



# Cooling Towers

OPERATION,  
INSTALLATION AND  
MAINTENANCE  
MANUAL

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**FC Series**

Where water  
means business.





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## Foreword

The cooling tower consists of evaporative fill material, a fan, water distribution system, shell, and water collection basin. The purpose is to provide evaporative cooling of process water.

This manual is to serve as a guide for installing, operating, and maintaining the equipment. Improper installation, operation, and maintenance can lead to poor performance and/or equipment damage. Use qualified installers and service technicians for all installation and maintenance of this equipment.

This manual is for our standard product. The information in this manual is general in nature. Unit-specific drawings and supplemental documents are included with the equipment as needed. Additional copies of documents are available upon request.

Due to the ever-changing nature of applicable codes, ordinances, and other local laws pertaining to the use and operation of this equipment, we do not reference them in this manual.

The cooling tower is for outdoor installation only. 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. Use a water treatment program to stop biological contamination in order to reduce such hazards. Do not operate this equipment without a proper water treatment program.

## Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment. The following is a list of symbols used in this manual and their meaning.



General Warning



Electricity Warning



Sharp Element Warning



Hot Surface Warning



Flammable Material Warning



General Mandatory Action



Wear Eye Protection



Wear Protective Gloves



Wear Ear Protection



Disconnect Before Carrying Out Maintenance or Repair



Connect an Earth Terminal to Ground

Only qualified personnel should install, start-up, and service this equipment. When working on this equipment, observe precautions in this manual as well as tags, stickers, and labels on the equipment.



**WARNING:** Any use or misuse of this equipment outside of the design intent may cause injury or harm.



**WARNING:** This equipment contains hazardous voltages that can cause severe injury or death.



**WARNING:** This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.



**WARNING:** The exposed surfaces of motors can be very hot and can cause burns if touched with unprotected hands.



**CAUTION:** Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Shut off the electric power at the main disconnect before opening access panels for repair or maintenance.



**CAUTION:** Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.



*CAUTION: The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the cooling tower.*



*CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.*

## Pre-Installation

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### Receiving Inspection

When the unit arrives, verify the information on the unit nameplate agrees with the order acknowledgement and shipping papers. Inspect the equipment for any visible damage and verify all items shown on the bill of lading are present. If damage is evident, document it on the delivery receipt by clearly marking any item with damage as "unit damage" and notify the carrier. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party. Do not install damaged equipment without getting the equipment repaired.

Shipping damage is the responsibility of the carrier. To protect against possible loss due to damage incurred during shipping and to expedite payment for damages, it is important to follow proper procedures and keep records. Photographs of damaged equipment are excellent documentation for your records.

Start unpacking the unit, inspect for concealed damage, and take photos of any damage found. Once received, equipment owners have the responsibility to provide reasonable evidence that the damage did not occur after delivery. Photos of the equipment damage while the equipment is still partially packed will help in this regard. Refrigerant lines can be susceptible to damage in transit. Check for broken lines, oil leaks, damaged controls, or any other major component torn loose from its mounting point.

Record any signs of concealed damage and file a shipping damage claim immediately with the

shipping company. Most carriers require concealed damages be reported within 15 days of receipt of the equipment. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party.

### Unit Storage

When storing the unit it is important to protect it from damage. Blow out any water from the unit; cover it to keep dirt and debris from accumulating or getting in, and store in an indoor sheltered area that does not exceed 125°F.

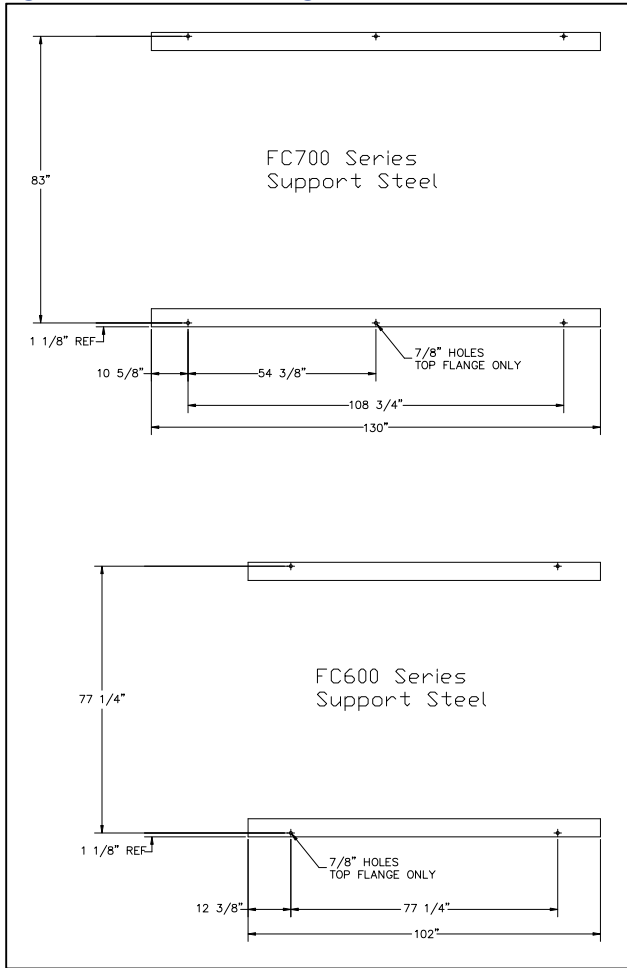
## Installation - Mechanical

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### Foundation

Install the unit on a rigid, non-warping mounting pad, concrete foundation, or level floor suitable to support the full operating weight of the equipment. When installed the equipment must be level within ¼ inch over its length and width. Fasten the tower to the steel or concrete of the supporting structure. For units mounted on a roof structure, the base holding the tower should be elevated above the roof and attached to the building.

Figure 1 – I-Beam Mouting Hole Dimensions



### Unit Location

The cooling tower is available in different configurations. Refer to the proposal and order acknowledgement document for the equipment to verify the specific design conditions in which it can operate.

Allow a minimum of 60 inches of clearance between the cooling tower and any walls or obstructions. For installations with multiple towers, allow a minimum of 60 inches between towers.

When locating the tower it is important to consider accessibility to the components to allow for proper maintenance and servicing of the unit. Avoid locating piping or conduit over the unit to ensure easy access with an overhead crane or lift to lift out heavier components during replacement or service.

Avoid areas that can create a “micro-climate” such as an alcove with east, north, and west walls that can be

significantly warmer than surrounding areas. The cooling tower needs to have unrestricted airways so it can easily move cool air in and heated air away. The discharge air must be allowed to flow upwards without obstruction. Above all, it is important that air intake is not hindered or affected by heat and/or humidity producing devices. Consider locating the cooling tower where fan noise and vibration transmission into nearby workspaces is unlikely.

### Fan Motor and Blade Assembly

In order to prevent possible shipping damage, the fan motor and fan blade were removed prior to shipping. The motor support (and optional fan guards if purchased) shipped mounted on top of the tower.

*Note: The fan motor has condensation drain holes located on the shaft end of the motor to permit any moisture to drain out to extend motor life. The drain holes are 1/8 inch in diameter and are either just a hole or what looks like a hex head bolt with a hole drilled in the center. If any of the drain holes has a plastic shipping cap in them, remove them before installing the motor.*

Figure 2 – 3 hp and 5 hp Motor Mounting

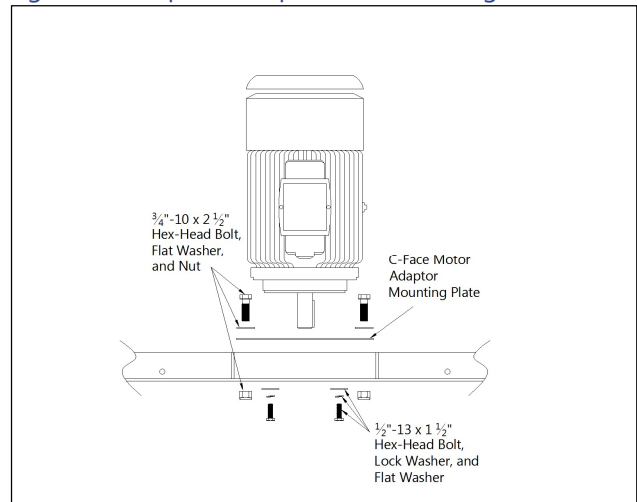
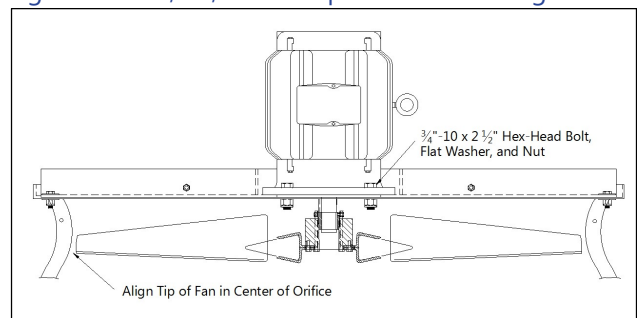


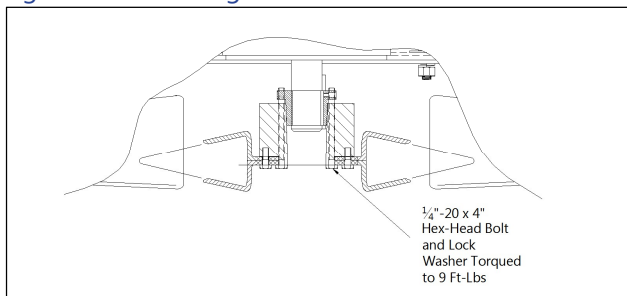
Figure 3 – 7½, 10, and 15 hp Motor Mounting



Use the following steps to install the fan motor and blade assembly:

1. Remove motor support frame (and optional fan guards if purchased) from top of tower.
2. Set the motor frame up off the ground (use saw horses or some other means of support).
3. Place the motor with the shaft pointing down onto the motor frame and bolt the motor to the frame using the bolts provided.
4. Grease the shaft with Anti-seize or some other type of grease. Slide the split tapered bushing onto the motor shaft with the shoulder of the bushing facing towards the motor. The bottom of the bushing should be flush with the end of the motor shaft.
5. Slide the tower fan (the top of the fan has the aluminum spool attached to it) over the split tapered bushing.
6. Line up the non-threaded holes of the fan spool with the threaded holes in the split tapered bushing.
7. From the underside of the fan, insert the 1/4" x 4" bolts with lock washers provided through the non-threaded holes in the fan and screw them into the split tapered bushing. The bushing should still be flush with the end of the motor shaft.

Figure 4 – Mounting Fan Blade to Motor Shaft



8. Tighten up the bolts in a uniform pattern until the fan is locked onto the fan bushing. Once the bolts are tight, the fan bushing should still be flush with the end of the motor shaft.

9. Remount the entire fan motor and fan assembly (and optional fan guards if purchased) back on top of the cooling tower.

### Lifting

Use only qualified persons using the proper equipment when lifting and positioning the cooling tower. Proper rigging methods must be followed to prevent damage to components.



*Avoid impact loading caused by sudden jerking when lifting or lowering the cooling tower. When abrasive surface contact is anticipated use pads to protect the surface of the fiberglass. The use of a spreader bar is highly recommended. Keep rigging clear of inlet piping. Do not use the motor support for lifting the cooling tower.*

Figure 5 – FC600 Series Rigging

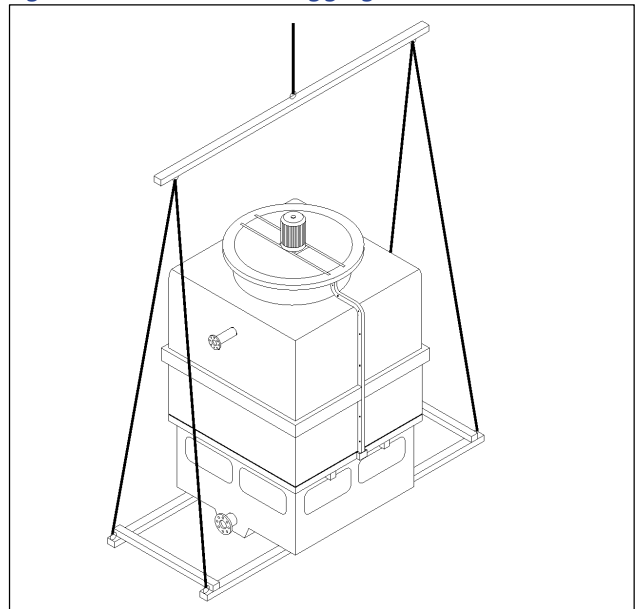
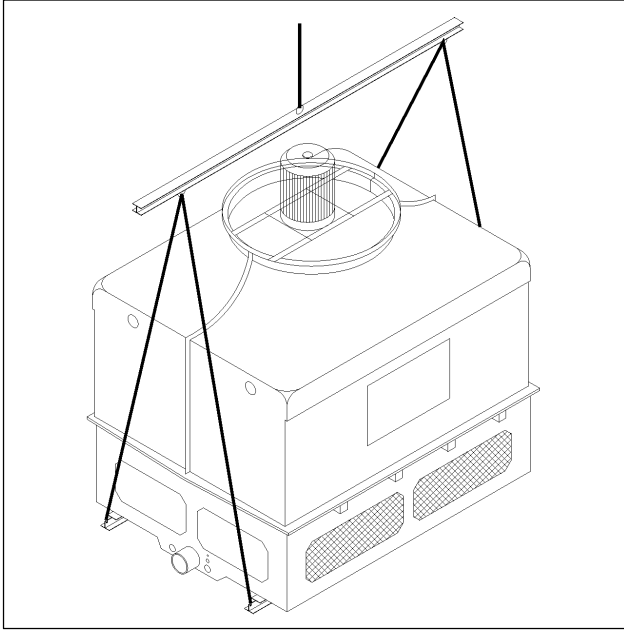




Figure 6 – FC700 Series Rigging



## Piping

The PVC piping and connections on the tower are not designed to support the weight of the external piping. To prevent stress fractures and leaks ensure all field piping connections are properly aligned with the tower connections, there is no piping stress on the basin connections, and all flanges are properly aligned with full flange face contact.

Inspect water spray nozzles when installing connecting piping to the tower inlet lines. This inspection should be done through the access door on the side and through the top of the cooling tower. All spray nozzles must be oriented in a fully vertical position to ensure proper water distribution through the tower. These should be adjusted before final connections are made to the tower. The cooling tower is supplied with PVC pipe stub connections. Optional inlet and outlet flanges are available. Some form of flow control, such as a butterfly valve and inlet pressure gauge, are required to set the flow through the tower. Where climates reach freezing temperatures, be sure the supply line to the tower is able to drain when the pump shuts off.

## Installation - Electrical

All wiring must comply with local codes and the National Electric Code. Minimum circuit amps (MCA) and other unit electrical data are on the unit nameplate. A unit specific electrical schematic ships

with the unit. Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included with the unit. If the measured voltage on any leg is not within the specified range, notify the supplier and correct before operating the unit. Voltage imbalance must not exceed two percent. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail. Voltage imbalance is determined using the following calculations:

$$\% \text{Imbalance} = (V_{\text{avg}} - V_x) \times 100 / V_{\text{avg}}$$

$$V_{\text{avg}} = (V_1 + V_2 + V_3) / 3$$

$V_x$  = phase with greatest difference from  $V_{\text{avg}}$

For example, if the three measured voltages were 442, 460, and 454 volts, the average would be:

$$(442 + 460 + 454) / 3 = 452$$

The percentage of imbalance is then:

$$(452 - 442) \times 100 / 452 = 2.2 \%$$

This exceeds the maximum allowable of 2%. There is a terminal block for main power connection to the main power source. The main power source should be connected to the terminal block through an appropriate disconnect switch. There is a separate lug in the main control panel for grounding the unit. Check the electrical phase sequence at installation and prior to start-up. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read "ABC" on the meter. If the meter reads "CBA", open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). Do not interchange any load leads that are from the unit contactors or the motor terminals.



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**CAUTION:** The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the cooling tower.



**CAUTION:** Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.



**CAUTION:** Ground the unit properly and in compliance with local and national codes.

## Start-Up Procedure

Use a qualified technician to perform the start-up and that they follow the start-up procedure in sequence. The following serves as a checklist for the initial start-up and for subsequent start-ups if the cooling tower is out of service for a prolonged time.



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### Step 1 – Flush the Basin

Once the tower has been completely assembled and placed, make sure all disconnects are locked out. Remove one of the inlet louver sections. Open the drain and flush the basin with water to remove any remaining dirt and debris from basin. Check all fasteners to make sure there are no loose components.

### Step 2 – Connect Main Power

Connect main power properly ensuring it matches the voltage shown on the nameplate of the unit. Check the electrical phase sequence prior to start-up. Check the phasing prior to applying power. The proper sequence is "ABC". If the phasing is incorrect, open the main power disconnect and switch two line leads on the main power terminal blocks (or the unit mounted disconnect). All electrical components are in-phase at the factory. Do not interchange any load leads that are from the unit contactors or the motor terminals. After making proper power connection and grounding, turn the main power on.

### Step 3 – Fill Water Circuit

Check to make sure all water piping connections are secure. Fill the circulation system with water. If the basin of the cooling tower is fitted with a make-up, fill the system until the make-up valve is closed.

#### System Fill Water Chemistry Requirements

The properties of water make it ideal for heat transfer applications. It is safe, non-flammable, non-poisonous, easy to handle, widely available, and inexpensive in most industrialized areas.

When using water as a heat transfer fluid it is important to keep it within certain chemistry limits to avoid unwanted side effects. Water is a “universal solvent” because it can dissolve many solid substances and absorb gasses. As a result, water can cause the corrosion of metals used in a cooling system. Often water is in an open system (exposed to air) and when the water evaporates, the dissolved minerals remain in the process fluid. When the concentration exceeds the solubility of some minerals, scale forms. The life giving properties of water can also encourage biological growth that can foul heat transfer surfaces.

To avoid the unwanted side effects associated with water cooling, proper chemical treatment and preventive maintenance is required for continuous plant productivity.

*Unwanted Side Effects of Improper Water Quality*

- Corrosion
- Scale
- Fouling
- Biological Contamination

*Cooling Water Chemistry Properties*

- Electrical Conductivity
- pH
- Alkalinity
- Total Hardness
- Dissolved gasses

The cooling tower uses a PVC evaporative fill media to spread the water over a wide surface area to facilitate evaporation and cooling of the water. The surface area of the fill, as are all heat exchangers, is susceptible to fouling of heat transfer surfaces due to scale or debris. Fouling of these surfaces reduces the heat-transfer efficiency of the cooling tower.

The complex nature of water chemistry requires a specialist to evaluate and implement appropriate sensing, measurement and treatment needed for satisfactory performance and life. The recommendations of the specialist may include filtration, monitoring, treatment and control devices. With the ever-changing regulations on water usage and treatment chemicals, the information is generally up to date when a specialist in the industry is involved. Table 1 shows the list of water characteristics and quality limitations.

**Table 1 – Fill Water Chemistry Requirements**

Water Characteristic	Quality Limitation
Alkalinity (HCO <sub>3</sub> <sup>-</sup> )	70-300 ppm
Aluminum (Al)	Less than 0.2 ppm
Ammonium (NH <sub>3</sub> )	Less than 2 ppm
Chlorides (Cl <sup>-</sup> )	Less than 300 ppm
Electrical Conductivity	10-500µS/cm
Free (aggressive) Carbon Dioxide (CO <sub>2</sub> )†	Less than 5 ppm
Free Chlorine(Cl <sub>2</sub> )	Less than 1 PPM
HCO <sub>3</sub> <sup>-</sup> /SO <sub>4</sub> <sup>2-</sup>	Greater than 1.0
Hydrogen Sulfide (H <sub>2</sub> S)	Less than 0.05 ppm
Iron (Fe)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm
Nitrate (NO <sub>3</sub> )	Less than 100 ppm
pH	7.5-9.0
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	Less than 70 ppm
Total Hardness (dH)k	4.0-8.5

† Dissolved carbon dioxide calculation is from the pH and total alkalinity values shown below or measured on the site using a test kit. Dissolved Carbon Dioxide, PPM = TA x 2<sup>[(6.3-pH)/0.3]</sup> where TA = Total Alkalinity, PPM as CaCO<sub>3</sub>

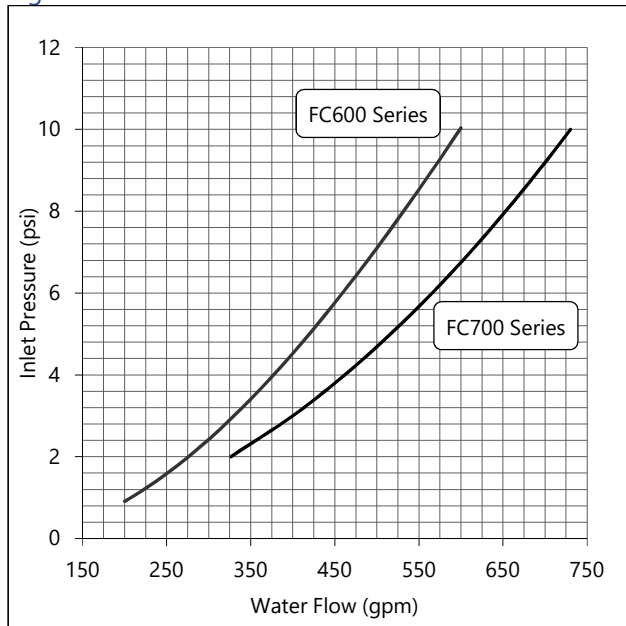
Check tower basin and connections for leaks. Close discharge valves of pumps completely. Check rotation of tower pumps by starting them momentarily. Once proper pump rotation is established, slowly open each pump discharge valve to ¼ open and run the pumps for about five minutes to make sure all air has been removed from the system. Stop pumps and check tower outlet to make sure it is still clean and free from debris. Check water level in the system again to make sure system is still full. Start pumps again. While pumps are running, set the flow to the tower by adjusting the discharge valves of the pumps.

**Table 2 – Nominal Flow Rates**

Model	Operating Range (gpm)	Nominal Flow (gpm)	Inlet Pressure Required for Nominal Flow (psi)
FC610	200 min 600 max	300	6
FC620		345	4
FC630		375	4
FC640		420	5
FC710	350 min 725 max	510	5
FC720		555	6
FC730		615	7
FC740		720	10

After steady water flow is established, adjust tower inlet valves to proper pressure to allow for design flow using the inlet pressure versus flow chart.

Figure 7 – Inlet Pressure vs. Flow Chart



Stop the pumps and lock out disconnects until ready to start system.

#### Step 4 - Trial Fan Operation

Lock out all disconnects before servicing any portion of the tower. Check for smooth operation and clearance between blades and tower by manually turning the fan blade. Clear the air intake and discharge areas of any foreign material. Check the power supply for correct voltage, frequency, and phase. Turn on fan motor for a moment to check fan rotation to confirm fan will properly discharge air out of top of tower. If the fan is rotating in the wrong direction, turn off fan motor, wait for fan to stop, and lock out disconnect. Rewire fan motor, by switching any two power leads. Once proper rotation has been established, operate the fan motor and check the amp draw to verify that it falls within the nameplate rating. If amp draw is in excess of the nameplate amps, call the Customer Service Department for assistance. Continue to operate the fan motor for two or three hours. If abnormal vibration or sound develops, disconnect power and contact the Customer Service Department for assistance. Stop fan motor and lock out disconnects until ready to start the system. Check all fan bolts to assure they are tight.

## Operation and Maintenance

### Fan Motor

The motor should bring the fan up to full speed in less than five seconds. If it does not, check connections, fuses, overloads, and voltage at the motor terminals. If everything does not properly check out, call the Customer Service Department for assistance.



**WARNING:** If vibration occurs, shut the fan off immediately. Check the motor mounting and make sure all fasteners are tight. If everything is tight, remove fan blade assembly from motor and start without the fan blade. If the motor vibrates, contact the Customer Service Department for instructions. If the vibration is not in the motor, check the alignment of motor with mechanical equipment and the balance of the fan blade. Make sure all fan blades are secure and complete. If source of vibration cannot be isolated, contact the Customer Service Department for assistance. An optional vibration switch wired in series with the fan motor contactor will protect the tower from potential damage caused by vibration.



**WARNING:** Do not cycle a motor on and off more than necessary. Frequent cycling may cause the windings to burn out. Generally, the total of the starting times should not exceed 12 starts per hour. When changing fan direction, allow a minimum of two minutes before reenergizing the motor.

### Water Distribution

Scale or sludge buildup will impede the proper operation of the spray nozzles. If the spray pattern slows or stops, check the water flow to make sure it is correct. If it is not correct, dismantle and clean the nozzles by twisting the nozzle and pulling downward. Clean nozzles with plastic bottle brush and cleaning solution. Do not soak nozzle in cleaning solution. Only use a cleaning solution with a pH of 3.0 or greater.

### Seasonal Shutdown

If the tower will be shutdown during the winter, it is recommended that the motor be run for three hours a month to keep the bearings lubricated and the windings dry. Be sure to inspect motor before bringing it back into full operation. Check basin for debris, clean if required. Inspect fill for contamination, change fill if needed.

## Freeze Protection

When cooling towers are subjected to intermittent shutdown (nights, weekends, etc.) during cold weather, or when operating against minimum loads, the opportunity for freezing of the water contained in the water basin and internal piping within the tower exists. Maintain freedom of fan rotation. Do not operate if snow, ice, or other obstructions will interfere with fan rotation.

An indoor auxiliary sump is the best means of avoiding tower freeze-up. With a properly piped remote sump system the water within the tower basin and internal piping of the tower is allowed to drain to the indoor sump whenever the recirculation water pump is stopped.

Where a remote sump is impractical because of tower location or space limitation, heat must be supplied to the water in the tower basin through the use of electric immersion heaters. Basin heater packages are available.

## Calculations

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### Evaporation Loss

If exact evaporation losses are not known, an approximation can be obtained by using the following formula (see ASHRAE Equipment 1992, 39.11):

$$\text{Evaporative Loss (GPM)} = \text{Range} \times \text{GPM} \times .0008$$

Range = water in (°F) less water out (°F)  
GPM = gallons per minute through tower

### Drift Loss

Drift loss can be approximated from the equation below which assumes a loss of .02% of the water flowing through the tower.

$$\text{Drift Loss (GPM)} = \text{GPM} \times .0002$$

### Bleed-Off Rate

The bleed-off rate required is dependent on the condition of the make-up water and the number of concentrations desired. The bleed-off rate should therefore be calculated by the company providing the water treatment equipment.

## Number of Concentrations

The number of concentrations present in the system is the measure of how concentrated the level of dissolved solids in the water.

$$\text{Number of Concentrations} = \frac{\text{Evaporation} + \text{Drift} + \text{Bleed-Off}}{\text{Drift} + \text{Bleed-Off}}$$

## Make-Up Water Required

The amount of make-up water required is dependent on a number of factors

$$\text{Make-up water required (GPM)} = E + D + B$$

E = Evaporative Loss in Gallons per Minute

D = Drift Loss in Gallons per Minute

B = Bleed-Off Rate in Gallons per Minute

## Notes

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5680 W. Jarvis Ave. • Niles, IL 60714  
847.966.2260  
[www.thermalcare.com](http://www.thermalcare.com)

**New Equipment Sales**  
847.966.2260  
[sales@thermalcare.com](mailto:sales@thermalcare.com)

**Customer Service**  
847.966.2636  
[tcservice@thermalcare.com](mailto:tcservice@thermalcare.com)

**Parts Department**  
847.966.8560  
[tcparts@thermalcare.com](mailto:tcparts@thermalcare.com)