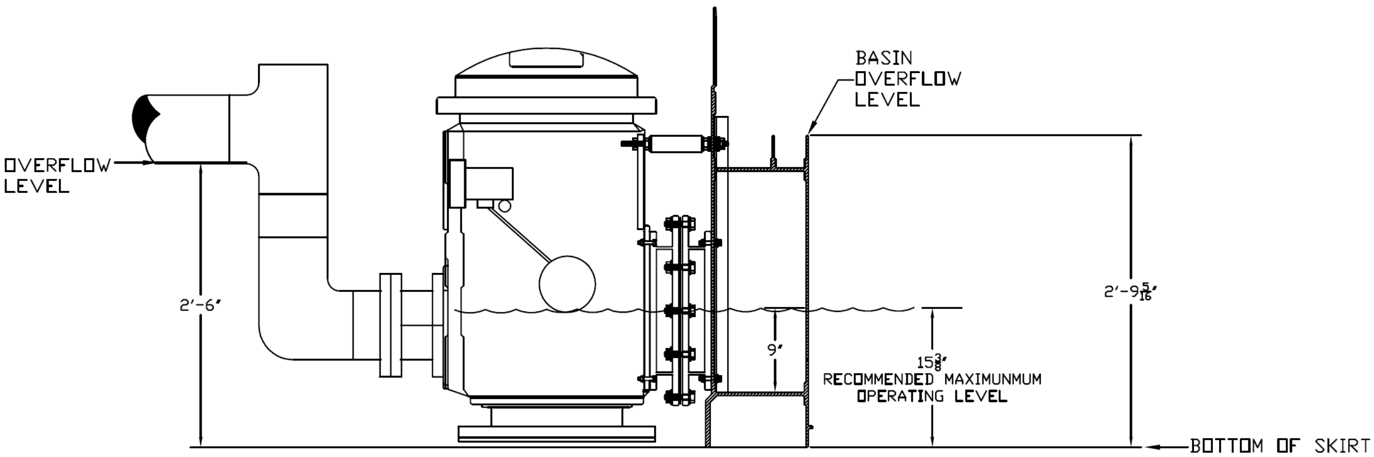


Figure 19B – Sump Detail With Equalization/Overflow Pipe (No Ultrasonic Level Sensor)

Chapter Five: Preparing for Installation

Table 8 – Weights and Dimensional Data (Below)

TTXR Model	Weights in Lbs. (kg)		Dimensions per Illustration Below [a] (cm)							
	Shipping [b]	Operating	A	B	C	D	E	F	G	H
i119xx	3,450 (1,564)	6,090 (2,762)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	7'-00" (213.4)
i219xx	4,360 (1,978)	9,470 (4,305)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	13'-06" (411.5)
i319xx	6,155 (2,792)	12,991 (5,905)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	19'-03" (586.7)
i419xx	7,950 (3,606)	16,503 (7,501)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	25'-00" (762.0)
0419xx	7,800 (3,538)	14,394 (6,543)	12'-00" (365.8)	6'-00" (182.9)	9'-11" (302.3)	1'-04" (40.6)	6'-00" (182.9)	6'-00" (182.9)	17'-00" (518.2)	13'-06" (411.5)
i519xx	9,745 (4,420)	20,024 (9,102)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	30'-09" (937.3)
i619xx	11,540 (5,235)	23,553 (10,706)	7'-00" (213.4)	3'-06" (106.7)	10'-01" (307.3)	1'-04" (40.6)	4'-00" (121.9)	6'-00" (182.9)	17'-00" (518.2)	36'-06" (1,112.5)
0619xx	10,775 (4,887)	19,587 (8,903)	12'-00" (365.8)	6'-00" (182.9)	9'-11" (302.3)	1'-04" (40.6)	6'-00" (182.9)	6'-00" (182.9)	17'-00" (518.2)	19'-03" (586.7)
0819xx	13,750 (6,237)	24,780 (11,264)	12'-00" (365.8)	6'-00" (182.9)	9'-11" (302.3)	1'-04" (40.6)	6'-00" (182.9)	6'-00" (182.9)	17'-00" (518.2)	25'-00" (762.0)
1019xx	16,855 (7,645)	29,964 (13,620)	12'-00" (365.8)	6'-00" (182.9)	9'-11" (302.3)	1'-04" (40.6)	6'-00" (182.9)	6'-00" (182.9)	17'-00" (518.2)	30'-09" (937.3)
1219xx [c]	19,700 (8,936)	35,156 (15,980)	12'-00" (365.8)	6'-00" (182.9)	9'-11" (302.3)	1'-04" (40.6)	6'-00" (182.9)	6'-00" (182.9)	17'-00" (518.2)	36'-06" (1,112.5)

[a] Dimensions are approximate and should not be used for construction purposes. Dimension F may be 1'-00" (30.5 cm), 4'-00" (121.9 cm), 6'-00" (182.9 cm), 8'-00" (243.8 cm), 10'-00" (304.8 cm), or 12'-00" (365.8 cm) depending on project requirements. 12'-00" (365.8 cm) may be specified with prior approval of Tower Tech engineeing manager only. Dimension F on drawing below is 6'-00" (182.9 cm).

[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 sump, substructure or other accessories not directly attached to the tower module during shipping.

[c] TTXR-1219xx requires two sumps. See TTXR-1219xx drawings on Tower Tech website.

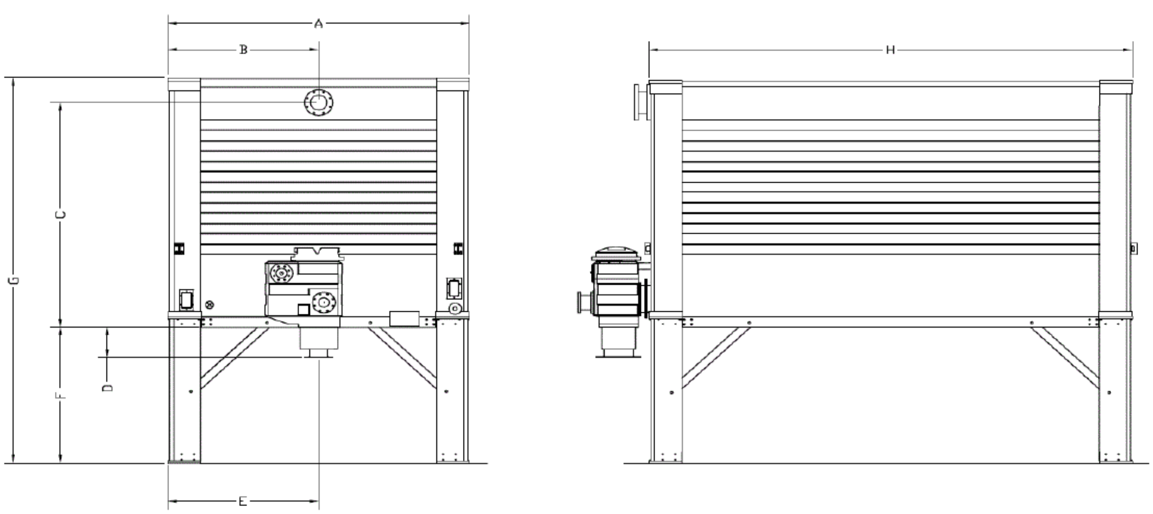


Figure 20 – Dimensional References

5.1 Limitations

The cooling tower module 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 waste water 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 tower specification and are made according to generally accepted methods of thermal calculation.

The thermal performance of the TTXR Series Modular Cooling Tower 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 50º F and 90ºF (12.8ºC and 32.2ºC), a maximum process fluid temperature of 125ºF (51.7ºC), a cooling range of 4ºF (2.2ºC) or greater, and a cooling approach of 5ºF (2.8ºC) or greater.

5.2 Tower Location

The most suitable location to install a cooling tower from both a performance and safety perspective is a rooftop. However, when this is not possible, use the following guidelines to select a satisfactory location for installation.

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

5.2.1 Environmental Safety Considerations

A cooling tower module must be installed in a location where contaminated tower-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 tower is in compliance with applicable air pollution, fire, and clean-air codes.

5.2.2 Re-Circulation Considerations

Re-circulation is a condition that arises when warm moisture-laden exhaust air is inadvertently drawn back into a tower's intake. This condition elevates the cooling tower entering wet bulb temperature and affects the tower's capacity to cool to design requirements. Re-circulation commonly occurs when towers are located within enclosed areas or in close proximity to 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 cooling tower. To minimize re-circulation Tower Tech recommends the following:

- Position the top of the cooling tower 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 tower 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.

5.2.3 Interference Considerations

Interference is a condition that arises when the cooling tower is situated down wind or in close proximity to a heat-emitting source. To avoid interference careful locating of the cooling tower is essential. Consider the following:

- A cooling tower should be designed for the entering wet bulb temperatures at the proposed tower location rather than ambient wet bulb for the locality.
- Install the cooling tower 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 tower.

5.3 Tolerances

5.3.1 Leveling

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.

5.3.2 Foundation/Slab or Pier Requirements

Weights are provided in the drawings for towers. Information provided includes dry shipping weight and operating weight. Roof structures must be able to support the maximum load of the module and its accessories. Install the module on a solid steel frame or appropriate substructure.

5.3.3 Positioning

Install modules with a minimum of 2 inches (5.1 cm) between them in order to accommodate inherent manufacturing tolerances for the tower and the components.

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

5.3.4 Piping

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

Never support piping, ladders, walkways or stairways from a TTXR Series cooling tower module. Never attach control panels to plumbing or piping as this may induce vibration.

⚠ CAUTION An automatic check valve or pump control valve must be installed at each pump discharge to prevent any water in the pipes that are above the elevation of the tower basin water level from backflowing and over filling the tower basin on shutdown.

⚠ 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.

⚠ CAUTION Do not reduce pipe connected to the cooling tower by more than 2 inches (5cm) of the tower connection flange size. Tower Tech recommends that any pipe reductions occur after the first elbow of the pipe connection. Elevation of piping should never exceed the tower flange connection height without engineering review and approval.

5.3.5 Multi-Tower Configuration

Tower Tech recommends a common manifold pipe be installed for the hot water pipe and cold water piping when operating multiple cooling towers. A common manifold pipe is critical to balance the flow of the system. Figure 21 below illustrates the proper use of a common manifold to eliminate problems with pressure drop across the cooling tower connection flanges. It is important to connect the hot water pipe and the cold water pipe to the center of the common manifold for proper equalization. The piping layout shown in Figure 21 will help insure the tower with the shortest pipe distance to the pump doesn't pull air into the system during startup or overflow during shutdown of the pumps. The common manifold for the hot water piping should be installed to allow for riser connections to the inlet flanges of the cooling tower.

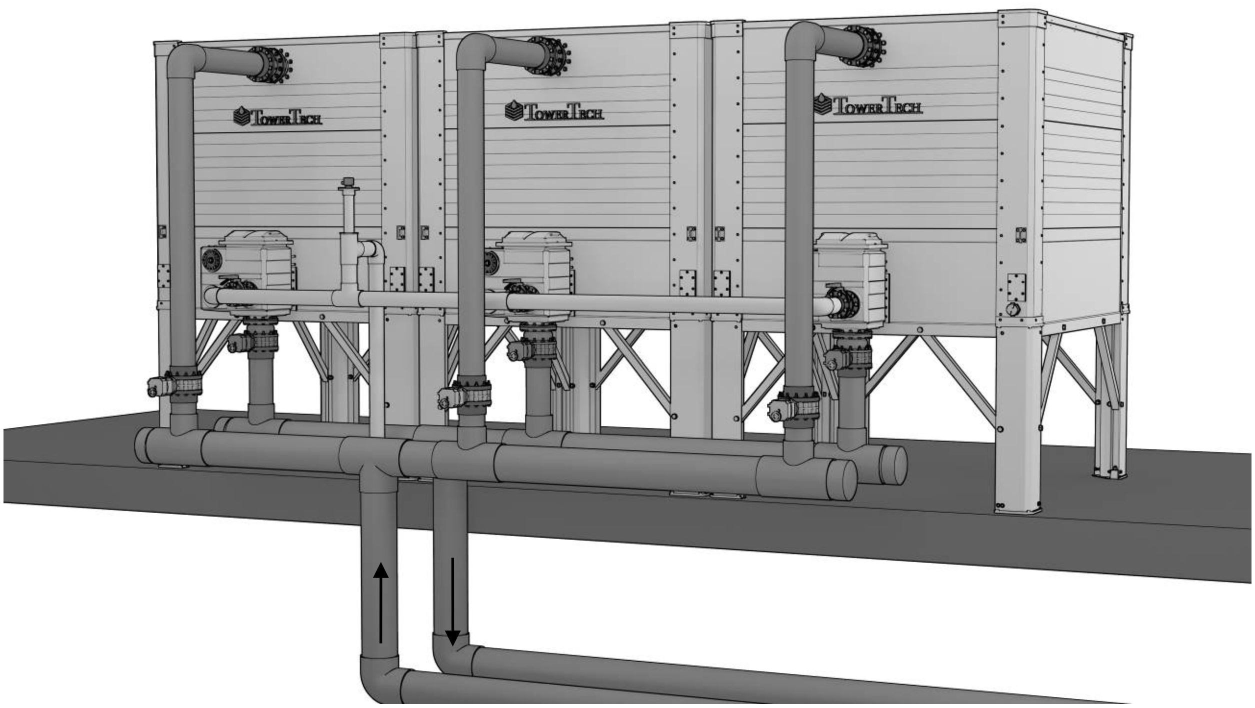


Figure 21 – Multi-Tower Layout and Piping Recommendations

5.4 Sub-Structure Installation

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

5.4.1 Installation of Tower with Folding Leg Bracket

Tower Tech has designed a folding leg bracket that connects the sub-structure to the tower allowing for all four legs to swing safely and easily into the correct position for secure fastening.

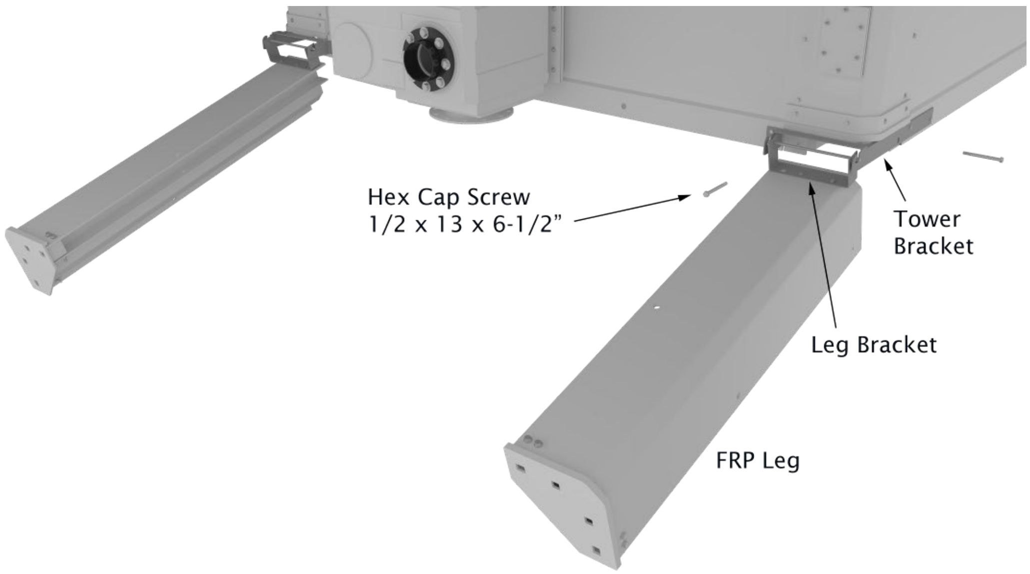


Figure 22 – Folding Leg Bracket Detail

1. Lift and position the tower over a clear, level area and hold the tower approximately 24" above the ground (Figure 23) according to requirements provided in Tower Tech's Installation, Operation and Maintenance Manual.

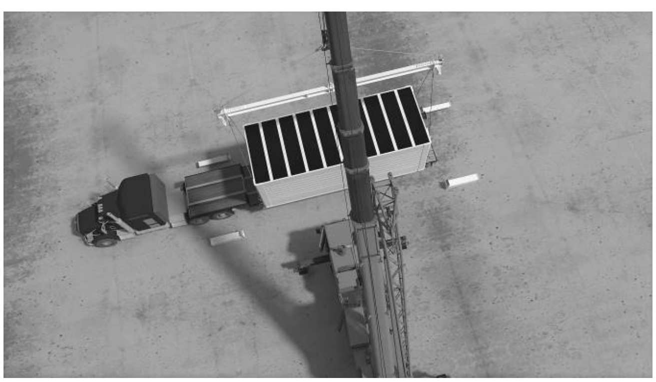


Figure 23

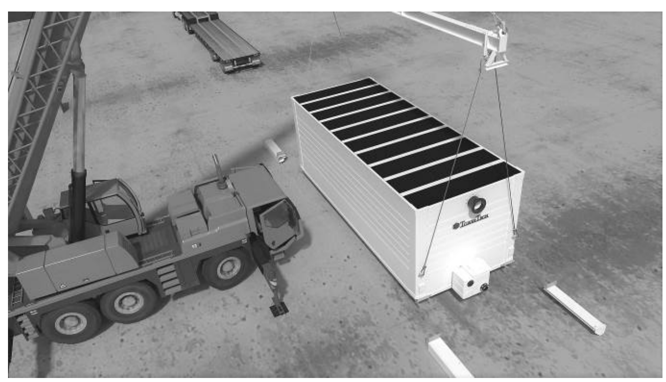


Figure 24

2. Lay each of the four legs on the ground with the hinge pointing up (Figure 24).

3. Align each leg bracket with the tower bracket and hang threaded bolt (Part A) by inserting into the slotted hinge (Part B) locations (Figure 25 and Figure 26).

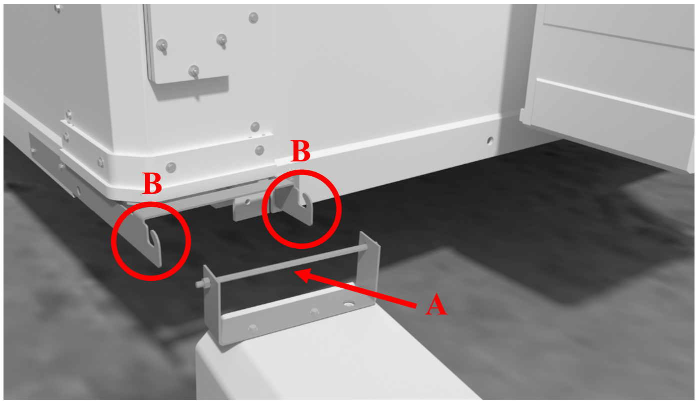


Figure 25

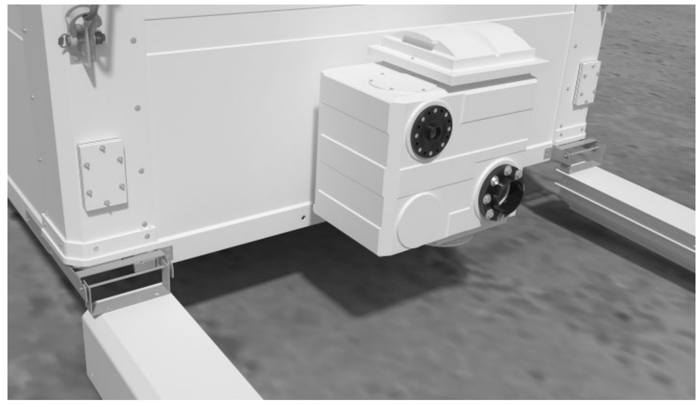


Figure 26

4. Distribute the leg braces around the tower. Lift the tower approximately 5' above the ground and attach the leg braces to the tower with the braces hanging down with two braces at each corner (Figure 27).

Figure 27

Figure 28

5. Lift the tower until the legs swing fully into position and then lower the tower until the legs are fully engaged in the molded corner part. Insert two ½"x6" bolts into the top of each leg to secure it to the molded corner part. Swing the tower braces into position and secure them to the tower legs with the 1" bolts (Figure 28).

Seismic rated towers may have additional bracing that can be installed after these initial braces. All bolts should be finger tightened only until the tower is set in its final position and squared and plumbed. After setting, tighten all bolts to recommended torques. Do not over tighten as excess torque may crush the fiberglass.

5.4.2 Installation of Sub-Structures (No Folding Bracket) 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 cooling tower'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 cooling tower 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 tower module can be lowered onto its main support beam, pier or pad after the legs and braces are attached. After setting the tower module 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.

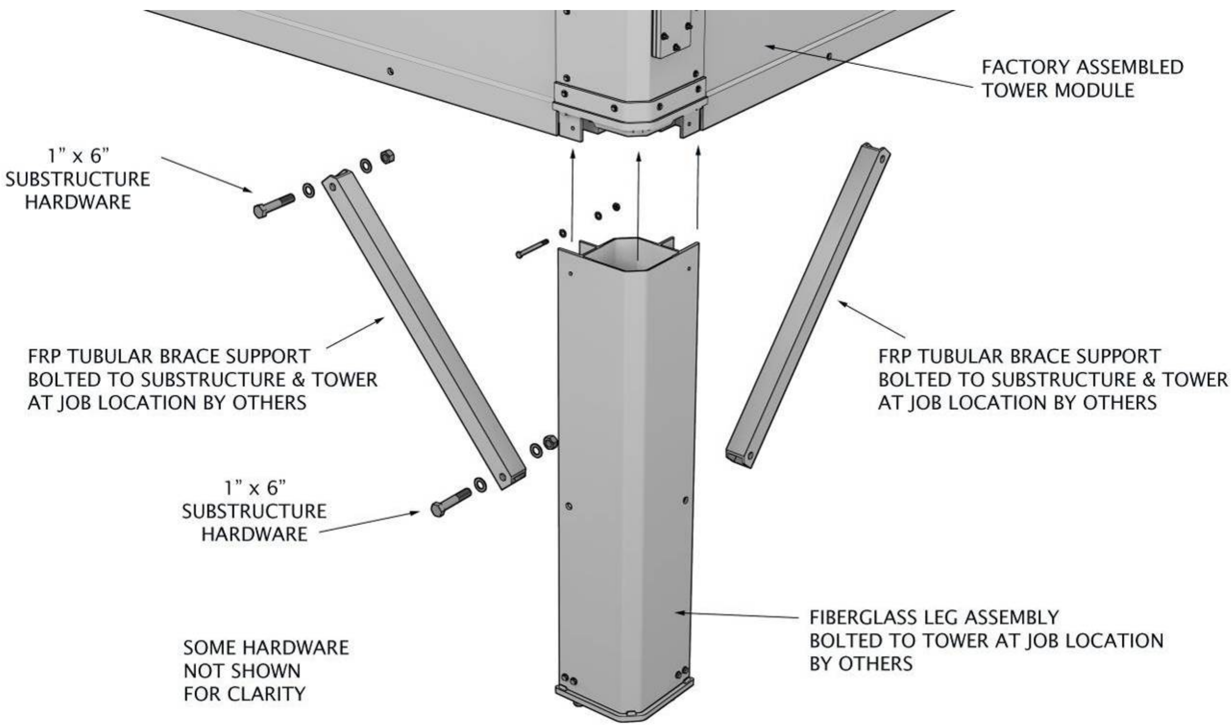


Figure 29 – Installation Detail for Sub-Structures Taller Than One Foot (30.5 cm)

5.4.3 Installation of One-Foot (30.5 cm) Sub-Structure (No Folding Bracket)

With the cooling tower 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 cooling tower'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 cooling tower module can be lowered onto its main support beam or pad. Upon setting the cooling tower verify that the tower 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.

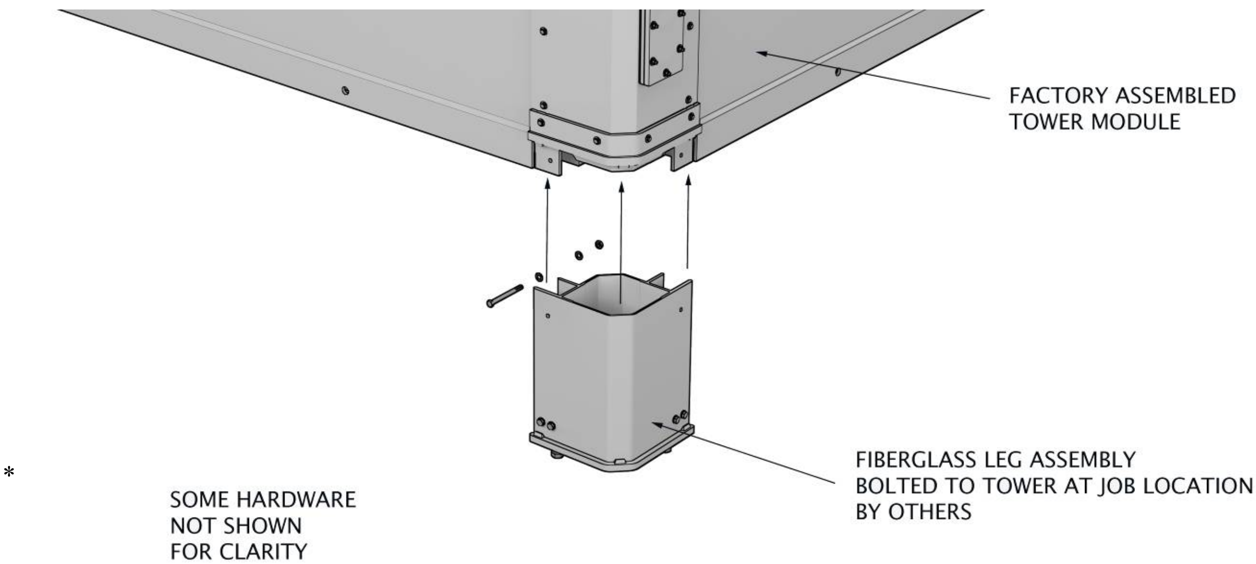


Figure 30 – Installation Detail for 1' Sub-Structure

5.4.4 Installation of Sub-Structure Footpad

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

1. Set the tower into position with each footpad on the anchor bolt or location anchor bolt will be installed. The size and length of the anchor bolt to be provided by a structural engineer. Refer to cooling tower submittal drawings for leg geometric properties. Tower Tech can provide seismic and wind loading calculations upon request for each tower

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 31.

2. Once the sub-structure leg is lowered onto its main support beam, pier or pad and the footpad is secured then verify the tower 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.

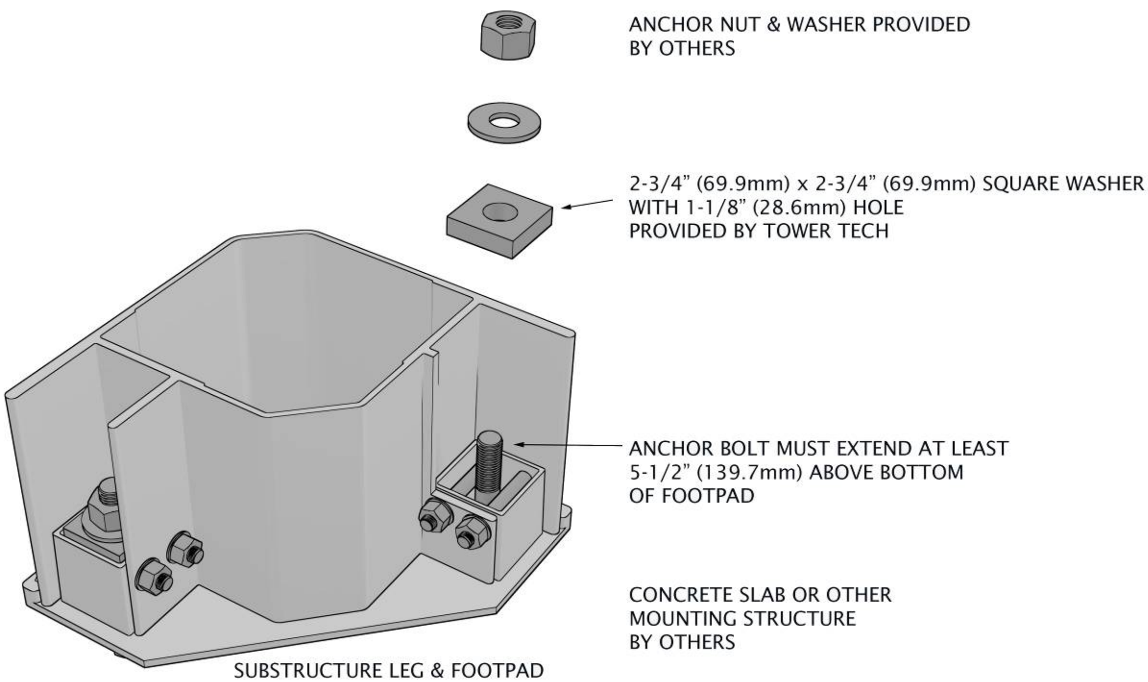


Figure 31 – Installation Detail for Sub-Structure Footpad

Chapter Six: Rigging and Handling

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

6.1 Introduction

Factory assembled TTXR Series Modular Cooling Towers shipped on flatbed trailers should be lifted directly from the trailer to the final point of installation. Sub-structure kit, motor control panel, or other optional equipment are 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 9).

The owner shall be responsible for lifting and placement of the tower. Owner shall furnish all incidental materials required for location of tower 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.

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

CAUTION All tower 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.

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

6.2 Accessory Location Checklist

Accessories will always ship on pallets and be shipped with the cooling tower 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 9 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	Boxed, bubble wrapped and palletized
RTD (Temperature Sensor)	Bubble wrapped inside Panel (T2100 or T9900 only)
Substructure Braces and Legs	Palletized and shipped on truck bed
Substructure Hardware	Boxed and palletized with substructure legs
Sump Hardware	Boxed and palletized if not pre-mounted on tower
T2100 Motor Protection Panel	Boxed and palletized if not pre-mounted on tower
T9900 Control Panel	Boxed and palletized on individual pallet
VFD Controls	Boxed and palletized on individual pallet

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

Table 9 – Accessory Location List

6.3 Procedure

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

DANGER **Never attempt to lift or move a tower module using a forklift as damage to the tower, 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 tower on a sound and level surface whenever ground storage is needed. Always use cribbing diagonally across each corner when setting the tower on the ground or other surface without substructure attached to prevent damage to the bottom side of the cooling tower.

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

2. Remove any excess water (rainwater, snow melt, ice) from the tower 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.

3. Inspect the lifting bracket attachment for cracks or loose hardware. Refer to Figure 32.

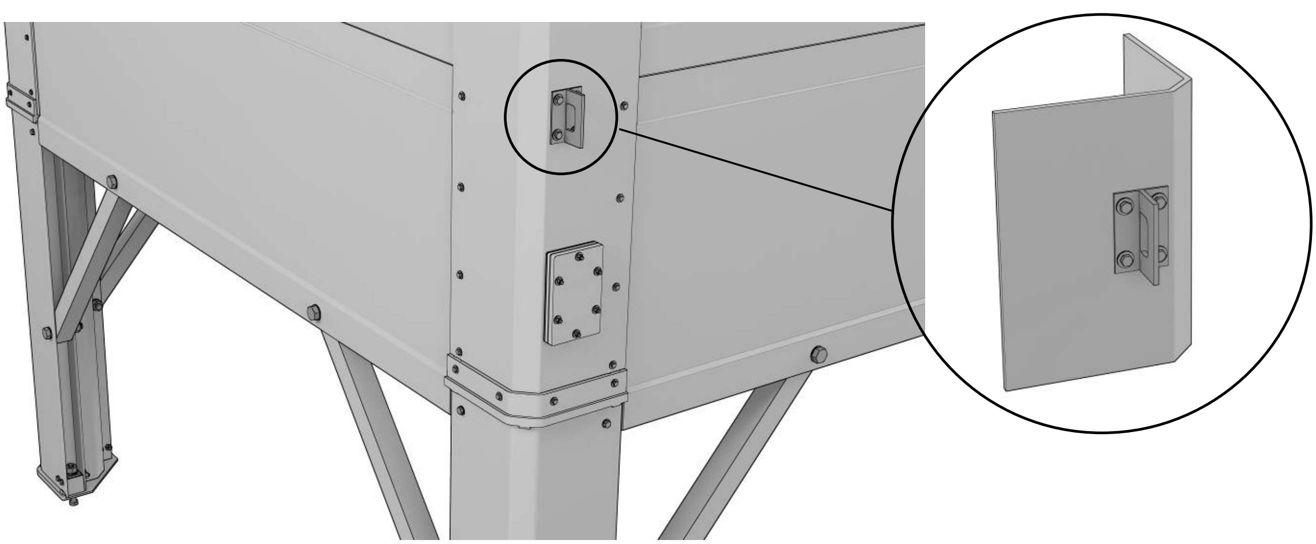


Figure 32 – Lifting Bracket

4. Prepare and position lifting item 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 34 and Table 9 for appropriate lifting cable length and the spreader beam length. Spreader bar must run the full length of the tower as shown in Figure 32 and not the short side of the tower. Recommended cable and beam lengths are designed to minimize side loading of tower walls. Position crane at the center of the tower, misaligned lifting will damage the tower shell and/or its water tightness.

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

6. Lower the tower 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 tower for plumb and stability then tighten all hardware at leg braces before detaching the crane.

8. Proceed with the tower startup operation.

Should the tower need to be transloaded or temporarily placed on the ground prior to its final positioning, the tower shall always be placed on a sound and level surface. Care shall be taken at all times not to distort or rack the tower 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 Based Supports (MBS) as shown in Figure 33 below.

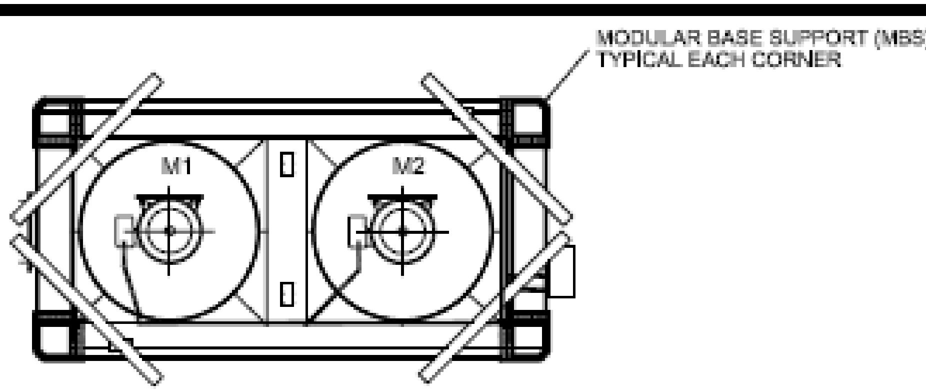


Figure 33 – Cribbing Detail

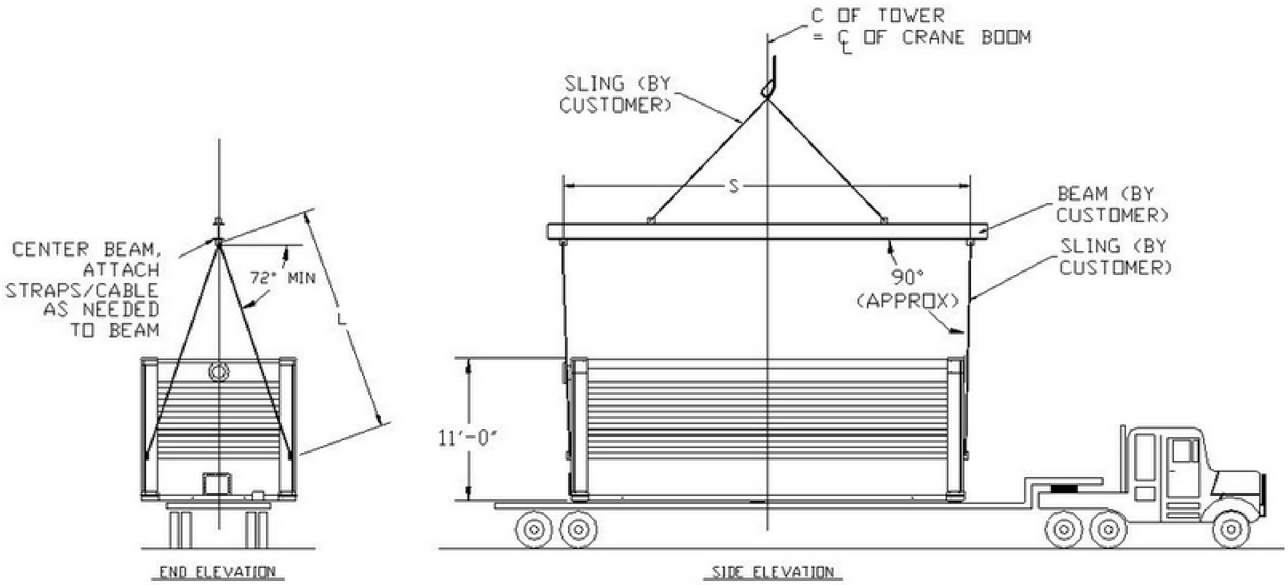


Figure 34 – Tower Lifting Procedure

TTXR Model	Tower Dry Weight in Lbs. * (kg)	L = Sling Length in Feet (cm)	S = Spreader Beam in Feet (m)
i1xxxx	3,450 (1,564)	20' (6.1 m)	8'-6" (2.6 m)
i2xxxx	4,360 (1,978)	20' (6.1 m)	14'-6" (4.4 m)
i3xxxx	6,155 (2,792)	20' (6.1 m)	20'-3" (6.2 m)
i4xxxx	7,950 (3,606)	20' (6.1 m)	26'-0" (7.9 m)
04xxxx	7,800 (3,538)	20' (6.1 m)	14'-6" (4.4 m)
i5xxxx	9,745 (4,420)	20' (6.1 m)	31'-9" (9.7 m)
i6xxxx	11,540 (5,235)	20' (6.1 m)	37'-6" (11.4 m)
06xxxx	10,775 (4,887)	20' (6.1 m)	20'-3" (6.2 m)
08xxxx	13,750 (6,237)	20' (6.1 m)	26'-0" (7.9 m)
10xxxx	16,855 (7,645)	20' (6.1 m)	31'-9" (9.7 m)
12xxxx	19,700 (8,936)	20' (6.1 m)	37'-6" (11.4 m)

* 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 10 – Tower Lifting Data

Chapter Seven: Tower and Peripherals Installation

7.1 Sump Attachment (Instructions for Optional Field Installation)

Sump box is attached to the cooling tower before shipping from the factory unless otherwise requested or required for jobsite installation.

CAUTION The sump must be installed before piping can be attached to the module. All piping from the sump must be self-supporting. Flexible coupling connection must be used. Failure to observe these directions may result in leaking or damage to the tower structure.

CAUTION If shipped separately, attach the sump to the cooling tower module AFTER the tower has been unloaded from the truck and the sub-structure legs have been securely attached.

7.1.1 Procedure (FOR FIELD INSTALLATION ONLY)

Refer to Figure 35.

1. Remove the two wooden plates from the sump flanges.
2. Remove the sump lid then remove contents packaged inside.
3. Check contents to verify that they are in agreement with packing slip and to ensure that all needed materials are present before proceeding with installation.
4. Do not remove nuts used to attach pipe spacers or the white pipe spacers. Refer to Figure 26.
5. Clean outside surfaces of both sump flanges, both the factory-installed flange (bolted to the tower wall) and the factory installed sump flange.
6. Apply a 3/8-inch (9.5 mm) bead of silicone to the perimeter of each flange.
7. Place the large rectangular gasket on the flange attached to the tower wall.
8. Place one 3/8-inch (9.5 mm) neoprene washer on each of the four all-thread rods. Orient the washer so that the neoprene faces towards the sump wall.

9. Place two 1/2” x 2” bolts in the two outer holes of the flange attached to the tower wall. Orient the bolts so that the head of the bolt faces towards the tower wall.

10. Lift the sump into position and align the two all-thread rods and the two 1/2” x 2” bolts into their corresponding holes.

11. Loosely attach and hand tighten each of the remaining twenty 1/2” x 2” bolts using one flat washer and one nut per bolt. Once all are loosely attached, begin to tighten them from the top center. Tighten to 30 ft. lbs.

12. Through the sump lid opening access, insert onto each all-thread rod, one 3/8-inch (9.5 mm) neoprene washer, one 2” x 1/2” x 8” (5.1 cm x 1.3 cm x 20.3 cm) FRP backer support, one washer and one nut.

⚠ CAUTION Two FRP backer supports are provided with one backer support having two holes accommodating the two left facing all-thread rods and the second backer support accommodating the two right facing all-thread rods. Sealant must be used between the backer support plate and the sump wall around each hole. **REFER TO FIGURE 35**.

13. Set sump screen at the bottom of the sump then attach the ball to the float valve arm using thread-locking adhesive, tape or other self-locking mechanism to prevent the ball from vibrating loose and falling off.

14. Replace sump lid.

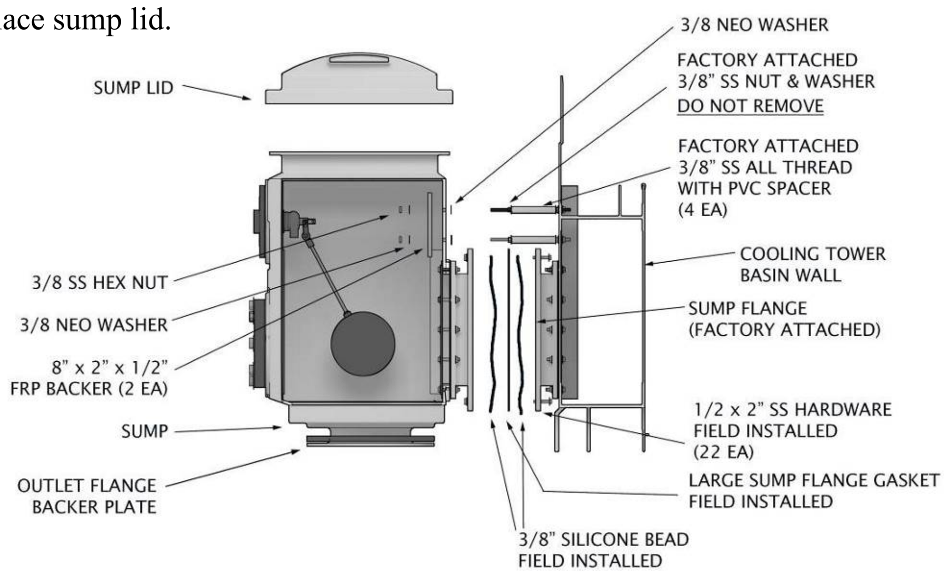


Figure 35 – Sump Installation Detail

7.2 Piping Connections

Standard piping connection locations on a TTXR module are illustrated in Figure 36. Standard dimensions are noted in Table 10. A description of each connection and its related function follows.

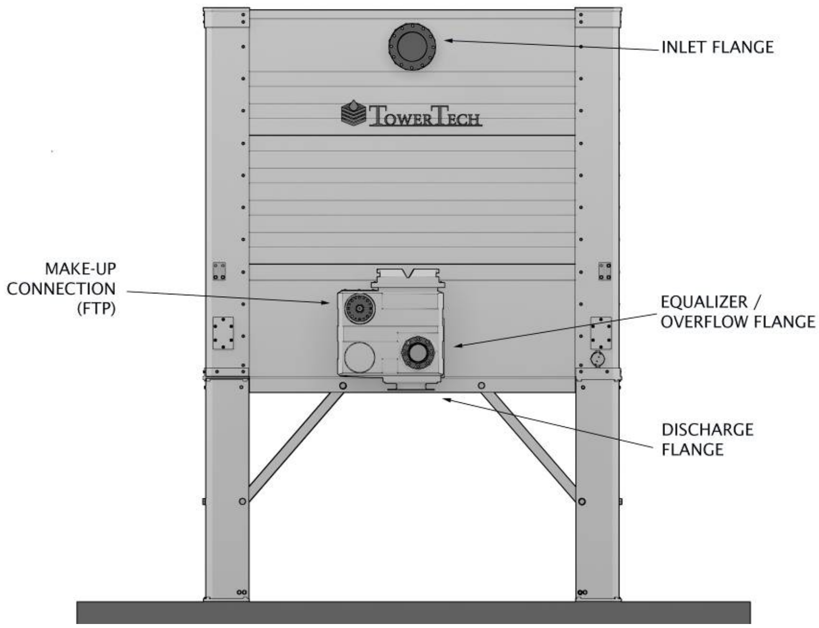


Figure 36 – Standard Piping Connections

TTXR Model	Connections (inches)			
	Inlet Diameter	Outlet Diameter	Make-Up Diameter *	Overflow/Equalizer Diameter
i1	4	8	1	4
i2	8	8	1	4
i3	8	8	1	4
i4	8	10	2	6
04	10	10	2	6
i5	8	12	2	6
i6	8	12	2	6
06	10	12	2	6
08	12	14	2	6
10	12	14	2	6
12	12	12 **	2	6

* The make-up valve located inside the sump box is designed to operate with an inlet pressure of **25 psi.** Install a pressure reducing valve if local supply pressure exceeds **25 psi.**

** TTXR-12 has two sump boxes with 12" outlets, however, only the first sump box make-up and overflow/equalization connection is needed. The second sump box will have plugged make-up flange and no overflow/equalization flange.

Table 11 – Standard Pipe Connections Data

⚠ 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 cooling tower 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.

7.2.1 Inlet Connection

The cooling tower inlet connection is located at the top of the module end wall. Tower Tech recommends the use of an appropriate flexible flange connection on the header inlet in order to better accommodate minor piping tolerances. Failure to use a flexible flange connection may result in damage to the tower structure, as well as adjacent piping. Final connections to the cooling tower module must be field fitted after tower installation to prevent pipe stress on the tower, 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 inlet pipe to regulate flow to each module and to provide a means of tower isolation. Design the header piping to the inlet connection for a maximum water velocity of 10 ft/s.

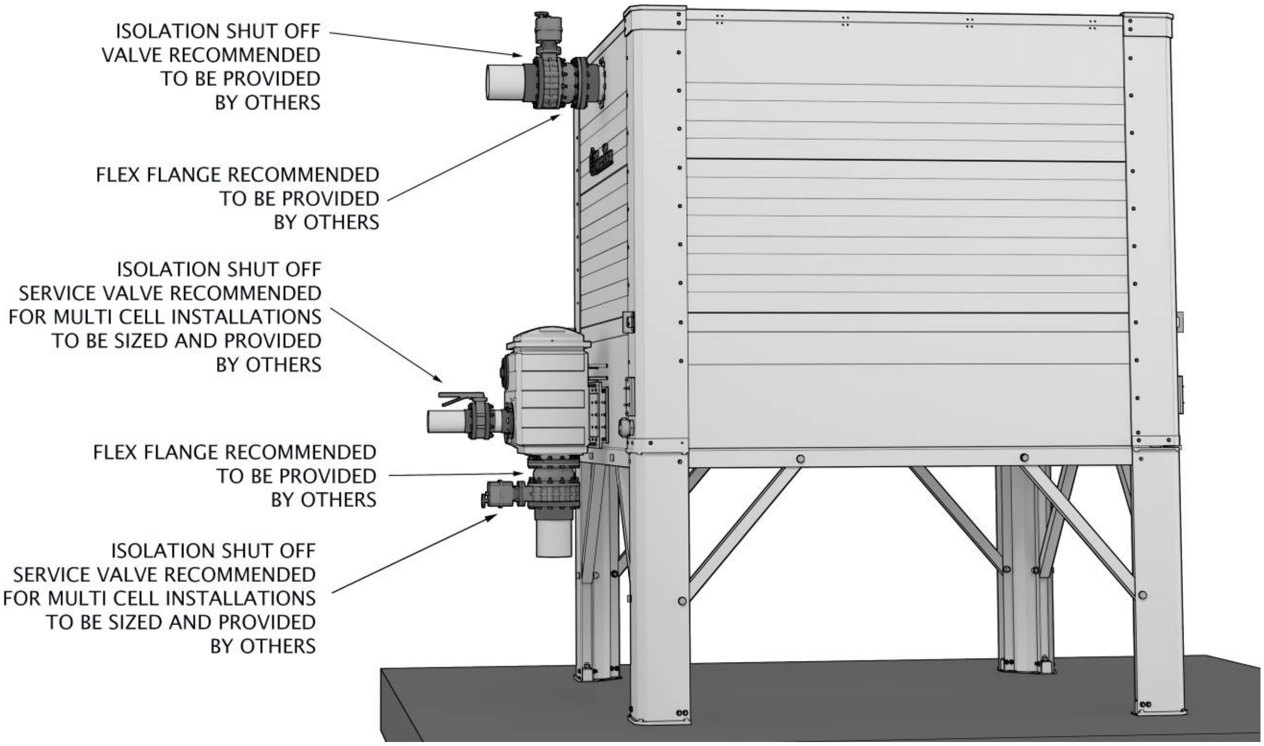


Figure 37 – Connection Flexible Flanges & Flow Control Valves

7.2.2 Discharge Connection

The discharge connection is located on the bottom of the sump. Design the discharge piping for a maximum water velocity of 6 ft/s to prevent excessive suction leading to potential pump cavitation. Velocities of 5 ft/second or less are preferred. Refer to Figure 38 for a detailed view of the discharge flange and its accompanying split ring. It is recommended that a shut-off valve be installed in the discharge pipe to regulate flow from each module. Tighten bolts to 30 ft. lbs.

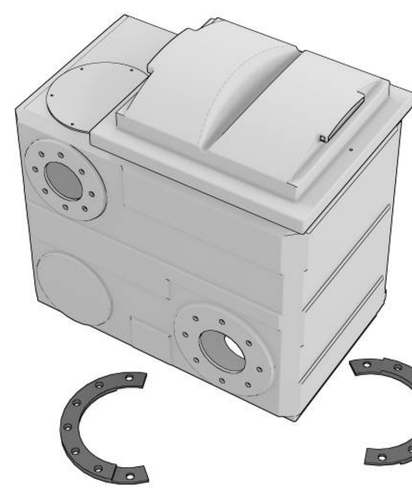


Figure 38 – Discharge Flange and Split Ring

7.2.3 Make-Up Connection

The standard make-up connection is located on the top left corner of the front of the sump. 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 sump box is designed to operate with an inlet pressure of 25 psi. **<u>Install a pressure reducer if local supply pressure exceeds 25 psi</u>.**

7.2.4 Overflow/Equalization Connection

The 6" overflow/equalization connection is located on the bottom right corner of the front of the sump. (Note: 1-fan, 2-fan and 3-fan tower modules have a 4" overflow/equalization connection.) In a single-module application, this connection serves as a basin overflow line. In a multi-cell application, this connection serves as a flow level equalization line, as well as a 6" overflow connection point. This 6" connection also serves as the mounting point if tower is equipped with optional electronic liquid level control equipment. Refer to Figure 39A, 39B or 40.

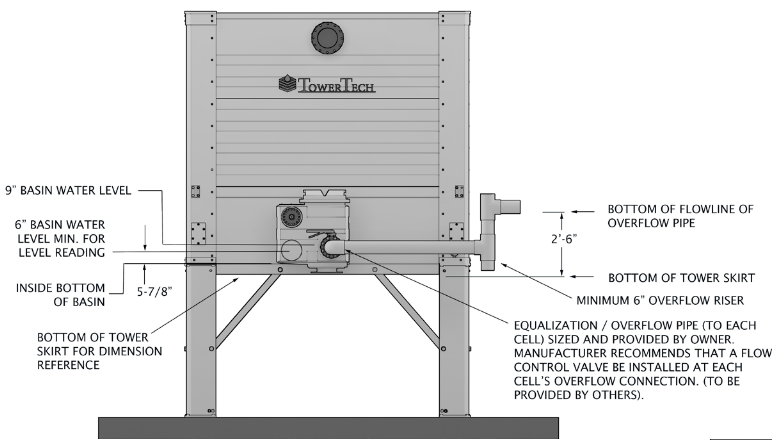


Figure 39A – Typical Overflow/Equalization Pipe

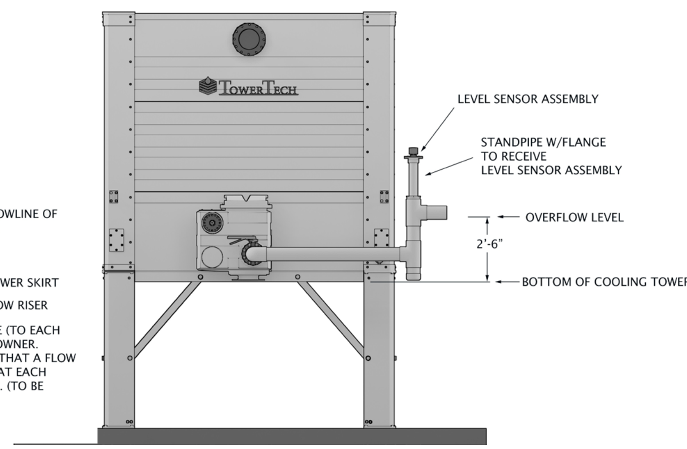


Figure 39B – Typical Ultrasonic Stand Pipe with Overflow

⚠ CAUTION In all cases, it is important that the overflow piping be at the specified level.

⚠ CAUTION All overflow lines must be equipped with a siphon breaker to prevent the module from being siphoned dry during overflow situations.

Figure 40 – Typical Overflow/Equalization Piping for large tower installations with Electronic Level Control.

Tower Tech recommends installing additional overflow pipe on multiple tower installations. An overflow pipe should be installed for every 4 modular towers.

Keep all vents clear and open. Stand Pipes must be heat traced and insulated in cold climates.

Chapter Eight: Tower Start-Up

CAUTION In addition to the tower module's standard sump screen, it is recommended that an additional fine-mesh construction/start-up screen be used during initial cooling tower start-up and after every service event. Placing this additional screen on top of the tower module's standard sump screen will help prevent any debris that may have entered the cooling tower during manufacture, shipment, storage, installation or service from being ingested into heat exchangers and other downline equipment. Monitor the construction/start-up screen for cleanliness approximately once hourly until satisfied that water stream is clear of debris. Clean and replace construction/start-up screen as needed.

To ensure all required parts are shipped with each TTXR Series Modular Cooling Tower, Tower Tech's Shipping Department uses a Sump Parts Packing Checklist when the sump box and hardware are not attached to the tower prior to shipping. Refer to Figure 41.

JOB NAME:				JOB NUMBER:	MODEL NO.:	TOWER#___.OF___.	
SUMP PARTS PACKING CHECKLIST							
Leg Kit: Used to connect the 1', 2', 4', 6', 8', legs to the bottom of the Base Support "on the 4 corners of the cooling tower".							
Part & Quantity Inspected	**OK?**	**Crew**	**Spvr**	**List Size**	**Reworked By**	**OK?**	**QC**
16= 1/2"X2 SS Bolts	Y / N					Y / N	
16= 1/2" SS Nuts	Y / N					Y / N	
32= 1/2" SS Washers	Y / N					Y / N	
4= Legs	Y / N			*Circle Size:* 1' 2' 4' 6' 8'		Y / N	
2= Mid Leg, *If applicable*	Y / N					Y / N	
Brace Kit: Used to connect the brace to the tower leg and the bottom tower. (only for Tower legs of 4', 6', & 8')							
Part & Quantity Inspected	**OK?**	**Crew**	**Spvr**	**List Size**	**Reworked By**	**OK?**	**QC**
16= 1" X 2 1/2" SS Bolts	Y / N					Y / N	
16= 1" SS Nuts	Y / N					Y / N	
32= 1" SS Washers	Y / N					Y / N	
8= 4 x 4 x 64 1/4" FRP Brace	Y / N					Y / N	
Mid Leg Kit: Used to connect the Mid Leg to the center of the cooling tower. (Only for 10 Fan Unit).							
Part & Quantity Inspected	**OK?**	**Crew**	**Spvr**	**List Size**	**Reworked By**	**OK?**	**QC**
12= 1" X 2 1/2" SS Bolts	Y / N					Y / N	
12= 1" SS Nuts	Y / N					Y / N	
24= 1" SS Washers	Y / N					Y / N	
Sump Kit: Used to connect the Sump Box to the flange on the cooling Tower.							
Part & Quantity Inspected	**OK?**	**Crew**	**Spvr**	**List Size**	**Reworked By**	**OK?**	**QC**
1= Sump Box Size	Y / N			*Circle Size:* 8" 10" 12" 14"		Y / N	
1= Makeup Flange	Y / N			*Circle Size:* 0" 1" 2"		Y / N	
1= Overflow Flange	Y / N			*Circle Size:* 0" 4" 6"		Y / N	
1= Sump Split Ring 2 Pcs	Y / N			*Circle Size:* 8" 10" 12" 14"		Y / N	
1= 8" Black Plastic Float Ball	Y / N			*Provide only for Makeup Valve*		Y / N	
1= 10" Brass Stem	Y / N			*Provide only for Makeup Valve*		Y / N	
22= 1/2" x 2" SS Bolts	Y / N					Y / N	
22= 1/2" SS Nuts	Y / N					Y / N	
44= 1/2" SS Washers	Y / N					Y / N	
4= 3/8" SS Nuts	Y / N					Y / N	
8= 3/8" SS Washers	Y / N					Y / N	
8= 3/8" SS Neos	Y / N					Y / N	
2= FRP Sump Spacers	Y / N					Y / N	
1= SS Sump Screen	Y / N					Y / N	
1= Tube Clear Silicone	Y / N					Y / N	
1= Large Sump Gasket	Y / N					Y / N	
Comments:							
				Supervisor Approval:	Date:		

QC5027-1 Effective: 12/24/03

Figure 41– Sump Parts Packing Checklist

PAGE 2

JOB NAME: **JOB NUMBER:** **MODEL NO.:** **TOWER#__.OF__.**

SUMP PARTS PACKING CHECKLIST

Paper Kit: Used for Instructions.

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
1= Operation Manual *(One copy per Job)*	Y / N					Y / N	
1= CD OM *(One copy per Job)*	Y / N					Y / N	
1= Submittal Drawings *(One copy per Job)*	Y / N					Y / N	
1= Copy of the Sump Parts Packing Checklist *(One per Tower)*	Y / N					Y / N	

Rapid Link Kit:

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
1= *(If required)*	Y / N					Y / N	

Basin Heater Kit: Used to heat the Module Cooling Tower water.

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
Basin Heater Controller w/sensor (Quantity varies per Job) *Check Drawings*	Y / N			*Circle Quantity:* 1 / 2 / 3 *Circle one:* With Disconnects / Without Disconnects *Circle one:* 208v / 460v		Y / N	
Heater Element(s)	Y / N			*Circle Quantity:* 1 / 2 / 3 / 4		Y / N	
2" SS Heater Flange *(On Tower)*	Y / N			*Circle Quantity:* 1 / 2 / 3 / 4		Y / N	
3/4" Sensor Flange *(On Tower)*	Y / N			*Circle Quantity:* 1 / 2 / 3 / 4		Y / N	
1= Heater Manual *(If Required)*	Y / N					Y / N	

Flowline Kit: Special Optional Equipment.

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
1= Microspan (Flowline Sensor)	Y / N					Y / N	
1= A.L.C. 52 (flowline Controller Box)	Y / N					Y / N	
1= 6" Vanstone Flange	Y / N					Y / N	
1= 6" Blind Flange w/ Threaded 2" Hole and regular 1" Hole	Y / N					Y / N	
1= Flowline Hardware Kit	Y / N					Y / N	

Comments:

Supervisor Approval: Date:

QC5028-1 Effective: 12/24/03

Figure 41 – Sump Parts Packing Checklist (Continued)

PAGE 3

JOB NAME: **JOB NUMBER:** **MODEL NO.:** **TOWER#___.OF___.**

SUMP PARTS PACKING CHECKLIST

Control Panel:

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
1= Control Panel	Y / N			*Circle One:* 208v / 460v		Y / N	
1= Temp Controller (Optional)	Y / N			*Circle One:* With Temp / Without Temp		Y / N	
1= Temp Probe (Optional)	Y / N			*Provided only for Temperature Controller*		Y / N	
1= Control Panel Manual	Y / N					Y / N	

Optional Equipment:

Part & Quantity Inspected	OK?	Crew	Spvr	Size & Type	Reworked By	OK?	QC
	Y / N					Y / N	
	Y / N					Y / N	

Note: If a box is marked B/O for back order on any item, contact the Tower Tech Shipping Dept. Manager @ 405. 979.2125 for the status of the B/O shipment. **All items shipped by Tower Tech have been inspected and counted prior to shipment. All request for missing or incorrect items must be reported on this form by fax within 24 hours of delivery. All request after the 24 hour period will be handled on a billable basis.**

Comments:

TOWER TECH™
The Technology Company

MODEL

SERIAL NO.

DATE MFG.

MANUFACTURED UNDER U.S. PATENTS:
5,227,095 5,143,657 5,152,458 5,487,849 5,487,531 5,545,356 5,958,306
Other Patents Pending
Tower Tech, Rotary Spray Nozzle, SmarTTower, and Water Drop Logo
Are All Trademarks of Tower Tech, Inc.
Tower Tech, Inc., P.O. Box 891810, Okla. City, OK 73173 Phone (405) 290-7788

	Supervisor Approval:	Date:

QC5029-0 Effective: 04/22/03

Figure 41 – Sump Parts Packing Checklist (Continued)

The assistance of a factory-certified startup technician is required to help ensure initial startup of TTXR Series Modular Cooling Tower is performed in accordance with factory procedures. Factory authorized startup is mandatory for warranty validation. Factory-certified startup technician will use the following checklist for startup, and for classroom and field training of cooling tower operators and maintenance staff. Refer to Figure 42 and 43.

Figure 42 – Start-up, Warranty Activation, Owner/Operator Training Checklist

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Company Name: ______________________________ Project: ______________________________

Address: ____ Date: __________________

City: _______________________ State: _____________ Zip Code: ________ Country: ________

Company Contact Names: ____

Cooling Tower Model: _______________________ Cooling Tower S/N: _ ______________________

Ship Date: _____________ Module Number _____ of ______ Total Number of Modules on Site: __________

Warranty Terms: ____

GENERAL–PRE WATER / FAN STARTUP

Item	Good	Needs Attention	N/A
Inspect Sump Installation – Ref. IO&M 7.1			
Have construction screens been installed?	☐	☐	☐
Is there a watertight seal on sump flange gaskets?	☐	☐	☐
Are the sump flange bolts secure?	☐	☐	☐
Is the fiberglass backing plate sealed?	☐	☐	☐
Are appropriate nuts and bolts coated?	☐	☐	☐
Verify Piping & Headers are self supported – Ref. IO&M 5.3.4			
Is piping independently supported, separate from the tower?	☐	☐	☐
Verify Piping Connections – Ref. IO&M 7.2			
Is check valve installed?	☐	☐	☐
Is there a control / isolation valve (hot water)?	☐	☐	☐
Is there a control / isolation valve (cold water)?	☐	☐	☐
Is the overflow / equalization piping installed according to IO&M?	☐	☐	☐
What is the height of the Overflow Pipe from bottom of Tower:_________________			
Does the make-up line have maximum 25psi (PRV) and is it sealed to the fitting?	☐	☐	☐
Is the inlet / outlet piping installed according to IO&M limits?	☐	☐	☐
Inlet Piping Size:___________________ Outlet Piping Size__________________			
Verify Electrical Components & Wiring – Ref. Submittals			
Lockable disconnect present within sight of cooling tower?	☐	☐	☐
If Tower Tech Panel is not installed, is there individual motor overload protection?	☐	☐	☐
Verify Proper Direction of Fan Rotation	☐	☐	☐
Verify All Electrical Terminations Tight & Secure			
Verify field wiring from motors to J-box (or Disconnects)	☐	☐	☐
Verify power feed(s) to tower Control Panel	☐	☐	☐

Comments ____

____

____

Inspected By **Date** **Company**

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ____________________ **S/N** ____________________ **Date:** ____________

ELECTRICAL / FANS

Fan Startup / Hand Mode (Without Water Flowing)

Set HOA switches to OFF	Good	Needs Attention	N/A
Initiate Power to Control Panel	☐	☐	☐
Verify settings for Thermal Overload Protection.	☐	☐	☐
Turn on Motor Disconnects.	☐	☐	☐
Verify that the fan motor resets are not tripped.	☐	☐	☐
Bump Fans in Sequence / Verify Fan Rotation.	☐	☐	☐
Operate fans in HAND MODE.	☐	☐	☐
Power up the rest of the fan sets in 1-minute intervals in HAND mode.	☐	☐	☐
Verify Water Collector Dampers open properly?	☐	☐	☐

Voltage & Amperage Measurements (readings must be taken across the line with all fans operating)

	Voltages (AC)				Amperages			
	L1-L2	L1-L3	L2-L3	Total	L1	L2	L3	Total
Incoming Main								
Fan 1 (Starter)								
Fan 2 (Starter)								
Fan 3 (Starter)								
Fan 4 (Starter)								
Fan 5 (Starter)								
Fan 6 (Starter)								
Fan 7 (Starter)								
Fan 8 (Starter)								
Fan 9 (Starter)								
Fan 10 (Starter)								
Fan 11 (Starter)								
Fan 12 (Starter)								

PLC CONTROL PROGRAMMING	RECORDED INPUT VALUES
TEMPERATURE SET POINT:	
NUMBER OF FAN STAGES:	
ON DEADBAND TIME:	
OFF DEADBAND TIME:	

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________ **S/N** ____________________ **Date:** ________________

Fan Startup / Auto Mode	**Good**	**Needs Attention**	**N/A**
Switch HOAs to OFF – all fans stop	☐	☐	☐
Switch HOAs to AUTO – all fan contactors controlled by PLC	☐	☐	☐
Set Temp Set Point 10˚ F/C below current temp shown on LCD	☐	☐	☐
Verify Fan Staging Sequence	☐	☐	☐
Set Temp Set Point 10˚ F/C above current temp shown on LCD	☐	☐	☐
Verify Fan de-staging Sequence	☐	☐	☐
→ **Record amp / voltage readings for L1, L2, L3 for each motor.** NOTE: VFD must be in By-Pass Mode for these measurements	☐	☐	☐
→ **Set Temp Set Point to Operating Value – Ref. Submittal Drawings**	☐	☐	☐
Inspect the sump screens for start-up debris.	☐	☐	☐
Verify air is exiting top of tower modules, not blocked	☐	☐	☐
VFD			
Verify connections between VFD & Control Panel			
Verify all 4-20mA control wires are twisted shielded pair cable grounded on one end	☐	☐	☐
Verify VFD Operation of Fan Motors	☐	☐	☐
Record VFD Settings & Operational Values (VFD Startup Checklist)	☐	☐	☐
VFD Startup completed by VFD Certified Technician	☐	☐	☐

VFD Inspected by ______________________ Printed Name ______________________
Signature

Cell Phone ____________ Office Phone ____________ Email ____________________

Company ______________________________ Main Phone ____________________

Address: ______________________________ Fax ____________________

City ________________ State ______________ Zip ______ Country ________

Comments (include VFD Brand, Model # and qty. if not provided by Tower Tech): ________________

____

____

____

Electrical Inspected By

Printed Name ___________________________ Company ______________________

___________________________ Date ______________________
Signature

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________ **S/N** ____________________ **Date:** ________________

WATER STARTUP & FLOW

	Good	Needs Attention	N/A
Filling System – Ref. IO&M 8.1			
Verify Makeup Water Level – **Ref. IO&M 8.2 *Basin level:*** ______________	☐	☐	☐
Startup Valve Settings – Ref. IO&M 8.3.1, 8.3.2			
Hot Water Control / Isolation Valve set for soft start-up, **Ref. IO&M 8.3.1 & 8.3.2**	☐	☐	☐
Cold Water Control / Isolation Valve(s) open, **Ref. IO&M 8.3.1 & 8.3.2**	☐	☐	☐
Overflow / Equalization Valve Open	☐	☐	☐
Bypass Water Valve Open - Water Flowing to Cooling Tower	☐	☐	☐
Water Level Control – Ref. IO&M 8.2			
Make-up Water Valve Open	☐	☐	☐
Circulating Water - Single Pump Operation			
Verify Water Level Control – **Ref. IO&M 8.2**	☐	☐	☐
→ **Slowly Open Hot Water Control / Isolation Valve.**			
→ **Slowly Close Bypass Valve.**			
Verify Water Flow Values – **Ref. Submittal Drawings**	☐	☐	☐
Verify Water Collector Operation	☐	☐	☐
Verify Nozzle Operation, (Visually)	☐	☐	☐
Record Final Valve Settings & Flow Values	☐	☐	☐
Circulating Water - Multiple Pump Operation			
→ **Start Additional Pumps After Basin Level Recovers** (Approx 5-Min. Intervals)			
Verify Water Flow Values – **Ref. Submittal Drawings**	☐	☐	☐
Verify Water Collector Operation	☐	☐	☐
Verify Nozzle Operation (Visually)	☐	☐	☐
Balance Hot, then Cold Water Flow across tower modules – **Ref. Submittal Drawings**	☐	☐	☐
Verify Water Level Control – **Ref. IO&M 8.2**	☐	☐	☐
Is Chiller Operational with Load? What Brand Chiller: ____________________	☐	☐	☐
→ **Add Heat Load**			
Verify Water Flow Values – **Ref. Submittal Drawings**	☐	☐	☐
Verify Water Collector System functions without water drips	☐	☐	☐
Record Final Valve Settings & Flow Values	☐	☐	☐

Comments ____

____

____

Inspected By **Date** **Company**

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________ **S/N** ____________________ **Date:** ________________

GENERAL STARTUP

	Good	Needs Attention	N/A
Verify basin walls, seams & joints.	☐	☐	☐
Verify all water flanges & gaskets for water tightness.	☐	☐	☐
Verify tower footpads are securely anchored per IO&M	☐	☐	☐
Verify all braces are securely fastened to legs	☐	☐	☐
Verify all Fan Guard Screens are securely fastened	☐	☐	☐

Comments ____

____

BASIN HEATERS

	Good	Needs Attention	N/A
Electrical –before Energizing			
Verify Electrical Components & Wiring – **Ref. Submittal Drawings**	☐	☐	☐
All Wiring Terminations tight & secure	☐	☐	☐
All Heater Element Conduit Openings are Sealed	☐	☐	☐
Pump/Flow Interlock Installed (Prevents Heater Operation with Flowing Water)	☐	☐	☐
Electrical –After Energizing			
Verify that Heater Elements Do NOT Energize with Flowing Water	☐	☐	☐
Verify that Heater Elements Do NOT Energize without water in Basin	☐	☐	☐
Verify Amp draw of Heater Element	☐	☐	☐
Follow all procedures - Basin Heater O&M Manual	☐	☐	☐

Comments ____

____

____

Start-up Inspector ______________________________ Printed Name ______________________________
Signature

Company _________________ Phone____________ Cell ____________ Email__________________

Customer ____________________________________ Company ____________________________
Signature

____________________________________ Date _____________ Email___________________
Printed Name

Office Phone ________________________ Cell ______________________ Fax _________________

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

SITE PLAN DETAILS (sketch or insert pictures of cooling tower installation)

ELEVATION OF TOWER & SURROUNDING BUILDING/EQUIPMENT (Include Measurements)

PIPING DETAILS

COMMENTS:____

____

____

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________ **S/N** ________________ **Date:** ______________

OWNER & OPERATOR TRAINING

		Good	Needs Attention	N/A
1.	Each attendee has seen the cooling tower and its controls beforehand.	☐	☐	☐
2.	Each attendee has signed in on Tower Tech's Sign-In Sheet.	☐	☐	☐
3.	Tower Tech sales video has been shown to each attendee.	☐	☐	☐
4.	Chapter-by-chapter discussion of IO&M Manual has been completed.	☐	☐	☐
5.	Q&A session has been completed at the conclusion of training.	☐	☐	☐

Names of Attendees: ______________________ ____________________________

____________________ ______________________ ____________________

____________________ ______________________ ____________________

____________________ ______________________ ____________________

____________________ ______________________ ____________________

Comments ____

Trainer ______________________ Printed Name ________________ Date__________
Instructor Signature

Company _____________ Tel ____________ Cell _________ Email______________

Customer ____________________________ Printed Name ______________________
Signature

Company _________________________ Date __________ Email_______________

Office Phone _________________ Cell __________________ Fax _______________

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________ **S/N** ________________ **Date:** _____________

WARRANTY REGISTRATION FORM

Registration Date ________________ Work Order # ________________

Customer ____________________ Serial # ________________

End User ____________________ Control Panel S/N ______________
(Tower Location if different than customer)

Tower Ship Date ________________ Warranty Term ________________________
(Tower Tech to complete)

Address__________________________ City ________________ St ____ Zip_______
(Tower Location)

Contact ___________________ Tel _________________________ Fax __________
(At Tower Location) (Office / Cell, At Tower Location)

Email___________________ Other ____
(At Tower Location)

Start-up Completion Date __________ By ____________ Tel/ Email____________________

O & M Training Completion Date __________ By _______________ Tel/ Email ____________

Comments:

____

____

____

____

____

Acknowledged by: ____________________________ Filed ____________ By________
Tower Tech Warranty Manager Signature & Date Date Initials

Figure 43 – VFD Startup Checklist

TOWER TECH

Tower Start-up, Warranty Registration, Owner/Operator Training Checklist

Project: ______________________________ **S/N** ______________________ **Date:** ___________________

VFD/Building Management Information

VFD

	Yes	No
Who manufactured the VFD: ________________________________		
Model #: ____	☐	☐
VFD HP Rating: ___________ VFD AMP Rating: _______________	☐	☐
Does the VFD have Bypass Feature?	☐	☐
Is there a single VFD per Tower Tech module?	☐	☐
If multiple VFD's per module, how many? ______________________		
Briefly describe how multiple VFD's are wired to control the fans:		
Is all of the control wiring shielded twisted pair and grounded on one end only?	☐	☐
Is the power wiring in separate conduit from control wiring and grounded on both ends?	☐	☐
Is a Tower Tech control panel installed with the VFD?	☐	☐
Please provide picture of control panel internals if not Tower Tech?	☐	☐
Are Line Filters installed on the VFD?	☐	☐
Are Load Reactors installed on the VFD?	☐	☐
Is there a Building Management System in operation?	☐	☐
If Yes, who is the manufacturer: _______________________________________		
Communications protocol (BACnet, LONworks, etc…): _____________________		
Is the Building Management connected through:	Ethernet/IP ☐	RS485 ☐
Is Remote Enable/Disable Active?	☐	☐
Is Remote Temperature Set Point Active?	☐	☐
Is Tower Tech RTD installed and used?	☐	☐
Has the control loop been fine tuned?	☐	☐

Voltage & Amperage Measurements (In VFD Mode at 60hz)

	Voltages (AC)				Amperages			
	L1-L2	L1-L3	L2-L3	Total	L1	L2	L3	Total
Incoming Main								

NOTES:

8.1 Filling System with Water

1. Open make-up valve(s) and allow basin(s) and piping to fill to the tower overflow.

2. Check all flanged connections and piping for leaks.

3. Bleed air from piping by opening bleed valve at pump until water flows out in a steady stream without interruption.

4. Close bleed valve.

8.2 Controlling Water Level

The TTXR Series Modular Cooling Tower utilizes either an electronic solenoid valve (optional) or mechanically (standard) controlled float valve located in the sump to maintain water level in the tower module. Refer to the instructions provided by the manufacturer to properly calibrate the water level for electronically controlled system. Note: Standard mechanical level control is pre-set at factory and should not require modifications to the setting.

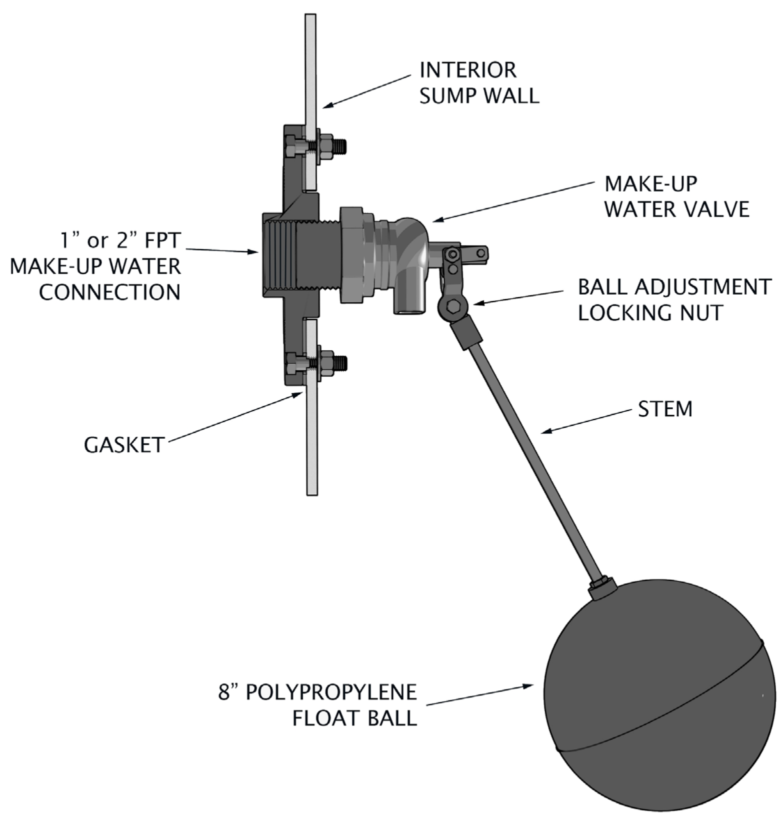


Figure 44 – Mechanical Float Valve

Use the following procedure to set the mechanical float valve. Refer to Figures 44 and 45.

1. Close make-up valve(s).
2. Remove sump lid and make-up valve access cover and set aside. Check sump water level. The proper water level should be within the range of the standard operating level specified in Figure 38.
3. Loosen the locking nut on the adjustment bolt for the Ball Stem specified in Figure 44, then loosen the bolt itself. Do not remove the bolt.
4. Rotate arm and stem to desired water level.
5. Tighten adjustment bolt and nut.
6. Restore water supply and verify that the water level is at the desired operating level.
7. Replace sump lid and make-up valve access cover.

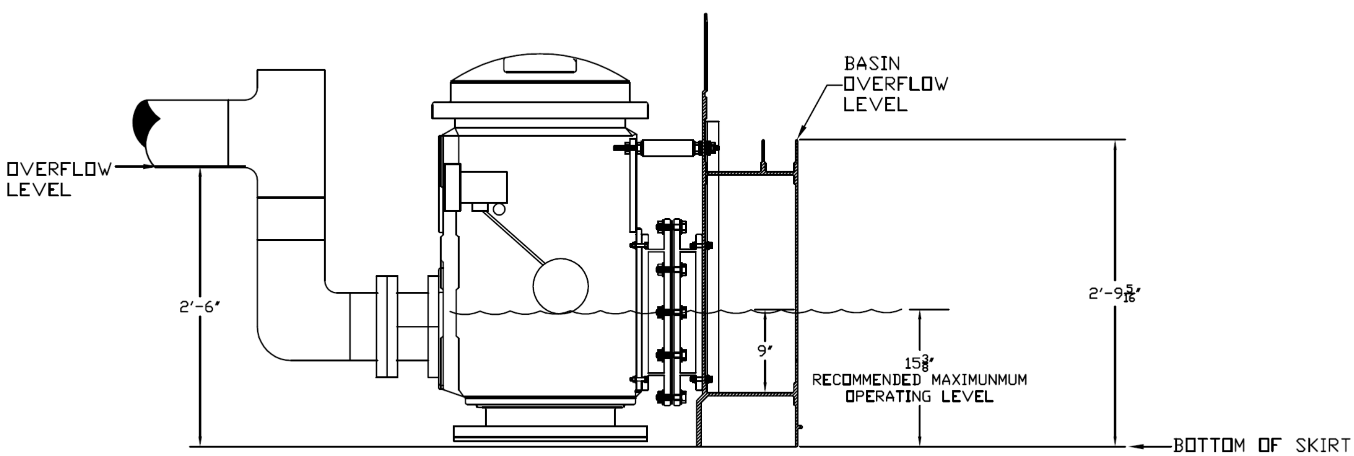


Figure 45 – Sump Level Control Detail

⚠ CAUTION Operating below recommended operating level of 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, and fill, and NOT any of the water in piping outside the cooling tower. 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 Water Collection System.

8.3 Hydraulics

Refer to Table 12 for respective tower hydraulic data.

Criterion	TTXR Model										
	i1	**i2**	**i3**	**i4**	**04**	**i5**	**i6**	**06**	**08**	**10 ***	**12 ***
Minimum Flow Rate GPM (m^3/hr) **	100 (27.3)	200 (45.4)	300 (68.1)	400 (90.8)	400 (90.8)	500 (113.6)	600 (136.3)	600 (136.3)	800 (181.7)	1,000 (227.1)	1,200 (272.5)
Maximum Flow Rate GPM (m^3/hr) **	300 (81.8)	600 (136.3)	900 (204.4)	1,200 (272.5)	1,200 (272.5)	1,500 (340.7)	1,800 (408.8)	1,800 (408.8)	2,400 (545.1)	2,700 (613.2)	3,000 (681.4)
Basin Capacity U.S. Gal (m^3)	316 (86.2)	535 (2.02)	810 (3.07)	1,085 (4.11)	760 (2.88)	1,235 (4.67)	1635 (6.19)	1,050 (3.97)	1,325 (5.02)	1,600 (6.06)	1,920 (7.27)

* Flow rate above 2,700 GPM necessitates the use of two sumps per tower module.

*** 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 12 – Tower Hydraulic Data

8.3.1 Single Pump Operation Procedure

This procedure describes water level balancing for an installation that is operated by a single system pump.

1. Open the make-up valve(s) to the module(s) to the full open position.

2. Open inlet water valve(s) to the module(s) approximately fifty percent (50%) open.

3. Start pump.

4. Allow system to operate until the sump float valve(s) closes to allow the make-up water to replenish the water removed from the basin(s) by the pump.

5. If the pump surges, shut off the pump, close the make-up valve(s), and adjust the sump float valve(s) to a higher setting.

6. Open the make-up valve(s) to the module(s) to the full open position. Repeat Steps 1 through 3.

7. Verify the operating level in the module(s) is within the specified range (refer to Figure 45 after the system has equalized.

8. Shut off pump and check sump water level for overflow.

9. If the sump overflows, close the make-up valve(s), lower the float valve(s) setting, and repeat Steps 1 through 8.

8.3.2 Multiple Pump Operation Procedure

> **⚠ CAUTION** Tower Tech cooling towers are designed for variable flow rates so pumps can be sequenced On and Off according to system load requirements. In certain applications, if pumps are not staged properly, pump surging, chiller shutdown, and/or water overflow into the fan shrouds could occur. Allow 10-15 minutes staging between start/stop of pumps to allow system time to balance water level.

To balance the water level in a multiple pump system:

1. Open the make-up valve(s) to the module(s) to the full open position.

2. Open inlet water valve(s) to the module(s) approximately fifty percent (50%) open and start one pump.

3. Allow the system to operate until the sump float valve(s) closes to allow the make-up water to replenish the water removed from the basin(s) by the pump. If the pump surges, shut off the pump, close the make-up valve(s), and adjust the sump float valve(s) to a higher setting. Repeat Steps 1 through 3.

4. Open the inlet valve(s) to the module(s) to the full open position and start the second pump. Repeat Steps 3 through 5.

5. Start remaining pumps one at a time by repeating Steps 3 through 5.

6. Verify the operating level in the module(s) is within the specified range after the system has equalized.

7. Shut off one pump.

8. Open drain valves on pumps to simulate evaporation.

9. When sump float valve(s) on module(s) opens, shut off second pump.

10. Shut down remaining pumps one at a time as the sump float valve(s) opens.

11. Close pump drain valves.

12. Check sump water level for overflow. If the sump overflows, shut off the make-up valve, lower the float valve setting, and repeat Steps 1 through 11.

8.3.3 VFD Pump Operation Procedure

To balance the water level in a VFD pump system:

1. Open the make-up valve(s) to the module(s) to the full open position.

2. Open inlet water valve(s) to the module(s) to the full open position and start one pump with a slow ramp time of 1-2 minutes.

3. Allow the system to operate until the sump float valve(s) closes to allow the make-up water to replenish the water removed from the basin(s) by the pump. If the pump surges, shut off the pump, close the make-up valve(s), and adjust the VFD ramp up to a longer time. Repeat Steps 1 through 3.

4. If the pump continues to surge then close the make-up valve(s), adjust the sump water level to a higher setting and repeat Steps 1 through 3.
5. Open the inlet valve(s) to the module(s) to the full open position and start the second pump. Repeat Steps 3 through 5.
6. Start remaining pumps one at a time by repeating Steps 3 through 5.
7. Verify the operating level in the module(s) is within the specified range after the system has equalized.
8. Shut off one pump with same ramp down time as set for ramp up time.
9. Open drain valves on pumps to simulate evaporation.
10. When sump float valve(s) on module(s) opens, shut off second pump.
11. Shut down remaining pumps one at a time as the sump float valve(s) opens.
12. Close pump drain valves.
13. Check sump water level for overflow. If the sump overflows, shut off the make-up valve, lower the float valve setting, and repeat Steps 1 through 11.

8.4 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 TTXR tower, 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 counter-clockwise direction and push air upwards. Use a qualified electrician to interchange two of the three electrical wires to the motor to correct the rotation if rotation is incorrect.
4. Start each fan and measure the motor amperage. The amperage should not exceed the motor nameplate rating, with service factor, as given in Table 1.

> 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 the fan staging control to ensure that fans cycle properly. Refer to Section 9.3.

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

8.5 Flow Balancing

It is often necessary to balance the water flow entering each cell or pair of cells in multi-cell installations. Tower Tech requires a professional flow balancer set and certify that flows are balanced and correct for cooling towers being started up. Remove a section of drift eliminators from the top of each cell to view the water distribution. Flow balancing can be simplified by using isolation valves in both the inlet and discharge piping systems of each module. A typical flow balancing problem and its solution are given below using Figure 39.

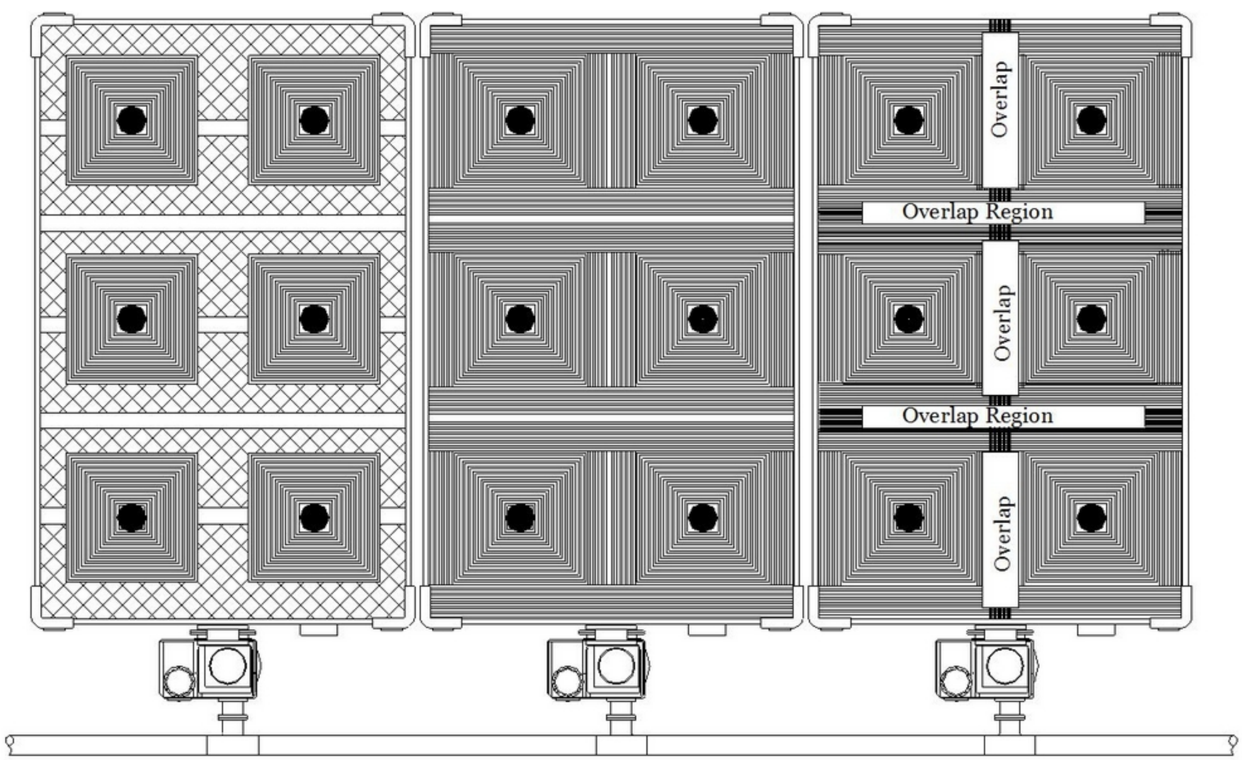


Figure 46 – Typical Flow Balancing Problem

Flow Balancing Problem:

Cell #1 (L to R) does not have enough water flow resulting in dry void regions.
Cell #2 has the correct water flow.
Cell #3 has too much water flow resulting in regions of overlapping spray pattern.

Flow Balancing Solution:

Close inlet valve to cell #3 slightly until cells #1 and #3 are like cell #2. It may then be necessary to re-adjust cells #2 and #3.

> Rule of Thumb: Always begin flow adjustments with the cell that has the heaviest water flow.

It is recommended that the flow to each tower be balanced using a flow-metering device, such as an ultrasonic meter, as small variations in flow rates may not be visually detectable. These small variations, however, may not allow some towers to function properly, reducing the thermal performance of the system. Once all inlet valves have been adjusted so that each tower receives the same flow rate, some attention must be paid to the tower water levels to insure they are consistent.

In multi-cell installations, pressure differentials in the piping system may cause variations in the water levels of subsequent towers. To equalize these pressure differentials, some adjustments to the discharge piping valves, if equipped, may need to be made. By adjusting the discharge piping valves, the water levels can be equalized, eliminating variations in system performance. These adjustments, however, must be made by qualified personnel to ensure tower performance is not jeopardized.

> Tower Tech requires a professional flow balance report be provided to insure the pump(s) are properly operating to provide proper flow to the cooling tower(s).

Chapter Nine: Operation

Due to the TTXR Series Modular Cooling Tower's advanced design there are several operational conditions that will allow efficiency levels not possible in a conventional cooling tower.

9.1 Water Flow Control

The TTXR Series Modular Cooling Tower's Spin-Free™ spray nozzle makes it possible to supply a varying range of water flow rates to a system. The optimum spray pattern for the nozzle is obtained without significant variation in spray pattern or distribution characteristics when operated from 40 GPM to 75 GPM, which is the approximate upper limit established by tower module hydraulics. Somewhat higher flows may be possible in some tower module sizes; contact Tower Tech engineering manager for specifics. Due to the spray nozzle's design, reduced flow rates during part load conditions can be distributed to all towers eliminating the need to shut down individual modules. This allows each module's fill media surface to be fully utilized increasing the efficiency of the system. By ensuring full and continual water coverage of the fill media, scaling is notably reduced. (**The Spin-Free™ spray nozzle's rotor disc may spin below 25 GPM however this could cause uneven wear of nozzle components.** The rotor disc will spin freely with flow 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 will result in a slightly larger spray pattern. **Operation above 100 GPM may result in uneven wear of nozzle components.**) Flow rates below 25 GPM and above 100 GPM per nozzle are not allowed.

> ℹ Fill media will scale when allowed to intermittently dry out. Scaling affects cooling tower performance.

> **⚠ CAUTION** Restarting the cooling tower without resetting inlet isolation valves to 25% may result in water hammering and cause damage to the tower's hot water distribution system header, laterals and or nozzle components.

9.2 Water Temperature

The PVC fill media and PVC hot water distribution system standard in TTXR Series towers are designed for tower entering hot water temperatures not exceeding 140°F in continuous operation. For applications having hot water temperatures of up to 150°F in continuous operation, HPVC fill media and a CPVC hot water distribution system are required.

9.3 Fan Control (without VFD)

Cooling and cost savings benefits may be obtained from cycling the fans on a cooling tower. With the Tower Tech design, each module has a combination of fans that can be staged on or off depending on cooling load requirements. By allowing the total water flow volume in a system to circulate through all the modules rather than just a few, cooling efficiency is increased because of the utilization of the total fill surface area. This increase in efficiency also allows the total fan horsepower usage to be further reduced by eliminating the need for some of the fans to run at low usage times of operation.

With part-load conditions occurring during the majority of the year (namely, spring and fall, or colder seasons), energy savings associated with these conditions can prove very significant. In most geographic climates, full-load conditions occur during less than 10% of the year. Because part-load conditions occur more frequently, efforts to improve system efficiency during these periods can have significant payback rewards.

The Optional Control Panel provides a simple pre-engineered solution for proper control of the fans. It comes complete with a temperature sensor for mounting in a remote thermal well in the discharge water piping of the cooling tower or in the sensor flange provided in the tower module near the discharge sump. The sensor provides the Programmable Logic Controller (PLC) within the panel with the leaving Cold Water Temperature for comparison with the set point for the CWT.

⚠ CAUTION RTDs should be installed in the centerline of a horizontal section of suction piping and no more than 12’ from the cooling tower’s attached sump outlet flange.

The PLC software program controls the staging of the fans to achieve the current set point and match the current load. The fans must be cycled ON and OFF in adjacent pairs (except for the i-Line series tower which has a single row of fans), always starting the off-line fans nearest the sump end of the module first and then working toward the “back” end of the module in adjacent pairs. Fans are cycled OFF in reverse order, with the fans farthest from the sump end stopping first (last on, first off). Failure to cycle fans in this order will result in water blow-by and leakage above the off-line fans nearest the sump end of the tower.

When operating the tower module with a variable-frequency drive (VFD), for maximum efficiency and performance all fan motors should be operated all of the time at the same speed, and individual motor overload protection MUST be provided. Tower Tech motors operated by VFD can be ramped down to a minimal speed of 6hz but Tower Tech recommends a minimum operating speed of 10hz for the best efficiency and energy savings.

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

For an in-depth discussion of the advantages of variable flow cooling tower operation, refer to section 2.5.

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.

9.4 Cold Weather

9.4.1 Tower Offline During Cold Weather

Any TTXR Series Modular Cooling Tower 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 tower cold water basin must be drained. To drain, remove any of the four Inspection Ports located at each tower module's corners. (Tower modules manufactured after October 2009 also have two Inspection Ports located on the bottom of each Mid-Basin. A tower module manufactured after October 2009 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 tower in opposite corners of basin channel. To ensure each tower module drains completely, remove any Mid-Basin Inspection Port Cover in each tower module, or any 2" plastic plug in each tower module.) Refer to Figure 47. **Refer to Section 9.4.2**.

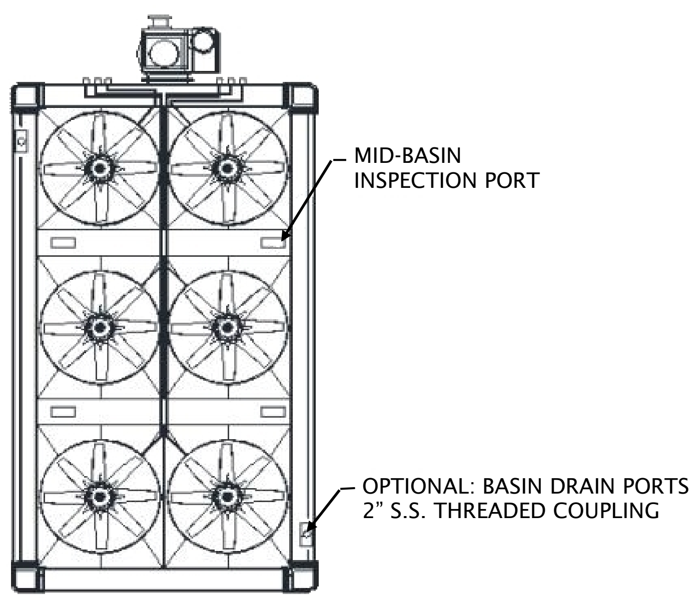


Figure 47 – Mid-Basin Inspection Ports (6-fan tower module shown)

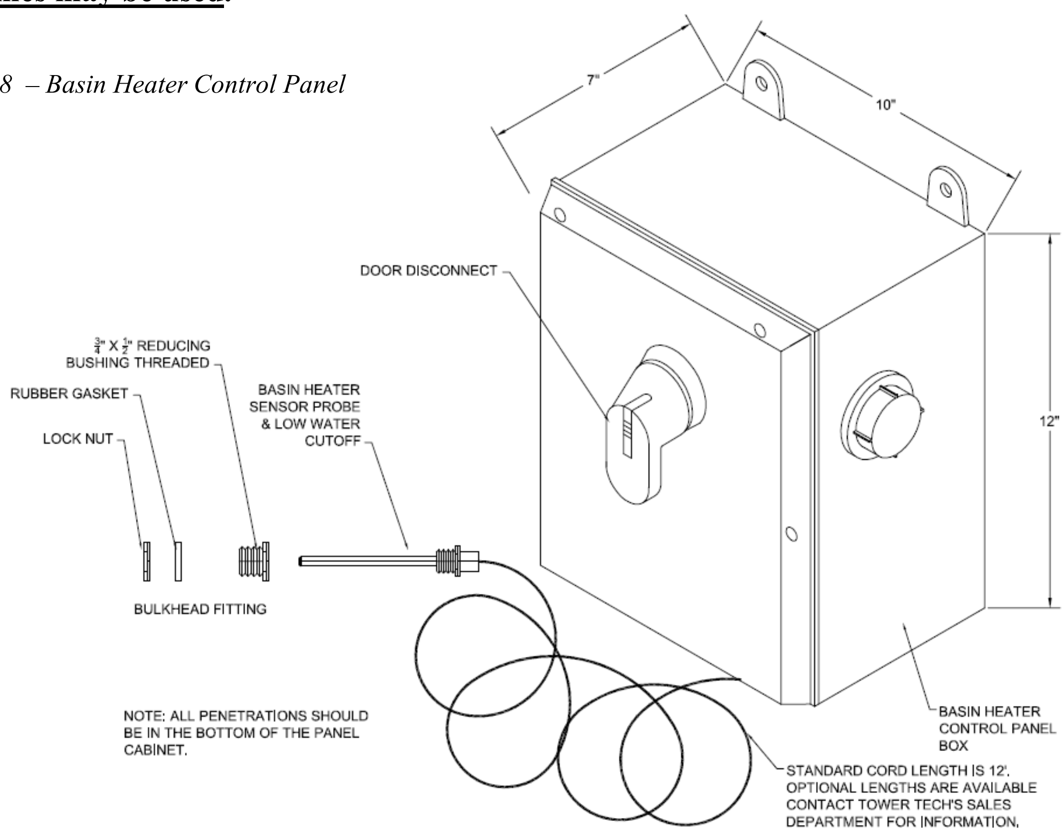
9.4.2 Cold Weather Operations

When the tower will be out of service for an extended period the basin must be drained of water. Drains are to be located in the tower's supply and discharge piping. Also refer to Section 9.4.1. Leave the drain valves open to prevent rain or snow from collecting in the basin, and disable the basin heater. When the cooling tower needs to be shut down without draining the basin, it is recommended that one or more optionally available basin heaters be installed.

Any cooling tower that operates in cold weather may experience freezing. Overflow/equalization piping and stand piping must be heat-traced and insulated. Additionally, a Tower Tech Modular Cooling Tower requires a specific sequence of steps to optimize operations in cold weather: To minimize ice formation and accumulation, the flow rate through each Spin-Free™ spray nozzle must be 50 GPM or greater, and tower leaving water be maintained at or above 45°F when ambient temperature is below 25°F.

In freezing conditions it may be helpful to cycle the tower fans OFF periodically in an attempt to remove any ice from within the Water Collection System. Cycle fans OFF more frequently as ambient temperature decreases and tower leaving water temperature is reduced. When temperatures are above 20ºF ice accumulates more slowly and longer fan cycle times may be used.

Figure 48 – Basin Heater Control Panel



The temperature to which water can be cooled without freezing depends on the heat inside the tower module, which is a function of entering hot water temperature, leaving cold water temperature, temperature of air flowing through the tower and water flow. The TTXR Series Modular Cooling Tower with its absence of conventional air inlet louvers, and with its enclosed design and optional ability to stage fans on and off automatically, can often operate in cold weather without significant ice formation. However, it is recommended that VFD be used in lieu of fan staging to reduce air velocity through the cooling tower and thereby lessen the possibility of ice accumulation that could damage the fill media, the Water Collection System, the tower structure, and other components.

Maintaining water flow of 50 GPM minimum through each spray nozzle (and adhering to the other recommendations in this Chapter) when the ambient air temperature is at or below freezing will maintain sufficient heat in the tower module to prevent accumulation of ice inside or under the tower.

It is recommended that a Tower Tech factory engineer be consulted about cold climate operations and for other design assistance. Variable-frequency drives are especially beneficial in preventing tower icing in areas where the ambient air temperature falls below 25°F for extended periods and or where the cooling tower is expected to produce water colder than 45°F. The latter often occurs in applications where a cooling tower is expected to provide "free cooling" during cold weather operations.

Tower Tech recommends that a TTXR tower not be expected to produce water cooler than 45°F when the ambient air temperature falls below 25°F unless variable frequency drives are utilized, in which case it may be possible to achieve 43°F leaving water so long as the ambient air temperature remains above 10°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 It is necessary to flow a minimum of 50 GPM through each Spin Free Nozzle when the ambient air temperature is below freezing in order to maintain sufficient water flow rate inside the cooling tower module to prevent accumulation of ice inside the tower.

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

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

Optional Basin Heater – General Description

When operating a cooling tower in extreme 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 freeze up 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, as long as the elements are located 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 submersed, 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.

Locating Basin Heater Element(s) and Control Panel Enclosure

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. See Figures 17, 41, 42 and Tables 7A, 7B for information regarding the immersion basin heater control panel. 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.

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

3. 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 of 304 stainless steel. A NEMA-4X wire junction box is integral to the heater element cap. See Figure 17 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.

Optional 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.**

Optional Immersion Basin Heater: 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. The excessive water temperature could damage the cooling tower.

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 for 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 of time 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.

Optional 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.**

Optional 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 runs leading to the control panel, install a drain in the bottom of the control panel and form a conduit loop.

Optional 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 15, 32 and 33.

⚠ 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 17 and 49 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. Refer to Figure 49. Tighten the locking nut fully onto the sensor probe. Tighten the reducing bushing into the probe flange. Twist the probe in a counter clockwise 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.

Optional 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 water tight and secure. Pull the incoming power wire into the control panel enclosure and make the connections per the control panel-wiring diagram.

Optional 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 a tap rules in the NEC/CEC. All heater power wiring should have a temperature rating of 75º C, 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 water tight and secure. Pull the heater power wire into the control panel enclosure and make the connections per the control panel-wiring diagram. Conduit connections to multiple heaters should be run so that each individual heater is branched off of the run until the conduit terminates at the last heater. Jumpering from one heater to the next is not recommended.

Optional 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.

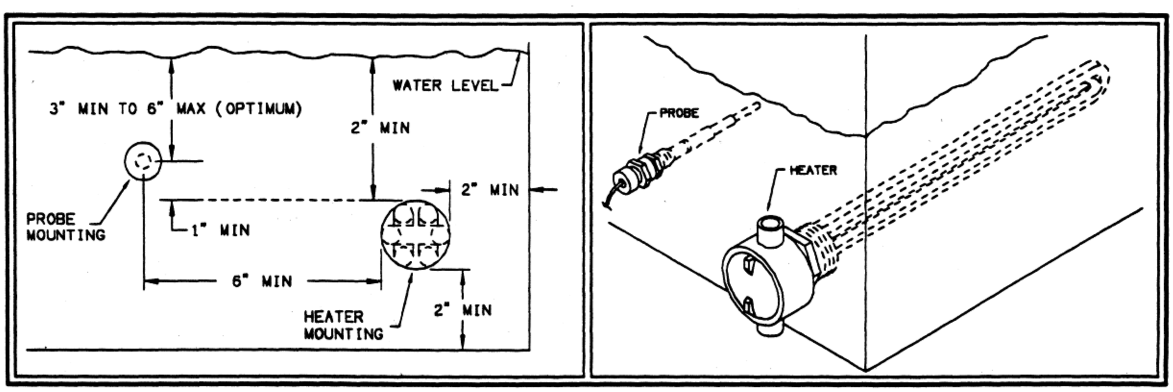


Figure 49 – Location of Basin Heater Probe & Element

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.

Optional Immersion Basin Heater: Start-Up and Annual Maintenance

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.

Optional Immersion Basin Heater: Troubleshooting, Startup and Maintenance Procedure

⚠ 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 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.**

Optional Immersion Basin Heater: Repair

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

Optional 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 per 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.

9.5 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 in order 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).

9.5.1 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 cooling tower thermal efficiency. Even minor visible scale accumulation on cooling tower fill (the tower's heat exchange medium) can prevent the even distribution of water as a thin film across the fill heat exchange surface. In the event that 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 fill 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.

Cooling tower water 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 TTXR Series Modular Cooling Tower and system equipment (e.g. heat exchangers, chillers, etc.): 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 tower's recirculating water conductivity (TDS) at a level which is 3-4 X that measured in the make-up water (applies to water's 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.

The TTXR Series Modular Cooling Tower'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 TTXR Series Modular Cooling Towers. In order 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.

⚠ CAUTION If acid is added to the cooling water loop it must be added using an injection quill positioned at the center of the return pipe to the tower and well upstream of the tower to ensure sufficient mixing **before entering tower module**. Failure to do so may result in damage to cooling tower components which are normally resistant materials.

⚠ CAUTION Cooling tower fill media and drift eliminators can be damaged by the use of some chemicals. Always use cleaning and water treatment chemicals in accordance with recommendations of a water treatment contractor.

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 towers. Alternative methods such as ozone must be used with stringent control as ozone radicals are known to embrittle PVC components such as fill media.

9.5.2 Solids Control

Undissolved solids are a measure of the insoluble substances found in suspension in cooling tower 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 TTXR Series Modular Cooling Tower's absence of side air louvers and open basins dramatically decreases the potential for undissolved solid entry into the circulating loop as compared with conventional tower designs. Further, the presence of a high velocity perimeter basin permits more effective use of centrifugal separators and other in-line filtration devices.

Undissolved solids serve as physical foulants which can plug fill thereby reducing tower efficiency, increase chiller head pressures (their deposition increases friction), and damage fill and shell structure by weight imposed. 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. de-sludgers, cyclones, centrifugal separators, strainers, filters (100 mesh or 150 um particle cut-off), pressurized media filters (sand/gravel beds good for most average industrial applications not exceeding 200 ppm and whose particulates do not exceed 10 um), and cartridge filters (for fine filtering 1 um or less, only chemical plants with stringent downstream requirements will need this; also HVAC systems incoming water 5 ppm or less) are used.

Solids removal is not a strict requirement for the TTXR Series tower unless 1) the tower is located in a high dust environment, or 2) the downstream process requires higher than normal quality process cooling water in which case it is recommended.

Blowdown does little in the way of reducing solid loads because there is little chance that particulates will be positioned near the tower's blowdown valve at the time blowdown or bleed occurs.

Cyclone or centrifugal separators, as well as other self-cleaning, impervious filtration technologies are preferred over media beds. The latter affords bacteria the opportunity to establish ecological niches insulating them from biocides.

9.5.3 Biological Control

Biological control is important both for safety (e.g. *Legionella*), thermal performance (*Pseudomonas* or slime formers can plug fill), and corrosion control (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) reasons.

⚠ DANGER **Cooling towers, as well as other water atomizing devices (such as 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 maintain a 0.5 ppm minimum residual chlorine level at all times.**

⚠ CAUTION **The tower 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 tower 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 so as to maintain a specific system concentration whilst the non-oxidizing chemical (DBNPA, Quats, glutaraldehyde, isothiazoline) 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 antimicrobially resistant sub-population will not occur. It is also recommended that a penetrant or biodispersant (see fouling section) be used in conjunction with the biocide program to enhance the ability of the oxidizing biocide to contact target microbes. This is particularly important if the tower is a process tower wherein organic leaks into the cooling loop are possible.

9.5.4 Corrosion Control

Corrosion control is necessary in TTXR tower systems not for preventing damage to the cooling tower itself, but rather to prevent damage to downstream piping and equipment. The cooling 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 noting: A good corrosion inhibitor must: 1) protect <u>all</u> 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 Ten: Maintenance

Adequate knowledge of the operation and maintenance of the Tower Tech TTXR Series Modular Cooling Tower 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 TTXR Series Modular Cooling Towers 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). Refer to Figure 43.

Figure 50 – 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.

10.1 Maintenance Schedule

TTXR Series Modular Cooling Towers 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 13 for recommended maintenance of TTXR components.

Table 13 – TTXR Maintenance Schedule

Component	Maintenance Frequency	Action To Be Taken	Reference Section
Shell Surfaces*	12 months	Visual Inspection	None
Drift Eliminators*	12 months	Visual Inspection	10.1.1
Fill Media	12 months	Visual Inspection	10.1.2
Spin Free Nozzles	12 months	Visual Inspection	10.1.3
Fan Guards*	1 month	Visual Inspection	10.1.4
Fan Blade Clearance*	1 month****	Visual Inspection	10.1.5
Fan Motors**	1 month**	Turn On Briefly	10.1.9
Fan Motors	12 months ***	Amp/Volt Check	None
Fan Motors*	6 months	Visual Inspection	10.1.9
Mechanical Float Valve*	3 months	Visual Inspection	10.1.10
Sump Screen*	1 month	Visual Inspection	10.1.11
Immersion Basin Heater	12 months (prior to cold season)	Visual Inspection	10.1.12
Water Collection System*	6 months	Visual Inspection	10.1.13

*	Items completed during a single walk around & under tower module, at specified intervals. Inspection time is expected to be completed in less than five minutes per tower module
**	Required only if tower is not operated regularly for an extended period of time.
***	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.

10.1.1 Drift Eliminators

TTXR Series Modular Cooling Towers 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 cooling tower.

Figure 51 – Sectional View of CF80-MAx Drift Eliminator

10.1.2 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 and Water Collection System while walking on them.

Inspect the cooling tower 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. If build-up is significant, it may be necessary to remove the fill media 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.

Figure 52 – Sectional View of CF1900 Fill Media 1'w x 1'h x 6'l

⚠ CAUTION Bacterial slime can contribute significant weight loads on the tower beyond that for which it was structurally designed. Damage to tower internals or shell due to bacterial growth excursion will void the TTXR Series Modular Cooling Tower warranty.

10.1.3 Spray Nozzle

TTXR Series Modular Cooling Towers 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 53).

⚠ CAUTION Optimal nozzle operating range is 40 GPM to 75 GPM. Damage to nozzles will occur if operated below 25 GPM and above 100 GPM. **NOTE**: Tower module hydraulic limits may be exceeded if nozzle is operated above 75 GPM; consult Tower Tech engineering manager before attempting operation above 75 GPM per nozzle.

Figure 53 – Exploded View of 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 not sold separately. Disassembly of spray nozzle voids nozzle warranty.

> **⚠ CAUTION** If a cooling tower module is valved out seasonally without adjusting flow rates across the remaining cooling tower modules, the spray nozzle's upper flow limit of 75 GPM may be exceeded and result in damage to the remaining online nozzles.

10.1.4 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 with convenient hinged access. 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 replace a fan guard (refer to Figure 54 for close-up of hinge hardware):

1. Turn off fan and lock and tag out power.
2. Remove the six 1/4” bolts that hold the screen angle to the tower mid basin and perimeter wall using a 7/16” wrench.
3. Unbolt the screen from the hinge by removing the three remaining 1/4” bolts.

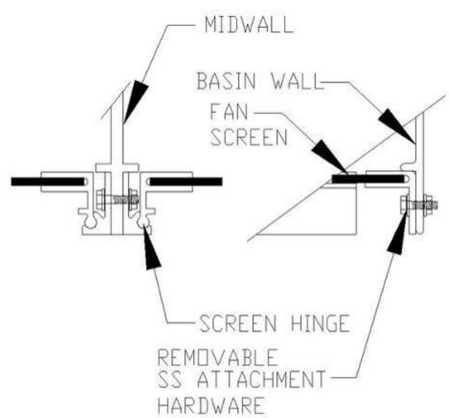


Figure 54 – Close-Up: Fan Guard Hardware

To lower a fan guard (refer to Figure 55A and 55B):

1. Turn off fan and lock and tag out power.
2. Remove the six 1/4” bolts that hold the screen angle to the tower mid basin and perimeter wall using a 7/16” wrench.
3. At this point you will have full access to the fan and motor.

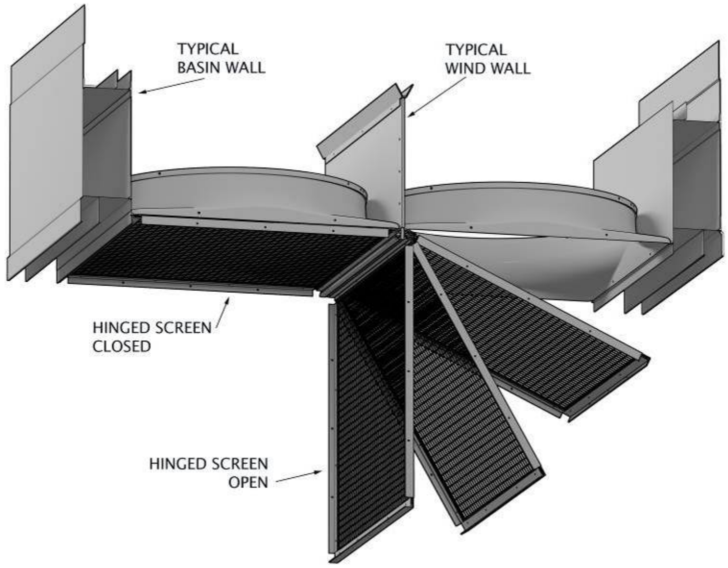


Figure 55A – Opening Full Screen Fan Guard

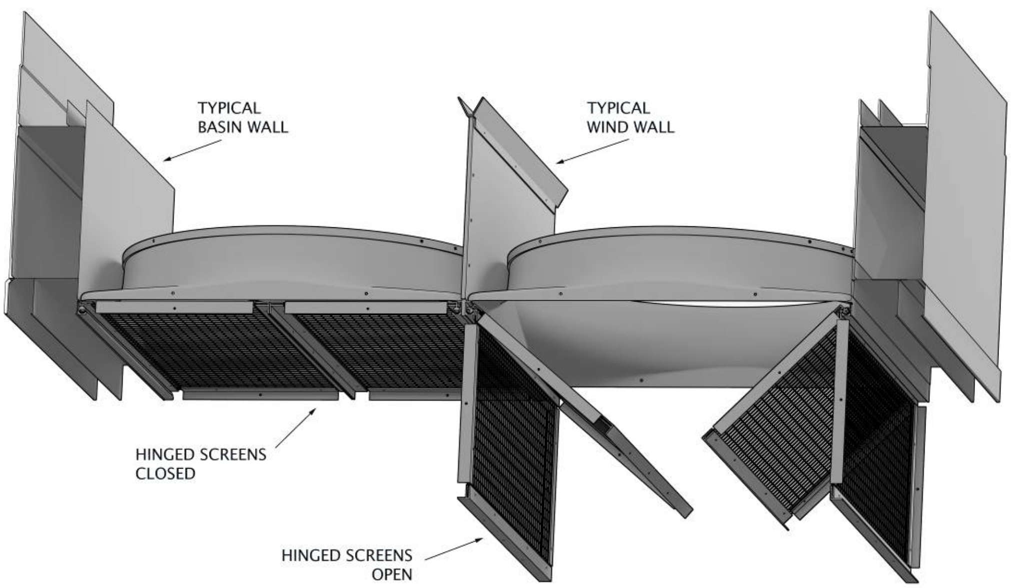


Figure 55B – Opening Split Screen Fan Guard

10.1.5 Fan Inspection and Replacement

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 monthly.

To remove a fan:

1. Disconnect power from motor, locking-out and tagging-out the motor/fan to be worked on.

2. Open 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.

10.1.6 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 thru 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 thru 19 from Checking & Re-Pitching Fan Blades (see Section 10.1.7).
4. Check fan balance and rebalance fan assembly if needed.

10.1.7 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 TTXR series cooling tower 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 of the parts to their original location.
7. Remove the center Uniboss 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 Uniboss 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 Uniboss 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 Uniboss 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.**

10.1.8 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. Open fan guard.
3. Remove fan.
4. Disconnect electrical wiring and conduit.
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.

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.

To install a motor, reverse the above procedure.

10.1.9 Fan Motor Lubrication

Standard motors on TTXR Modular Cooling Tower have sealed bearings. If the tower is not operated regularly for an extended period of time, the motors should be turned on briefly once each month. Refer to Table 13.

10.1.10 Mechanical Float Valve

To remove the float valve:

1. Remove sump lid and circular access plate.
2. Remove ball and rod assembly from the adjusting arm.
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. Screw rod and float to adjusting arm.
4. Adjust float for desired water level (refer to Figure 56 for details), then tighten adjusting bolt.

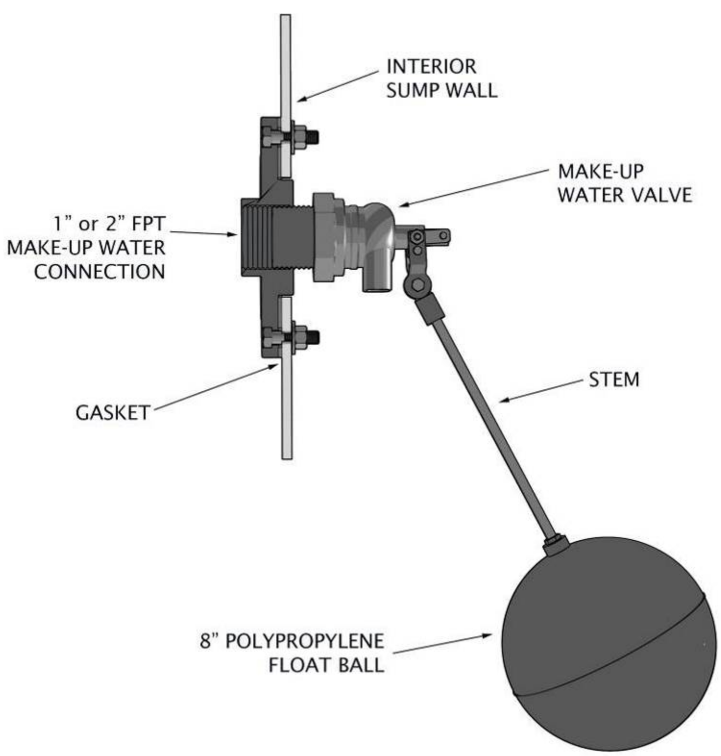


Figure 56 – Mechanical Float Valve

10.1.11 Sump Screen

It is important to visually inspect and document contents retrieved from the sump screen as it can provide valuable information in regards to 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 sump screen:

1. Shut off pump(s).
2. Remove sump lid.
3. Pull screen out of sump.
4. Empty contents of screen.

To install the sump screen, reverse steps 1 through 3. Refer to Figure 57.

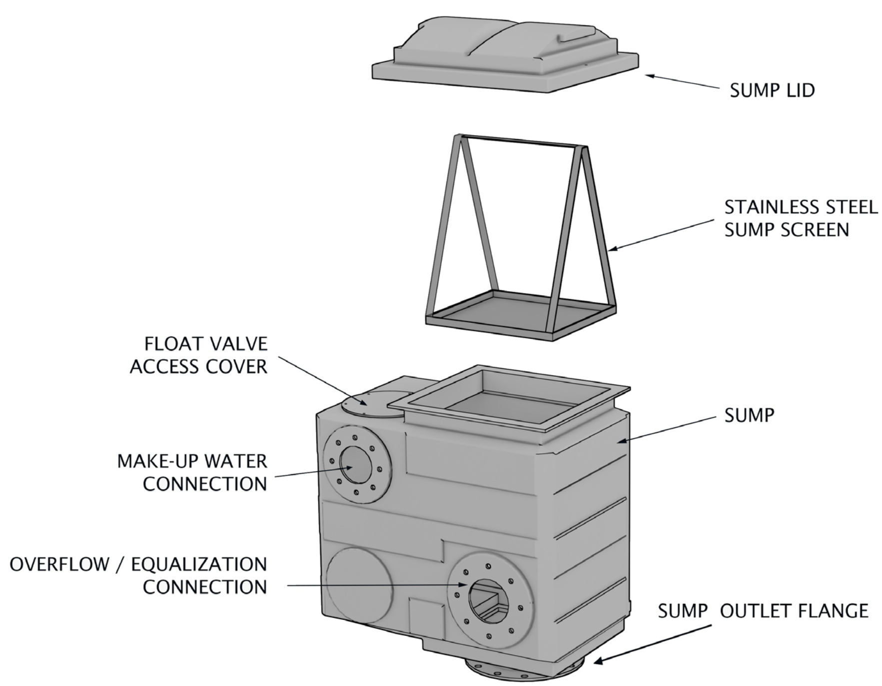


Figure 57 – Sump Layout, Sump Screen Detail

10.1.12 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.**

10.1.13 Water Collection System

The TTXR Series 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 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.

The TTXR Series Modular Cooling Tower's Water Collection System is designed so that adjacent fans must be operated in pairs. Thus, in a four-fan tower module, fans #1 and #2 should always operate simultaneously, and fans #3 and #4 should always operate simultaneously. The i-Line series modular towers have a single row of fans that aren't operated in pairs.

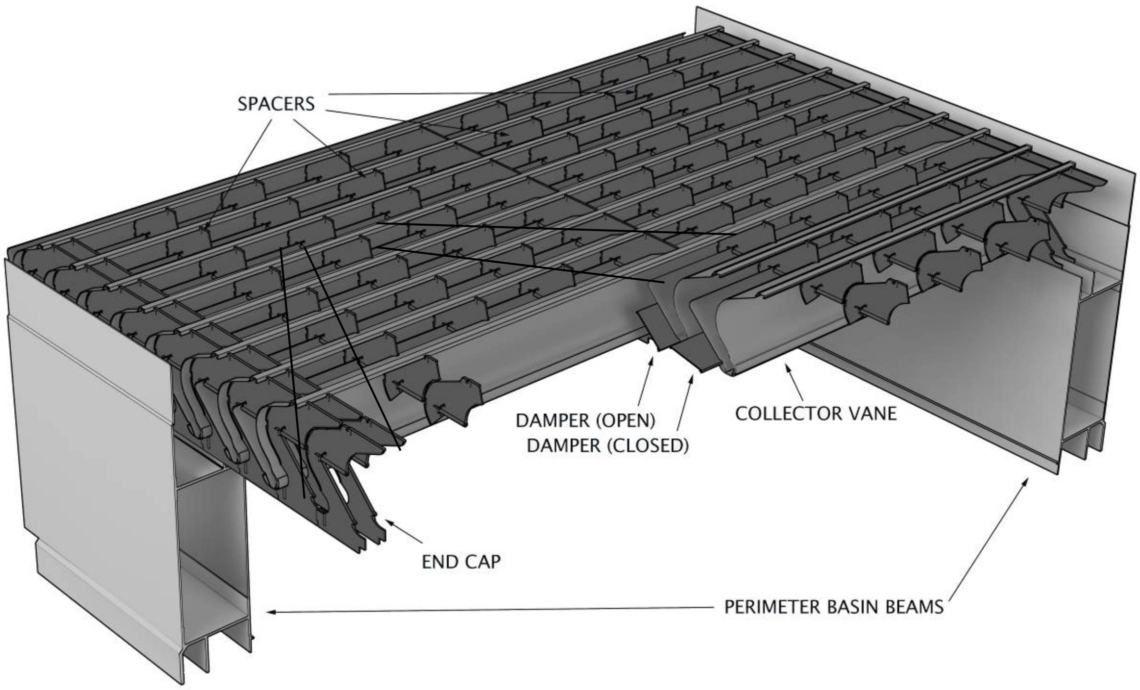


Figure 58 – Water Collection System

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 fill media and channel it into the perimeter basin beams. Refer to Figure 58.

- 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. One End Cap is also installed at the center of each collector vane. Refer to Figures 58 and 59.

- Spacers installed ~15" apart along the entire length of each collector vane fasten the Water Collection System together. Refer to Figures 58 and 59.

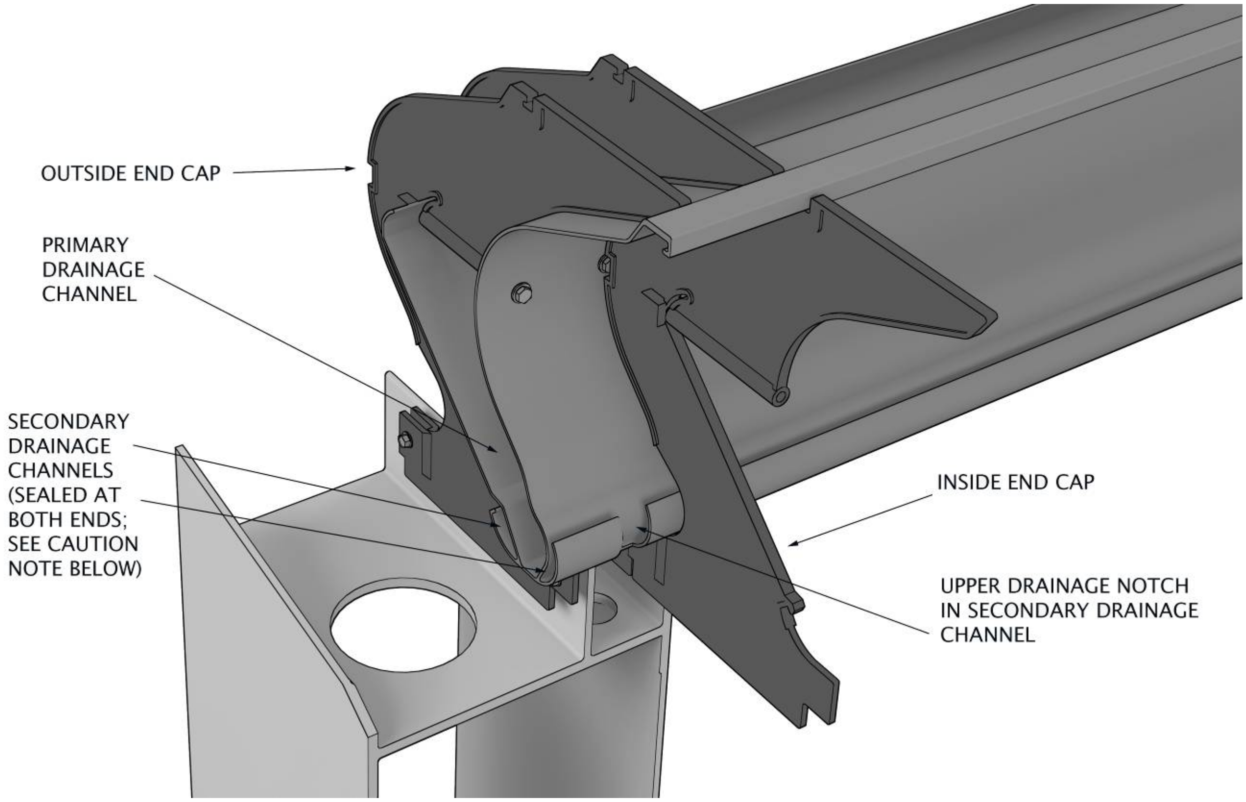


Figure 59 – Close-Up View: Water Collection System

- 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. Refer to Figure 59 and 60.

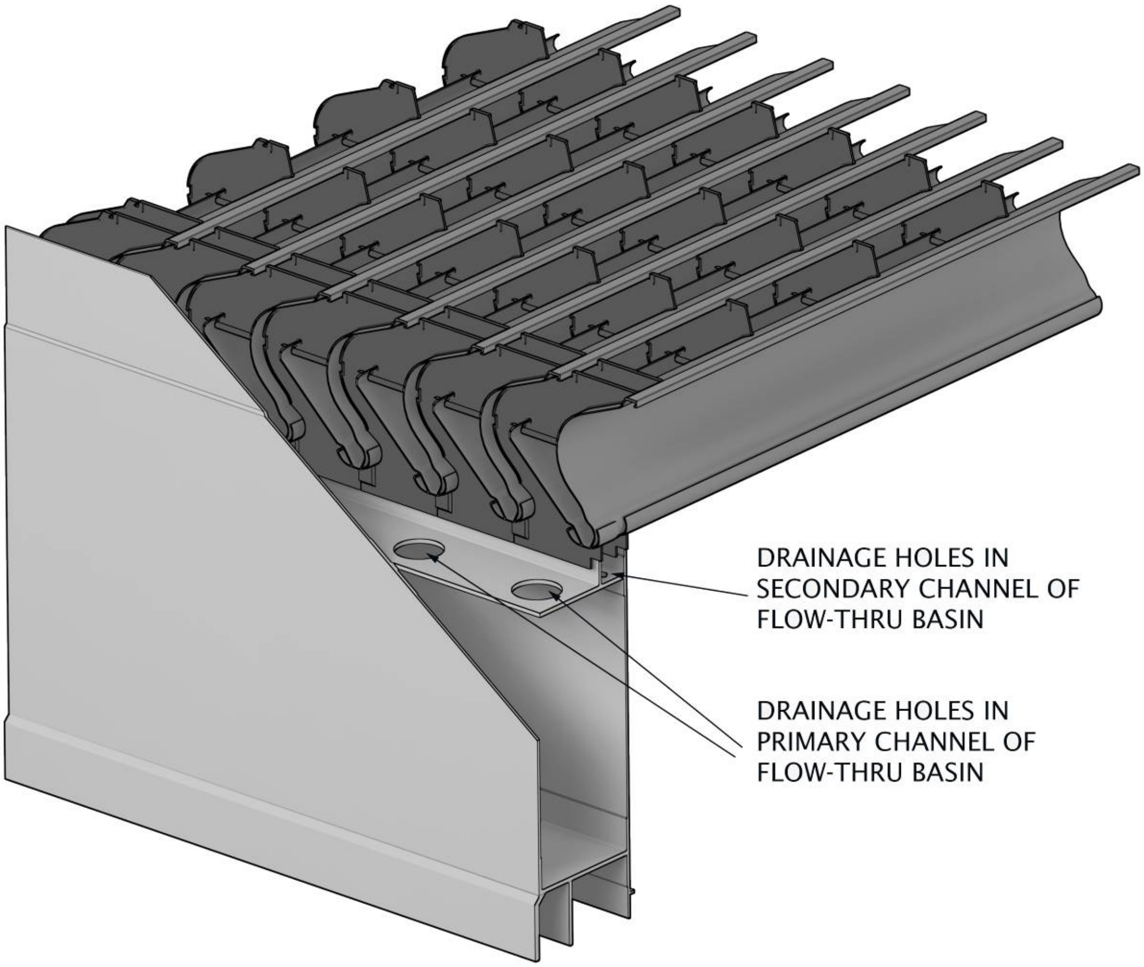
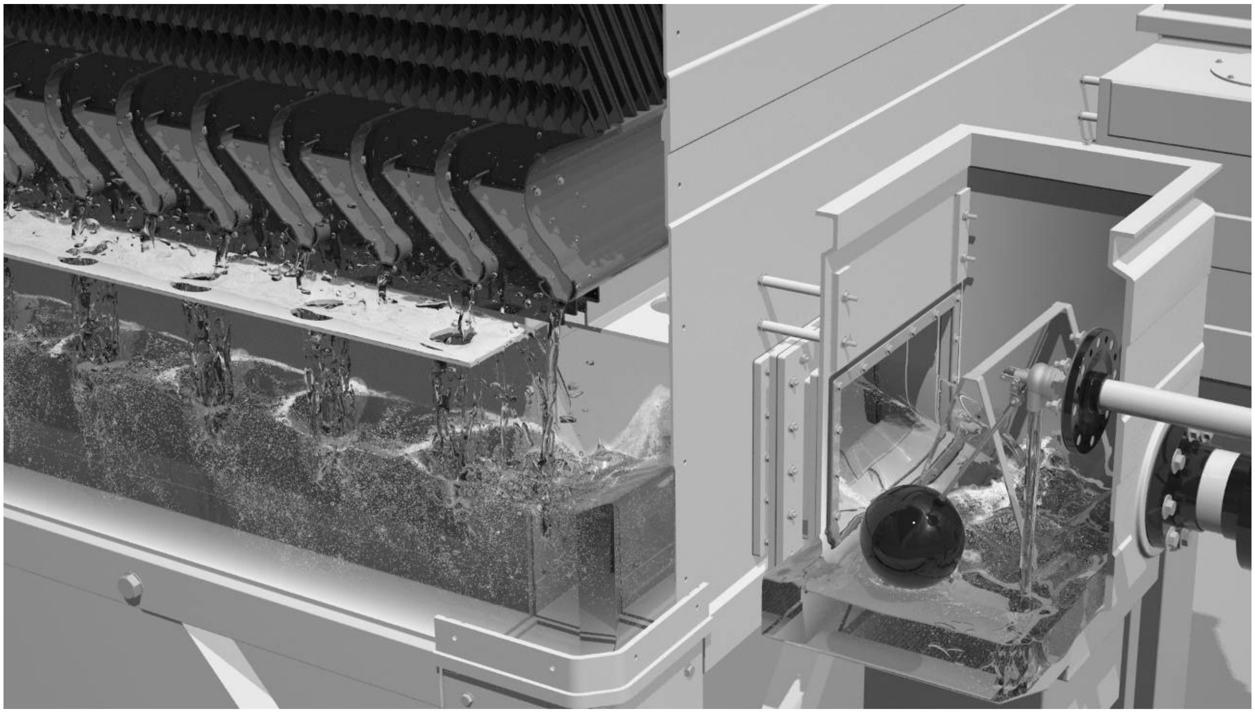


Figure 60 – Flow-Thru Basin Drainage (Perimeter Basin Wall)

- 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. Refer to Figures 58 and 60.

Figure 61 – TTXR See Through View of Tower Basin Wall



⚠ 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. Refer to Figure 58.

- Flow-Thru Basin Primary Drainage Holes in the Perimeter Basin Wall allow cooled water exiting the Water Collection System to flow into the Flow-Thru Basin. Refer to Figures 59, 60 and 61.

- Flow-Thru Basin Secondary Drainage Holes in the Perimeter Basin Wall allow any water that escapes primary containment within the collector primary drainage channels to be channeled back into containment within the perimeter basin beam. Refer to Figures 59 and 60.

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. Open the 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. Refer to Figures 58 and 60. 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.

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 in 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.

5. 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.

6. 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.

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

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

9. 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-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./ft^2, 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 above the area of the Water Collection System 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.

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 tower with a water treater or with Tower Tech's customer service staff.

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

6. Reinstall clean fill media in the tower module in the same way it was installed by the factory.

7. Reinstall drift eliminators.

8. Turn on water to-from tower module.

10.1 Spare Parts

The inherent redundancy and reliability of the TTXR's multiple-fan, direct-drive design assures customers that tower performance and efficiency will not be materially impaired if one motor/fan is offline. This redundancy and 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 14 – 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 Eleven: Appendix

11.1 Index of Figures

11.2 Index of Tables

11.3 Index of Graphs