Operations & Maintenance

Manual

For Series TCI Cooling Towers
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SECTION 1  INTRODUCTION

NOTICE TO OUR CUSTOMERS:

The information provided in this manual is intended to be current and correct, and to provide our customers with useful guidance for the proper installation, operation and maintenance of our towers. This manual, however, is not intended to be a totally inclusive reference source on Cooling Towers. Other requirements and guidelines -- such as OSHA regulations, local, state and federal codes -- that apply to tower installation and operation are beyond the scope and intent of this manual, and therefore are not included. It is the responsibility of the customer and user to identify and comply with applicable rules and practices, to use qualified and experienced personnel to perform the tasks involved, and to obtain professional advice as needed.

Providing proper installation, maintenance and operation of the Series TCI Cooling Tower is the owner’s responsibility, and is required for safe and efficient operation. Failure to follow the guidelines provided in this manual may result in poor performance, unnecessary equipment failure and down time. The Cooling Tower Company assumes no responsibility for the results of acts beyond their control.

Any questions regarding equipment operation and maintenance should be directed to your local TCTC Sales Representative / Assembly Distributor.
Series TCI Cooling Towers

Features

High Efficiency Fans
- Aluminum Blades
- Gear Drives
- Power Belt Drive

Distribution System
- 2:1 Turn Down
- Low AP Head
- Side Inlet
- Bottom Inlet

Fill and Drift Eliminator
- High Efficiency Fill
- Easily Inspected
- Large Access Doors
- 0.001% - 0.002% Drift

Cellular Inlet Louvers
- Minimize Sunlight
- Minimize splash-out

Fully Welded Basins
- Leak Tested At Factory
- Sloped For Proper Drainage

Materials Of Construction
- Basin: Stainless Steel- Galvanized
- Structure: Stainless Steel- Galvanized
- Casing: Stainless Steel- Galvanized

Accessories
- Maintenance Platform With Ladder
- Vibration Switch
- Basin Heater
- Brass Fill Valve

The Cooling Tower Company, L.C.

1.2 BASICS OF TOWER OPERATION

Cooling Towers are heat transfer devices that are designed to remove heat from the hot water which returns from an HVAC heat source such as a chiller, or from an Industrial Process such as a condenser or heat exchanger, and transfers this heat to the atmosphere. In the case of The Cooling Tower Company (TCTC) cooling towers, this transfer of heat is accomplished by forced-draft fans blowing ambient air through the heat transfer media known as “fill”. The air flows up, counter to the cascading water flowing through the fill. The fill material is designed to slow the falling water and maximize the intimate surface contact between the air and water. Approximately, 90% of the cooling that takes place in the tower results from evaporation of a small portion of the circulating flow.

Approximately 1% of the total circulating water flow is converted from water to water vapor in the evaporation process for every 10°F that the water is cooled. This phase change performs a substantial part of the heat duty within the tower. Conductive heat transfer as a result of the intimate contact between the water and air accomplishes the balance of the cooling.
1.3 WATER TREATMENT

The implementation of an effective water treatment program is the most important thing that can be done to ensure that your tower continues to operate at their peak performance. A water treatment program is important to restrict and control corrosion, the build-up of scale and biological growth in the cooling system. If left unchecked, any one of these problems can quickly reduce your system’s operating efficiency and the useful life of your tower. Of course, neglecting to implement a proper water treatment program can also foster health-related issues, i.e. providing a breeding ground for microbiological organisms such as the *Legionella Pneumophila* bacteria that causes Legionnaires Disease. It is crucial that the tower be treated with either an effective non-chemical system which includes copper and silver ion additions to the water or effective biocidal control agents specifically designed to control the proliferation of these microorganisms are a necessary part of the treatment plan.

In either chemical or non-chemical treatment systems, TCTC recommends the use of side-stream filtration equipment with cooling tower system’s, especially those in high solids loading environments, i.e. new construction sites, coastal installations, etc. to help ease the burden of basin cleaning. Automated filtration systems used in conjunction with the TCTC standard sloped basins have proven to be very effective in removing sediment that might otherwise settle in your cooling tower system and necessitate frequent basin cleaning.

For further information on water treatment, please contact your local water treatment provider.

**System Operation**

*Typical Filtration System*

*Water from the cooling system is pumped through valve A (in the direction indicated) and into the overdrain assembly at the top of the filter tank. The water is distributed over the media bed where suspended solids are trapped between the particles as the water passes through. The filtered water drains from the tank through valve B (in the direction indicated) and returns to the system.*
1.3.1 WATER COMPOSITION FOR DIFFERENT MATERIALS OF CONSTRUCTION

(A) Towers in 304 Stainless Steel

In order to maximize service life from your 304SS cooling tower the circulating water should conform to the following:

pH between 4 and 10

<table>
<thead>
<tr>
<th>Ion Concentration</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride ion</td>
<td>&lt; * See schedule below</td>
</tr>
<tr>
<td>Sulphate ion</td>
<td>&lt; 500 ppm</td>
</tr>
<tr>
<td>Fluoride ion</td>
<td>&lt; 7 ppm</td>
</tr>
</tbody>
</table>

Reducing acids e.g. sulphuric, for either pH control or de-scaling should not be used. The use of hydrochloric acid for any purpose is not recommended. If you require either pH control or to de-scale the tower and pack any of the following acids can be used: nitric, phosphoric, sulphamic, acetic, formic or citric in the appropriate concentrations.

* Temperature recycling through tower sump.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Chloride ion concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°C</td>
<td>40 ppm</td>
</tr>
<tr>
<td>27°C</td>
<td>70 ppm</td>
</tr>
<tr>
<td>25°C</td>
<td>100 ppm</td>
</tr>
<tr>
<td>23°C</td>
<td>150 ppm</td>
</tr>
<tr>
<td>22°C</td>
<td>180 ppm</td>
</tr>
</tbody>
</table>

(B) Towers in 316 Stainless Steel

In order to maximize a satisfactory service life from your 316SS cooling tower the circulating water should conform to the following:

pH between 4 and 10

<table>
<thead>
<tr>
<th>Ion Concentration</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride ion</td>
<td>&lt; 7000 ppm</td>
</tr>
<tr>
<td>Sulphate ion</td>
<td>&lt; 2000 ppm</td>
</tr>
<tr>
<td>Fluoride ion</td>
<td>&lt; 200 ppm</td>
</tr>
</tbody>
</table>

Reducing acids e.g. sulphuric, for either pH control or de-scaling should not be used. The use of hydrochloric acid for any purpose is not recommended. If you require either pH control or to de-scale the tower and pack any of the following acids can be used: nitric, phosphoric, sulphamic, acetic, formic or citric in the appropriate concentrations.

If you intend to operate the tower(s) outside of this range, then please seek the advice from your local TCTC representative, as well as your professional water treater.
1.3.2 Impact of Water Treatment on Performance

Typically, foreign contaminant build-up within the fill, it is the result of inadequate water treatment. A proper water program must be based on the site-specific cooling process and make-up water condition. Biological growth and mineral accumulation, as well as sedimentation, must be monitored and controlled by the water treatment program. Consultation with a qualified water treatment expert is highly recommended.

Biological growth increases with the temperature, sunlight exposure, environmental exposure, and stagnation of the circulating tower water. Besides reducing the tower’s heat transfer capacity, biological growth on the fill and collectors also increases the surfaces on which minerals can deposit. Consequently, biological growth can accelerate scaling (the accumulation of mineral deposits), and vice versa. Generally, the lower the biological growth, the greater the resistance of the tower system to overall plugging. Biological growth can be reduced to an acceptable level through the use of appropriately selected biocidal chemicals.

Tower water must also be evaluated for solids and mineral content. Minerals can form deposits or scale on the tower materials. As with biological growth, sedimentation and scaling of tower surfaces reduce the overall heat transfer coefficient and the cooling capability of the tower, as illustrated in Figure 2.

![Figure 2](image)

As material (biological, mineral, or particulate) is deposited within the fill, the overall tower effectiveness is lowered, and the weight of the fill increases substantially. This added loading can lead to structural failure of the fill and its support system. Clearly, the need for proper treatment, and its value, cannot be overstated.

The most obvious indicator that the fill is becoming contaminated is the loss of performance from the tower. This may be seen as an increase in the Cold Water Temperature (CWT) or an increase in fan power. Periodic visual inspection of the fill media is the most practical way to monitor water treatment effectiveness. The Series
TCI Tower is provided with large pack and basin access doors to accommodate this type of visual inspection.

Substandard water treatment can also impact operating costs, due to excessive chemical use from increased blowdown or drift losses.

### 1.3.3 Water Treatment / Health and Safety Considerations

The primary health and safety hazards related to cooling towers involve chemical exposures, Legionnaire’s disease, confined space entry, and physical hazards. Tower installers and service personnel should follow the applicable industry standards, government regulations, and other guidelines.

As discussed above, proper water treatment reduces accumulations of scale, sediment, biological slime and other microorganisms, such as amoebae and algae, in which *Legionella pneumophila* bacteria may grow. This bacterium is common in cooling tower waters and has been associated with outbreaks of Legionnaire’s disease. The risk factors and causes of Legionnaire’s disease have not been quantified or defined with certainty. Nonetheless, according to a relevant government report (”Control of *Legionella* in Cooling Towers,” by the State of Wisconsin Department of Health and Social Services, August 1987), outbreaks have generally not been associated with towers in which an effective water treatment program has been maintained consistently. This further emphasizes the importance of an effective water treatment program.

The tower system should be designed and the maintenance procedures should be specified to reduce the risk of exposure to Legionella bacteria for maintenance personnel and building occupants, if any. For example, towers should be sufficiently spaced from building air intake vents to prevent aerosolized, and possibly bacteria-laden, water from entering the HVAC system. For specification of this and other design details, the customer should enlist the services of a qualified professional. As another example, federal regulations of the Occupational Safety and Health Administration (OSHA) specify the use of personal protective gear and procedures to prevent harmful exposures to water treatment chemicals and bacteria, such as *Legionella pneumophila*. For the details on the proper handling of this and other safety issues, the customer should enlist the services of a qualified industrial health professional.

For further information on water treatment, please contact your water treatment provider or specialist.

For additional “on-line” information on Legionnaires’ Disease refer to the following:

- [www.cti.org](http://www.cti.org) Legionella Position Paper
- [www.ashrae.org](http://www.ashrae.org) Legionella Position Paper
1.4 IMPACT OF AIR AND WATER DISTRIBUTION ON PERFORMANCE

Uniform air and water distribution in the cooling tower is needed to optimize interaction of air and water within the fill material. When either the air or water distribution becomes less than optimum, the tower thermal performance drops off.

Significant variations in the water flowrate to your tower can reduce the spray pattern achieved by your nozzle spray header. Consequently, flow is concentrated within the fill and may locally exceed the liquid loading rate (gpm/sf) capacity of the fill. Excess loading will reduce heat transfer performance. In addition, such concentration of flow resulting from poor nozzle distribution leaves un-wetted pathways through the fill. Airflow intended for cooling the water moves to these dry, less obstructed pathways, effectively bypassing the hot water.

If your system flow to individual cells varies significantly by design, please consult your local TCTC representative to discuss optimization techniques or alternative water distribution systems.
1.5 PIPING SYSTEM CONSIDERATIONS

The Series TCI towers require the following customer-provided piping and connections to the TCTC supplied flanges, as shown on your TCTC drawings. Information about the piping and valve requirements are provided in this section.

- **Hot Water Inlet Line** – Single or individual cell inlets per tower cell
- **Cold Water Return Line** – Single outlet per tower basin for either bottom or side orientation. Dual outlets available.
- **Pump or Tower Bypass Line** - When needed for start-up, based on volume of the overhead piping. (optional)
- **Overflow/Equalization Line (or optional “Balance Line”),** for balancing or equalizing the water levels between individual tower basins making up the tower system.

**Make-up Water Line** - Feeds make-up water into each basin of the tower system.

1.5.1 Pipe Sizing

All TCTC towers are supplied with piping connections consistent with maintaining low water entry and exit velocities at the tower. Customer-designed and/or supplied piping can contribute or detract from good tower performance. This influence can come from local pressure drop or vortex effects if excessive velocities exist; particularly in the tower discharge piping leading to the circulation pump. Good piping design and construction practices should be followed. Also, the local effects of fittings should be prevented from influencing system performance. Recommended velocities are:

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<th></th>
<th>Inlet to tower</th>
<th>Outlet from tower</th>
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<tr>
<td></td>
<td>6 – 9 ft / sec</td>
<td>4 – 6 ft / sec</td>
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1.5.2 Valves

When a single connection is provided, isolation valves on the Cold Water Return, and Balance Line, are only needed to service the tower. Hot Water Inlet valves are needed to service the tower and to balance the flow rate between the individual towers on multiple inlet or multiple tower installations. Balancing is performed during initial start-up and as needed. See Section 3.

1.5.3 Make-Up Water System

Each TCI-series tower is supplied with a mechanical ball & float valve (1” to 2”) in the basin for automatic addition of system makeup water. The valves are field adjusted during start-up. By piping directly to each basin on multiple tower installations, the rate of makeup is maximized. Make-up water supply pressure should be less than 40 psi to prevent valve failure. If supply pressure exceeds 40 psi, the owner should supply a pressure-regulating valve.
1.5.4 Overflow Connection

The TCTC tower basins come standard with a 2” or 3” overflow connection depending on capacity.

Approximately 50% of the overall tower basin capacity is held in suspension in the fill media, while the tower is in operation. When the tower is removed from service, the water in suspension is released to the basin volume provided above the normal operating water level. If the overhead piping system is large, and exceeds the basin capacity, the excess water is diverted to the drain via the overflow piping. In these situations, either an extra deep basin or inlet isolation valves should be considered for the project.

1.5.5 Equalization (or “Balance Line”) Piping

When multiple basin systems are supplied, each basin is equipped with an equalization or balance piping connection. On multiple-cell installations, the balancing pipes from each basin are piped together, to “balance” or “equalize” the water levels in each tower. This piping is typically not part of the Tower Manufacturer’s scope of supply.

1.5.6 System Volume Considerations

The overall system volume-including all piping, when compared to the tower basin capacity and pump capacity, need to be evaluated during the design stages. Installations with large system volumes compared to the basin capacity and are going to be cycled on and off frequently and/or are mated to 100% flow pumps need special considerations. In this case, provisions need to be made in the system design and/or the startup procedures to prevent excessive water and chemical loss through overflow. Systems with an excessive amount of overhead piping should be evaluated in the design stages to determine if extra basin capacity or isolation valves are needed on shutdown to collect water that drains from hold-up in fill and in overhead piping. It is the responsibility of the customer to make TCTC aware of any needs this type of need prior to purchase.
SECTION 2 INSTALLATION

The proper installation of your TCI-Series Cooling Tower is vital to the overall operation and maintenance requirements of the tower system. The TCTC towers have been designed to minimize site-specific installation requirements, and most units required little or no field-assembly. Nonetheless, careful placement of the towers by competent personnel is an important consideration. Here are some general guidelines to help you provide the best installation, possible. Contact your TCTC representative for a complete set of installation instructions for your tower.

2.1 RECEIVING / HANDLING

All items are checked and inspected before leaving the factory. When you receive the equipment, examine it carefully for damage during transit and check that all the items indicated on the delivery note have been received. If you notice any damage or items missing inform the carrier and contact your TCTC Distributor immediately, and document in detail the damage that was found. Provide a copy of the damaged items noted.

The equipment should always be handled carefully to prevent damage. Series TCI towers are typically delivered in two sections: (1) the basin section and (2) the media and fan/distribution section. On large towers, they may have the fan shroud shipped separately. After the basin has been set in place at the assembly area, install the corners, mid-wall support channels, and wind bracing angles. Leave all bolt finger tight to allow alignment of the upper section. At this time, the upper section can be lifted and set on top of the supports. Once all bolts are installed, tighten all bolts. Note: Make sure that all bolting to the basin and to the upper section are tight prior to lifting. Use the lifting points provided, which have been positioned to reduce the strain applied to the unit. Do not scratch or damage the tower surface as corrosion can occur.

CAUTION:

For stainless steel 304 or 316 tower construction, it is essential that pipe fitters must not weld or grind mild steel components adjacent to faces of tower. Otherwise surface contamination will occur and corrosion of the mild steel particles will start the corrosion process and cause a rust discoloration of the stainless steel. Surface contamination of the stainless should be removed as soon as it is noticed to avoid short and long term damage to the stainless panels and basin.

2.2 ON-SITE TOWER LOCATION

Here are some guidelines for deciding on the best placement of your tower:

- For maximum air supply, install the cooling tower on an open roof area or on the ground away from any large obstacles which could reduce the air inlet efficiency.
- Ideally, the top of the cooling tower should be higher than any adjacent walls, buildings or other structures. When the top of the unit is lower than the surrounding structures, re-circulation of hot, moist air may occur, resulting in a decrease in overall tower performance.
- Tower should be located well away from and downwind of any building air intakes to further reduce the potential for aerosol to enter buildings. ASHRAE and CTI
guidelines should be closely followed. Under no circumstance should a tower be operated without drift eliminators in place and intact.

Please consult you’re TCTC Technical Manual or local TCTC Representative for other questions regarding proper tower placement.

2.3 FOUNDATION

Reinforced concrete or structural steel is recommended as the foundation for our equipment. For details of our recommended foundations see the TCTC contract drawing. Steel supports can be used, but must be adequately braced, as a rigid level foundation is vital for smooth trouble free quiet operation. Check foundations against the drawing before use.

2.4 RIGGING/LOADING

WARNING: Prior to lifting tower, check for residual water that may have accumulated in the basin during transit. Remove any excess water before lifting tower. Excess water in basin can drastically increase tower “dry” weight, causing the crane to be overloaded.

2.5 UNLOADING AND ASSEMBLY PROCEDURE

1. Series TCI towers arrive at site with the upper section(s) bolted directly to the basin. These corner and mid wall temporary bolts are to be removed and discarded. Each upper section (on multiple cells) can be lifted using chokers attached to the four lifting lugs supplied if they are a minimum of 20’ long. Once rigged, each cell is lowered to the assembly area. Note that on all upper sections and bottom outlet basins, dunnage must be provided by the customer at site to avoid damage to the individual sections prior to assembly.

2. After the upper sections have been lifted to the assembly area, lower the basin section to the ground in the assembly area-again providing any necessary dunnage to level the basin assembly. The tower is now ready for assembly.
TCTC INSTALLATION PROCEDURE (TWO-PIECE ASSEMBLY)

GENERAL

1. The following items are required for each cell to be assembled in the field:
   • TCTC supplied SS Bolts, nuts, and washers to bolt the upper section and the corner and mid-wall supports to the basin.
2. Only common hand tools are required for the installation and include, but are not limited to the following:
   • Large diameter (- ¼”) drift pins
   • Ladder(s)
   • Ratchet with sockets
   • Open end/adjustable wrench

SETTING OF TOWER SECTIONS

1. Bolt the tower corners and mid-wall supports hand tight to the basin.

2. Install all cross bracing between the mid-wall supports and hand-tighten bolts.

3. Lower the upper section onto the legs and corners using a drift pin to insure proper hole to hole alignment. Install all new bolts, nuts, and washers hand tight. LOWERING INTO THE FINAL POSITION SHOULD ONLY BE DONE AFTER FULL ALIGNMENT IS ASSURED.
4. Tighten all bolts between the basin, corners, mid-wall supports, and supplied cross-bracing prior to lifting the tower to location on site. Release crane after all bolts are tightened. Note that the inlet screens may be left out at this time, and installed when tower is secured in place.

5. On multiple cell towers where basin lifting lugs are used to lift the assembled tower, spreader bars are recommended. They must be long enough to avoid damage to the tower casing and fan assemblies. On nominal 8’, and 11’ deep towers, the overall basin and casing depth is 8’-6” to 11’-6” respectively. Single or dual spreaders are acceptable methods of lifting the towers.

6. Lift tower assembly for installation onto structural supports.

7. When vibration pads are used between the tower and the building steel, align the pads on the steel to accommodate the Engineer’s recommendations prior to setting of the tower.
8. Before bolting the basin to the steel, verify that the tower front and rear basin flanges are in reasonable contact with the mounting steel along the length of the basin. A gap of 1/4" is acceptable between the basin and bolted steel members. If the gap between the mounting flange and the steel exceeds 1/4", examine the steel assembly and the tower basin. If transportation damage to the basin is noticed, call TCTC for recommendations. If the steel is offset from the designed location, there are two solutions for this situation. (1) When practical, the steel, if bolted, a cross member can be moved to insure good contact or (2) if welded, shims can be placed between the basin and the tower support steel. Allow 24" between shims along the basin and bolt through the basin bolting locations. Relocating steel or shimming to achieve contact should be only be done when the gap exceeds 1/4" prior to connecting the piping and adding water. This procedure will eliminate any potential to introduce unforeseen stresses in the basin.

INLET SCREEN INSTALLATION

1. Once the basin has been secured to the steel, the inlet screens can be installed. Install and tighten the lower screen retaining clips to the upper basin walls.

2. Install each screen bottom edge first with the screen inlet entering down into the basin. Once all the screens are in place, install the upper holding lug on the upper surface and hand tighten with the knobs supplied by TCTC.
2.6 PIPING INSTALLATION

When installing piping connections to the tower, it is essential that there are no loads placed on the tower or supplied piping. Adequate pipe supports and expansion provisions are assumed to be considered by the customer’s engineer/contractor. It is always preferable to run the supply piping at a level below the inlet connection and then vertically up to the inlet. This avoids the return of large volumes of water from the pipework to the tower after shut down. If pipework at high level is unavoidable, a loop seal and water bleed should be fitted at the highest pipe level. A non-return valve on the pump discharge will ensure that the only water returning to the tower sump after shut down is from the header and tower pack. During operation the bleed from the top of the loop seal must be piped to drain or waste pipe - DO NOT FIT VALVES OR AUTOMATIC BLEED DEVICES ON THIS LINE.

Typical Front outlet configuration

A drain connection is provided on the underside of most basins. A drain valve should be fitted as close to the underside of the basin as possible. This will reduce the amount of debris that can accumulate in a stagnant pipe area full of water. This will reduce the possibility of a bacteria colony forming in this area.
2.7 ELECTRICAL INSTALLATION

1. On the Series TCI towers, the standard arrangement is for the motor and gearbox to be direct drive or close coupled inside the tower. The motors and gearbox low oil switch alarm (when supplied) can come pre-wired from the factory. When this is specified, the amount of field work is reduced.

2. All starters, fan thermostats, vibration switches, immersion heaters, three-way by-pass valves, and/or motor starters are supplied with your tower, wiring diagrams will be supplied attached to these individual items of equipment when the tower is shipped.

3. When specified and supplied, the vibration switch and control wiring and power wiring from the motor come pre mounted and wired inside the tower.

Typical pre-wired power and control installation

Do not under any circumstances switch on the immersion heater before there is enough water in the basin to completely cover it, as it will burn out. Starter overload protection units should be set to full load current of the motor.
SECTION 3 START-UP

Please read this section thoroughly prior to operating your TCTC cooling tower system. Although the intent of this section is not to be an “all encompassing” manual for cooling tower system start-up, the guidelines provided will assist the customer in “starting-up” the cooling tower in the safest, most efficient manner. Please contact your local TCTC representative if you would like to schedule a factory representative for “start-up” assistance on your TCTC cooling tower.

3.1 OPERATIONAL SAFETY

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 personnel safeguards should be taken with this equipment to safeguard personnel from injury and prevent damage to the equipment.

Only qualified personnel should undertake the operation, maintenance and repair of this equipment. All such personnel should be thoroughly familiar with the equipment, the associated system and controls, as well as the safe procedures for handling, lifting, installation, operation, maintenance, and repair of this equipment to prevent personal injury and/or property damage.

For the protection of authorized service personnel, the unit should be installed with a lockable disconnect switch located in close proximity and within sight of the modular cooling tower unit. No service work should be performed on or near the fan motors without first ensuring that the fan motor has been electrically disconnected and locked out.

CAUTION - The cooling tower must be located at such distance and direction as to avoid the possibility of contaminated tower discharge air being drawn into any building fresh air intake ducts. The purchaser is responsible for and should obtain the services of a Licensed Professional to certify that the location of the tower is in compliance with applicable air pollution, fire, and clean air codes.

ELECTRICAL HAZARDS WARNING

ALL ELECTRICAL POWER SHOULD BE DISCONNECTED AND LOCKED OUT BEFORE ANY SERVICING OF THE UNIT IS ATTEMPTED. COMPLY WITH LOCAL N.E.C., OSHA, AND OTHER APPLICABLE GUIDELINES.
3.2 WATER TREATMENT AT START-UP

TCTC strongly recommends that a proper water treatment program be instituted at or before startup of your cooling tower system. Failure to do so not only jeopardizes the corrosion, biological and scaling protection in your cooling tower, but also of the critical downstream equipment. Your water treatment specialist is best able to offer the appropriate treatment plan for your installation.

Do not operate this equipment without a proper water treatment program.

After an appropriate treatment plan has been established, the following steps should be performed to bring the tower “on-line”. Some of these steps may also be appropriate for a startup after an extended shutdown period.

1. Isolate your tower from downstream equipment and flush several times with water to remove any dirt, debris or residue. (This is the only step that should be performed with “untreated water”.)
2. Drain the tower, immediately after completing the flushing step. Allowing stagnant untreated water to remain in tower system for long periods of time can increase the likelihood of biofilm and scale formation.
3. Make sure the tower basin is free of any wood, trash or other debris.
4. Begin filling the tower basin and system piping through make-up water system.
5. Check water level inside of sump to assure proper float valve adjustment. The normal water level is noted on the drawings and should be verified by field measurements. If adjustment of the float valve is required, follow the instructions in Section 5.8.
6. Check all flanged connections and piping for leaks.
7. Bleed air from piping by opening bleed valve at pump until water flows out in a steady stream without interruption. Close bleed valve.
8. If the startup rate is too high, or the time to full flow is too short, the tower sump water level can be lowered to the point that the Net Positive Suction Head (NPSH) on the circulating pump becomes insufficient and the pump can cavitate. Proper water level settings are shown on the TCTC drawings and will provide the needed protection.

It is important that the system water quality be maintained from the initial tower filling through operating the tower on a daily basis.
3.3 **FANS & GEARBOXES**

1. On Series TCI towers the motors come close coupled to the gearboxes via a high temperature/humidity Rexnord elastomer coupling.

![Image of close coupled motor and gearbox](image1.png)

2. The aluminum bladed fans are mounted directly onto the gearbox output shaft and are pre-pitched at the TCTC factory. Specific of the fans and the Amarillo Gear Company gearboxes are outlined in the auxiliary equipment section of this manual (Section 8).

![Image of fan and gearbox assembly](image2.png)

3. On some belt drive fans, the motors are mounted in the field for shipping limitations. When applicable, section 8 includes the fan belt adjusting procedures.

4. Verify that the phase, voltage, etc. on motor nameplate agrees with site power supply.

5. With fan motor safely locked-out electrically, rotate the fans by hand to ensure “free running” condition.

6. Visually inspect each fan for uniform tip clearance of approximately 1/4” to 3/8” on fans up to 60” and 1/4” to 1/2” on 72” diameter and larger fans.

7. Make certain that all fan guards are secured in place.

8. Check for proper rotation of the fans by turning the fans on, then turning them off. If rotation is incorrect, a qualified electrician should interchange two of the three phases to correct the rotation.

9. Start fans and measure the amperage to determine if the fan pitch is properly adjusted. The current should not exceed the nameplate rating. *(NOTE: During winter operation conditions, or when the tower does not have a heat load applied, the current may run into the 1.15 service factor.)*
10. Check that bearings of fan and motor do not show noticeable temperature rise during 'Running-in' period or within first 24 hours of continuous running.
11. Verify that terminal box joints and wiring from outside the tower motor(s) are fastened and weatherproof. The motor and gearbox connections within the tower have been sealed at the factory.

3.4 FINAL OPERATIONAL CHECKS

Recommended final checks prior to startup of your cooling tower.

Make sure that:
1. All valves in piping system are in proper position for circulation of water.
2. Basin is filled to at least the normal operating level, as shown on the drawing in the submittal drawing package.
3. All debris has been removed from the basin, DE’s, etc.
4. Make-up valve is open to cooling tower basin.
5. All motor and fan safety circuits have been tested and are operational. (vibration and gearbox low oil alarm switches)
6. An alignment check of the motor to gearbox shows acceptable alignment between the shafts and no unusual alignment issues are present as a result of transport of the tower to site.

3.5 BALANCING WATER FLOW

On single inlet towers, there is no need to balance the flow. The system pressure drops insure uniform flow to each of the spray nozzles. On multiple inlet towers, if the piping to the tower is symmetrical, there will not be a need to balance flow between cells. On non-symmetrical inlet piping, you may need to balance the water flow between cells. The easiest way to accomplish this is to remove the drift eliminators (with fans off) and to observe the water distribution pattern over the fill on each cell. The water to individual cells can be adjusted by throttling the valve on the riser feeding each cell until the nozzle spray patterns are consistent and the resulting flow patterns over the fill on each cell are similar. This balancing should be performed at the anticipated/design flow to the tower.
SECTION 4 WINTER OPERATION

There are a few basic rules that should be followed to prevent possible damage to the TCI Series Cooling Tower during winter or freezing-temperature operation:

1. Never operate Series TCI towers fans when the exit water temperature is below 45°F. At this temperature, it would be possible to generate ice within the tower. It is good operating practice to limit the tower operation to water conditions above 40°F.

2. It is necessary for 65% of the design water flow to be maintained over the cooling tower to prevent the water loading from becoming so light that ice may start forming in the fill media.

3. If the circulating water cannot be secured, and when continuous operation in winter is expected, a winter bypass should be installed before operating the cooling tower in freezing conditions. The bypass should allow a portion of the entering hot water to go directly to the water basin. This will give the necessary control to maintain desired temperatures in the basin. Be certain to maintain ample water on the fill media to prevent the formation of ice.

4. The fans are the primary means of water temperature control. The fans will cycle “on” or “off”, based upon the exit water temperatures. When a VFD is used with your tower fan motors, the fans will not cycle, but change speed in response to changes for exit water temperature.

4.1 FREEZE PROTECTION

When towers are installed in a cold climate and operated year round, it is recommended that basin heaters be utilized. If specified and furnished for your installation, these sump immersion heaters have been supplied with a self-contained control system. This system provides for the heaters to come into service based on the set point established for each site. This feature should be checked each year for serviceability before winter operating temperatures are experienced, as well as during winter operation. The heater was sized to protect your basin down to 0ºF ambient conditions with no wind chill factor.

4.2 WINTER STORAGE

When cooling towers are not in service for any extended period of time, the water should be drained. The drain valve should be left open to prevent rain or snow from collecting in the basin. The motors should be run periodically during the storage period. Please refer to the motor manufacturer’s recommendations.

When the cooling tower needs to be shut down for short periods such as overnight or on weekends, and it is not going to be drained, a basin heater is recommended. These heaters are preprogrammed to turn on when the basin water drops to below a minimum set point, and should remain on until the temperature reaches the preprogrammed “off” value.
SECTION 5 MAINTENANCE

5.1 MAINTENANCE SAFETY REMINDERS

There are a few maintenance safety “reminders” that may be helpful to review before engaging in maintenance on your cooling tower.

A. Before working on the cooling tower, the internals should be disinfected at a level of residual chlorine of between 5 and 15 mg/l for 5 hours while the water is circulated. Before servicing or adjusting any rotating parts or electrical gear, switch off and isolate the fanset and tower electrically. You must lock-out/ensure that the power cannot be restored while an adjustment or service is in progress.

B. All rotating or moving parts must be at rest or standstill before opening the unit for service.

C. It is not likely for the cooling tower to catch fire during normal operations. If the tower is drained the internal plastic packing can catch fire if sufficient heat is applied. If the packing is PVC then the energy required to start combustion is high, however the products of combustion will contain Hydrogen Chloride and may contain Dioxin and Furans which noxious substances. Polypropylene packing and eliminators used on some “high temperature” applications require less energy to ignite, but the products of combustion are relatively harmless, i.e. carbon dioxide and water vapor.

The circulating water in a cooling tower may be harmful, and therefore under no circumstances should any maintenance be carried out while the liquid is circulating in the tower. Among the potential hazards typically presented by cooling tower water:

- Burns – It is possible for the circulating water to be hot and cause burns, especially in an industrial application.
- Chemical Exposure – Depending on the specific water treatment program employed at your site, many chemical used to control biological growth and scaling in the tower can damage human tissue and these may enter the body through the skin, through abrasions or as droplets into the nose or mouth or eyes.
- Biological Contaminants – It is also possible for bacteria or other microorganisms to be present in your circulating water, presenting a health hazard.
5.2 ROUTINE MAINTENANCE / INSPECTION SCHEDULE

The *Model TCI Series* Cooling Tower has been designed to require minimal maintenance. However, the care it receives will greatly affect the life of the tower and TCTC components. The following inspection and maintenance schedule is recommended as a minimum to ensure maximum life of the tower and TCTC components. If maintenance is required as a result of the inspection, follow the procedures identified below.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>FREQUENCY</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Motors</td>
<td>Semi-annual</td>
<td>Lubricate per manufacturers suggested schedule and procedure. (See Manual)</td>
</tr>
<tr>
<td>2. Gearbox</td>
<td>5 years</td>
<td>Change synthetic oil- “no maintenance” option gearbox. Immediately on low oil alarm switch</td>
</tr>
<tr>
<td></td>
<td>Monthly</td>
<td>Check oil level –on standard gearboxes</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>Change oil-on standard gearboxes</td>
</tr>
<tr>
<td>3. Rexnord coupling</td>
<td>Semi-annual</td>
<td>Inspect elastomer material for distortion-check for mis-alignment</td>
</tr>
<tr>
<td>4. Sump Screen</td>
<td>Monthly</td>
<td>Remove and discard any trash buildup, when applied</td>
</tr>
<tr>
<td>6. Float Valve</td>
<td>Quarterly</td>
<td>Check water level-adjust as required.</td>
</tr>
<tr>
<td>7. Basin</td>
<td>Semi-Annual</td>
<td>Check for debris or sludge build-up</td>
</tr>
<tr>
<td>8. Drift Eliminators</td>
<td>Annual</td>
<td>Insure surfaces are clean and free of algae and/or solids buildup.</td>
</tr>
<tr>
<td>10. Fill Media</td>
<td>Annual</td>
<td>Visual inspection for plugging.</td>
</tr>
<tr>
<td>11. Inlet screens</td>
<td>Semi-Annual</td>
<td>Insure surfaces are clean and free of algae and/or solids buildup.</td>
</tr>
</tbody>
</table>
5.3 DRIFT ELIMINATORS

The *TCI-Series* Cooling Tower utilizes low-pressure, high efficiency PVC drift eliminators that are impervious to rot, decay or biological attack. (High temperature applications may require an alternate material of construction for the drift eliminators). There is an ultra-violet inhibitor manufactured into the product to extend the life expectancy. These drift eliminators should be inspected once a year (in conjunction with the nozzle inspection). The drift eliminators should be free from mud and debris that can build up. If the inspection reveals that cleaning is required, the following procedure should be followed to accomplish it:

1. Slide out the drift eliminators and place them on the ground.
2. Wash the eliminators out, if required, by spraying with a low-pressure water hose.
3. Turn the eliminators over and spray until the remaining debris is removed.
4. Insert the eliminators back into place in the cooling tower.
5. If algae growth is noted, promptly consult your water treater to correct treatment deficiencies and cleaning techniques.

5.4 DISTRIBUTION SYSTEM

A routine inspection of the hot-water distribution system is recommended on an annual, or as needed basis. The distribution system can be easily inspected by visual inspection through the pack access door, or by removing the drift eliminators to expose the distribution nozzles to check for debris or sediment. Cleaning of the nozzles can be accomplished in-situ or by removing the nozzles from the spray header and washing them out. In the same manner the nozzle insert can be replaced without having to replace the entire nozzle.
5.5 FILM FILL PACK

The TCI-Series Cooling Towers have three feet of PVC cellular fill media that is the “heart” of the heat transfer that takes in your cooling tower. The life expectancy of this media is ten to fifteen years with proper water treatment and maintenance. Nevertheless, TCTC recommends at least an annual inspection of the fill media in the tower(s). Removing the pack access door on the side of the tower and pulling-out randomly selected blocks of fill quickly and easily performs this inspection. Visually inspect the water passages in the bottom side of the fill section removed to determine if any buildup is occurring.

Should your fill pack display biological growth or scaling, promptly contact your water treatment consultant to address the problem. If the buildup is significant, it may be necessary to remove the fill media and clean with low-pressure water.

Should it be necessary to remove the fill material, good safety precautions should be followed. Typically, a high-lift forklift truck is used with a pallet or platform to stack the fill material from the tower containment to lower to the ground. It is important to note that if the fill material has fouled, and requires cleaning, individual layers of fill may have gained significant weight and are not practical to safely lower to the ground without some mechanical assistance. By providing access to one side of the tower, the time to remove, clean, and replace the fill is significantly reduced.

**CAUTION:** Steam should never be used to clean the packing, as it can distort at high temperatures.

5.6 FANS / MOTORS

The following guidelines are intended only as a general outline for fan and motor maintenance. The motor(s) used on your TCTC towers may have additional requirements for maintenance depending on the manufacturer selected for your application.

A. Motor(s) should be greased with motor manufacturer’s suggested lubricant and suggested procedure and frequency.
B. Drain hole in motor (if applicable) should be checked to see that it is not blocked.
C. Inspect fan to ensure that there is no build-up of dirt or other matter that would cause overheating of the motor, out of balance running or obstruct the impeller track.

**OTHER IMPORTANT NOTES**

- Frequent stopping and starting of the motor can cause failure or burn out.
- It is not recommended to exceed 4 starts per hour.
- Ensure that single phasing does not occur. This is by far the most common cause for motor burnout.
If the fan is not in routine use, it is good idea to rotate the fan impeller on each cell once a week to prevent hardening of the grease and corrosion of the bearings.

For additional information on fans and motors, please see the respective manufacturer manuals attached in Section 8.

5.7 BASIN

Should the water be dirty, it is good practice to de-sludge the base tank of the tower. This can be done by opening the drain valve and releasing the water, then hosing clean the bottom of the cooling tower through the drain connection. This will prolong the life of your unit and keep it in good working order. The towers should be cleaned annually or as needed.

5.8 FLOAT VALVE

The Series TCI Cooling Towers utilizes a 1” to 2” float valve size depending on tower capacity. The valve is located in the basin adjacent or just below the basin access door located on the lower section of the tower. The valve is adjusted to level at the factory, however, if further adjustment is necessary, simply follow the instructions listed below. The following instructions are applicable to the float valve design used in the Series TCI towers.

Typical inlet configuration
Adjusting the Water Level (see Figure):

a. Determine the proper water level, typically called-out on submittals.
b. Turn water off which supplies the float valve (if possible).
c. Remove the basin access door.
d. Loosen the thumbscrew but do not remove.
e. Rotate the arm and stem for desired water level.
f. Tighten the thumbscrew.
g. Turn water on and verify the water level.
h. Replace the access door

Instructions for Installing Float Valve:

1. Attach valve to the tank wall and connect valve inlet to water supply.
2. Valve outlet must be $90^\circ$ to water level for bind-free operation.
3. Screw stem and float to the short arm.
4. Rotate arm and stem for desired water level, tighten short arm thumbscrew.
5. Verify water level during operation.
5.9 TOWER CLEANING

Even if scaling, bio-growth or sludge build-up do not necessitate the “routine” cleaning of your cooling tower(s), it is recommended that some frequency of cooling tower cleaning be established to combat the microbiological growth that leads to health-related issues, such as Legionnaires’ Disease. Though there is no way to completely eliminate the risk of Legionella transmission from your cooling tower, an appropriate water treatment program and proper maintenance (cleaning/disinfecting) can significantly reduce the risk.

A. Legionella Control

To control microbiological growth in your cooling tower system, particularly Legionella Pneumophila, the following steps are recommended as minimum:

1) Install a suitable water treatment system to restrict corrosion, the build-up of scale and biological contaminations.

2) Install an automatic filtration system to limit suspended solids in your cooling tower circulating water.

3) Thoroughly clean and disinfect your cooling tower system annually.

For additional recommendations for control of Legionella, refer to section 1.2.4 Water Treatment Health and Safety considerations.

B. Maintenance, Cleaning and Disinfection

For a typical system our recommendations are as follows:

a) The cooling tower system should be thoroughly inspected at least once a year, which will include checking the following tower components.

- Fan and Drive assembly
- Drift Eliminators
- Water Distribution System
- Cooling tower pack
- Louvers and Screens if fitted
- Basin
- Float Valve
- Immersion Heater and trace heating
- Cooling Tower internals including support etc.

b) In addition to above, depending on the condition of the cooling tower, the aforementioned components should be thoroughly cleaned as needed to minimize the risk of Legionella breeding and/or transmission from your tower.
SECTION 6 RECOMMENDED SPARE PARTS LIST

Spare parts for your cooling tower should not be necessary for several years, as long as that the tower is properly maintained and cleaned at regular intervals. However, as with any system critical to the operation of a business, it is recommended that the customer maintain an inventory of tower spare parts to minimize equipment downtime. The recommended minimum inventory for most applications is presented in the table below. The customer is responsible for selecting, purchasing, and maintaining the inventory consistent with his own needs.

Table 6.1

<table>
<thead>
<tr>
<th>PARTS</th>
<th>SINGLE CELL INSTALLATIONS</th>
<th>MULTIPLE CELL INSTALLATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fans</td>
<td>1</td>
<td>1 for every 3 cells</td>
</tr>
<tr>
<td>Motors</td>
<td>1</td>
<td>1 for every 3 cells</td>
</tr>
<tr>
<td>Gearbox</td>
<td>1</td>
<td>1 for every 4 cells</td>
</tr>
<tr>
<td>Float Valve</td>
<td>1</td>
<td>1 for every 2 cells</td>
</tr>
<tr>
<td>Basin heater</td>
<td>1</td>
<td>1 for every 3 cells</td>
</tr>
</tbody>
</table>

Please contact your local TCTC representative to purchase these items.
SECTION 7  CONTRACT SPECIFIC ENCLOSURES

Contract specific enclosures have been provided under separate cover during the design review stage of the project.
SECTION 8 AUXILIARY EQUIPMENT MANUALS

1. FAN
2. MOTOR
3. GEARBOX & LOW OIL ALARM SWITCH
4. ELASTOMER COUPLING
5. VIBRATION SWITCH
6. CONTROL SYSTEM
7. BASIN HEATER