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Bulletin 113C-AU

Operation & Maintenance Instructions

FOR EVAPCO FIBREGLASS COOLING TOWERS, CLOSED CIRCUIT COOLERS, AND EVAPORATIVE CONDENSERS

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Introduction

Congratulations on the purchase of your EVAPCO evaporative cooling unit. EVAPCO equipment is constructed of the highest quality materials and designed to provide years of reliable service when properly maintained.

Evaporative cooling equipment is often remotely located and periodic maintenance checks are often overlooked. It is important to establish a regular maintenance program and be sure that the program is followed. This bulletin should be used as a guide to establish a program. A clean and properly serviced unit will provide a long service life and operate at peak efficiency.

This bulletin includes recommended maintenance services for unit start up, unit operation and unit shutdown and the frequency of each. Please note the recommendations of frequency of service are minimums. Services should be performed more often when operating conditions necessitate. This manual applies to all of the following EVAPCO product lines:

	Open Circuit Cooling Tower	Closed Circuit Fluid Cooler	Evaporative Condenser
Induced Draft	MSS	MFC	MEC
Forced Draft	LRTF	LRWF	LRCF
Crossflow	AQX		

Closed circuit fluid coolers and evaporative condensers are supplied with pumps, open circuit cooling towers are not.

The manual must be read in conjunction with any requirements of the local authorities having jurisdiction concerning any relevant matters such as:

(a) Associated building work

(b) Electrical safety aspects.

(c) Environmental and public health issues.

(d) Environmental protection measures.

(e) Occupational health and safety precautions.

(f) Licensing of particular trade personnel.

(g) Work of water supply, drainage and trade waste.

In respect of the relevant State or Territory of Australia, the requirements of the applicable principal legislation (eg. Act) and secondary legislation (eg. Regulation) can usually be obtained from the Internet at www.austlii.edu.au. Enquire of the relevant authority as to the title for the applicable legislation.

If you have any questions about the operation or maintenance of this equipment contact your local EVAPCO representative or visit www.evapco.com.au.

Safety Precautions

Qualified personnel should use proper care, procedures and tools when operating, maintaining or repairing this equipment in order to prevent personal injury and/or property damage. The warnings listed below are to be used as guidelines only.

WARNING: **Before beginning any maintenance work make sure that the power is turned off and the unit is properly locked and tagged out.**

WARNING: **This equipment should never be operated without fan screens and access doors properly secured and in place.**

WARNING: **A lockable disconnect switch should be located within sight of the unit for each fan motor associated with this equipment. Before performing any type of service or inspection of the unit make certain that all power has been disconnected and locked in the "OFF" position.**

WARNING: **The top horizontal surface of any unit is not intended to be used as a working platform. No routine service work is required from this area.**

WARNING: **The recirculating water system may contain chemicals or biological contaminants including Legionella Pneumophila, which could be harmful if inhaled or ingested. Direct exposure to the discharge airstream and the associated drift generated during operation of the water distribution system and/or fans, or mists generated while cleaning components of the water system require respiratory protection equipment approved for such use by governmental occupational safety and health authorities.**

LOCATION: **All cooling equipment should be located as far away as possible from occupied areas, open windows or air intakes to buildings.**

LOCAL REGULATIONS: **Installation and operation of cooling equipment may be subject of local regulations, such as establishment of risk analysis. Ensure regulatory requirements are consistently met.**

Initial Storage and/or Idle Period Recommendations

If the unit will sit for idle periods of time it is recommended that the following be performed in addition to all component manufacturers recommended maintenance instructions.

- The fan shaft bearings and fan motor bearings need to be turned by hand at least once a month. This can be accomplished by tagging and locking out the unit's disconnect, grasping the fan assembly and rotating it several turns.
- The pump motor bearings need to be turned by hand at least once a month. This can be accomplished by tagging and locking out the unit's disconnect, removing the pump motor fan guard, grasping the fan assembly, and rotating it several turns..
- If unit sits longer than 3 weeks, lubricate the fan shaft bearings and motor adjustment all-thread bolt. Check pulleys and bushings for corrosion. Scrape and coat with ZRC as needed.
- If unit is equipped with gear drive option and is expected to sit for less than 3 weeks run gear reducer for 5 minutes weekly. If unit sits longer than 3 weeks, completely fill gear reducer with oil. Drain the oil down to normal level prior to running.
- If unit sits longer than one month, insulation test motor windings semi-annually.
- If fan motor sits idle for at least 24 hours while the spray pumps are energized distributing water over the coil, motor space heaters are suggested and (if equipped) should be energized. Alternatively, fan motors may be energized for 10 minutes, twice daily, to drive any moisture condensation out of the motor windings.

Initial and Seasonal Start-Up Checklist

General

1. Verify that the overall installation reflects the requirements of the installation guidelines found in EVAPCO Equipment Layout Manual available at www.evapco.com.au.
2. For multi-speed fan motors, verify that 30 second or greater time delays are provided for speed changes when switching from high to low speed. Also check to see if interlocks are provided to prevent simultaneously energizing high and low speed.
3. Verify all safety interlocks work properly.
4. For units operating with a variable speed drive, make certain that minimum speed requirements have been set. Check with VSD manufacturer for recommended minimum speeds. Check with VSD manufacturer for recommendations on locking out resonance frequencies. See "Fan System Capacity Control" section on page 17 for more information.
5. Verify that the sensor used for fan sequencing and by-pass valve control is located downstream of the point where the by-pass water mixes with the condenser supply water, if applicable.
6. Verify that a water treatment plan has been implemented. See "Water Treatment and Water Chemistry of the Recirculated Water System" section for more details.
7. For units subject to freezing climates, high humidity climates, or idle periods lasting 24 hours or more, motor space heaters (if equipped) should be energized. Alternatively, fan motors may be energized for 10 minutes, twice daily, to drive any moisture condensation out of the motor windings.
8. If the unit is going to sit idle for an extended period of time, follow all manufacturers' fan motor and pump instructions for long term storage. Plastic sheets or tarps should never be used to protect a unit during storage. This practice can trap heat inside the unit and cause damage to plastic components. See your local EVAPCO representative for additional information on unit storage.
9. **Before beginning any maintenance work make sure that the power is turned off and the unit is properly locked and tagged out.**

Before the unit has been energized, check the following:

1. Clean and remove any debris, such as leaves and dirt from the air inlets.
2. Flush the cold water basin (with the strainer screens in place) to remove any sediment or dirt.
3. Remove the strainer screen, clean, and reinstall.
4. Check mechanical float valve to see if it operates freely.
5. Inspect water distribution system nozzles and clean as required. Check for proper orientation.
6. Check to ensure drift eliminators are securely in place and in the proper orientation.
7. Adjust fan belt tension as required. See "

8. Fan Belt Adjustment" section on page 15.
9. Lubricate fan shaft bearings prior to seasonal start-up.
10. Turn the fan(s) and pump(s) by hand to insure they turn freely without obstructions.
11. Visually inspect the fan blades. Blade clearance should be approximately 10 mm (6 mm minimum) from tip of blade to the fan cowl. The fan blades should be securely tightened to the fan hub.
12. If stagnant water remains anywhere in the system including "dead legs" in the piping, the unit must be disinfected *before* the fans are energized. Please refer to ASHRAE Guideline 12-2000 and CTI guideline WTP-148 for more information.
13. Fill the cold water basin manually up to the overflow connection.

After the unit has been energized, check the following:

1. Fill the cold water basin to the proper operating level. See "Operating Level of Cold Water Basin" section for more details.
2. Adjust mechanical float valve to ensure continuous operation at proper water level.
3. Verify fan is rotating in proper direction.
4. Start the spray water pump and check for proper rotation as indicated by the arrow on the front cover.
5. Measure voltage and current on all three power leads of pump and fan motor. The current must not exceed the motor nameplate full load amp rating multiplied by the service factor.
6. Adjust bleed valve to proper flow rate. Maximum bleed off rate is 0.4 l/s per 1000 kW of heat rejection. Consult your qualified water treatment specialist to determine the appropriate bleed rate for your situation.

Maintenance Checklist

PROCEDURE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. Clean pan strainer – monthly or as needed												
2. Clean and flush pan* – quarterly or as needed												
3. Check bleed-off valve to make sure it is operative – monthly												
4. Lubricate pump and pump motor according to manufacturer's instructions												
5. Check operating level in pan and adjust float valve if necessary – monthly												
6. Check water distribution system and spray pattern – monthly												
7. Check drift eliminators – quarterly												
8. Check the fan blades for cracks, missing balancing weights, and vibrations – quarterly												
9. Lubricate fan shaft bearings – every 1000 hours of operation or every three months												
10. Lubricate fan motor bearings – see mfg's instructions. Typically for non-sealed bearings, every 2-3 years. Not required for sealed bearings.												
11. Check belt tension and adjust – monthly												
12. Inspect and grease sliding motor base – annually or as needed												
13. Check fan screens, inlet louvers, fans. Remove any dirt or debris – monthly												
14. Inspect and clean protective finish – annually • Galvanized: scrape and coat with ZRC • Stainless: clean and polish with a stainless steel cleaner.												
15. Check water quality for biological contamination. Clean unit as needed and contact a water treatment company for recommended water treatment program* – regularly												

OPTIONAL ACCESSORIES

1. Gear Reducer – Check oil level with unit stopped – 24 hours after start-up & monthly												
2. Gear Reducer/Piping – Do visual inspection for oil leaks, auditory inspection for unusual noises and vibrations – monthly												
3. Gear Reducer – Replace oil – semi-annually												
4. Oil Pump – Do visual inspection for leaks and proper wiring – monthly												
5. Gear Reducer/Coupling – Check alignment of the system – 24 hours after start-up & monthly												
6. Coupling/Shaft – Inspect flex elements and hardware for tightness, proper torque & crack/deterioration – monthly												

PROCEDURE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
7. Heater Controller – Inspect controller and clean probe ends – quarterly												
8. Heater – Inspect junction box for loose wiring and moisture – one month after start-up and semi-annually												
9. Heater – Inspect elements for scale build-up – quarterly												
10. Electronic Water Level Controller – Inspect junction box for loose wiring and moisture – semi-annually												
11. Electronic Water Level Controller – Clean probe ends of scale build-up – quarterly												
12. Electronic Water Level Controller –Clean inside the standpipe – annually												
13. Solenoid Make-up Valve – Inspect and clean valve of debris – as needed												
14. Vibration Switch (mechanical) – Inspect enclosure for loose wiring and moisture – one month after start-up and monthly												
15. Vibration Switch – Adjust the sensitivity – during start-up and annually												
16. Sump Sweeper Piping – Inspect and clean piping of debris – semi-annually												
17. Water Level Indicator – Inspect and clean – Annually												
DURING IDLE PERIODS:												
1. Two or more days: Energize motor space heaters or run motors for 10 minutes twice daily												
2. Less than three weeks: Run gear reducer for 5 minutes – weekly												
3. More than three weeks: Completely fill gear reducer with oil. Drain to normal level prior to running.												
4. One month or longer: Rotate motor shaft / fan 10 turns – bi-weekly												
5. One month or longer: Megger test motor windings – semi-annually												

Seasonal Shut-Down Checklist

When the system is to be shut down for extended periods of time, the following services should be performed:

1. The cold water basin should be drained, flushed, and cleaned with the suction strainer screens in place.
2. The suction strainer screens should be cleaned and re-installed.
3. The cold water basin drain connection should be left open to prevent rain water accumulation.
4. The fan shaft bearings and motor base adjusting screws should be lubricated.

5. The water make-up valve should be closed. All water make-up supply, overflow and drain piping should be drained or heat traced and insulated in freezing climates.
6. The exterior surfaces of the unit should be inspected, cleaned and refinished as needed.
7. The fan shaft bearings, fan motor bearings, and pump bearings should be turned at least once per month by hand. This can be accomplished by making sure the power disconnect is locked and tagged out then grasping the fan assembly rotating it several turns by hand.
8. Energize motor space heaters if supplied.
9. See fan motor and pump manufacturer maintenance and long terms storage for more detailed instructions.
10. Closed Circuit Coolers only – If the recommended minimum fluid flows thru the heat transfer coil cannot be maintained and an anti-freeze solution is not in the coil, the coil must be drained immediately whenever the system pumps are shut down or flow stops during freezing conditions. This is accomplished by having automatic drain valves and air vents in the piping to and from the cooler. Care must be taken to ensure that the piping is adequately insulated and sized to allow the water to flow quickly from the coil. This method of protection should be used only in emergency situations and is neither a practical nor recommended method of freeze protection. Coils should not be drained for an extended period of time as internal corrosion may occur. See "Freeze Protection of Closed Circuit Cooler Coils" section of this document for more details.

Basic Cooling Tower Sequence of Operation

System Off / No Load

The system pumps and fans are off. If the basin is full of water a minimum basin water temperature of 4.5 ºC must be maintained to prevent freezing. This can be accomplished with the use of optional basin heaters. See the "Cold Weather Operation" section of this bulletin for more details on cold weather operation and maintenance.

System / Condensing Temperature Rises

The system pump turns on. The unit will provide approximately 10% cooling capacity with only the pump running.

NOTE: If the load is such that simply running the system pump with the unit fan motor idle is sufficient, motor space heaters (if equipped) should be energized while the motor is idle. Alternatively, the motor can be energized twice daily for a minimum of 10 minutes to protect the motor insulation from damage. If the system temperature continues to rise, the unit fan is cycled on. For a variable speed controller, the fans are turned on to minimum speed. See the "Fan System – Capacity Control" section of this bulletin for more details on fan speed control options. If the system temperature continues to rise, then the fan speed is increased as required, up to full speed.

NOTE: During sub-freezing weather the minimum recommended speed for variable speed controllers is 50%. ALL FANS IN OPERATING CELLS OF MULTIPLE CELL UNITS MUST BE CONTROLLED TOGETHER TO PREVENT ICING ON THE FANS.

System Temperature Stabilizes

Control the leaving water temperature by modulating the fan speeds with variable speed drives or by cycling fans on and off with single or two-speed drives.

System Temperature Drops

Decrease the fan speed, as required.

System Off / No Load

The system pump turns off. The starter interlock will energize any optional basin heaters in cold weather. The recirculation pump should not be used as a means of capacity control, and should not be cycled frequently. Excessive cycling can lead to scale build-up, and reduce wet and dry performance.

Bypass Mode

During winter months when cooling load is minimal, bypass mode may be used as a form of capacity control. Bypass mode allows the water to "bypass" the tower's water distribution system and deposits the inlet water directly into the cold water basin. Alternatively, the incoming water bypass can be piped directly to the return condenser header pipe. Please note: The location of the bypass valve should be 15 feet below the cooling tower cold water basin elevation to assure proper operation and prevent cavitation. This bypass mode should be continued until the total water inventory reaches an acceptable temperature level (usually about 80°F), at which time the bypass may be closed to cause total flow over the fill. EVAPCO does NOT recommend a partial water bypass due to the potential for freezing the heat transfer media during low ambient operation.

Optional Defrost Cycle

In more severe climates, the incorporation of a defrost cycle may be used to manage the ice formation in and on the unit. During the defrost cycle, the cooling tower fan(s) are reversed at no more than half speed while the system pump flows water through the cooling tower's water distribution system. Operating the unit in "reverse" will melt any ice that has formed in the unit or on the intake louvers. All multi-speed or VFD duty motors supplied by EVAPCO, whether for standard belt drive or optional gear drive induced draft units, are capable of reverse operation.

Defrost cycles are NOT recommended for forced draft cooling towers. In these units, allowing the leaving water temperature set point to rise causes the fans to be off for very long periods of time, which increases the fan drive component potential for freezing. In lieu of a defrost cycle, forced draft units should be operated at low speed (with a 2-speed motor) or minimum speed (no lower than 25% with a variable frequency drives) in order to maintain positive pressure inside the unit to help prevent ice formation on the fan drive components.

NOTE: MINIMUM CONTROL POINT FOR WATER SHOULD NEVER BE LOWER THAN 5.5 ºC.

Basic Closed Circuit Cooler / Evaporative Condenser Sequence of Operation

System Off / No Load

The system pumps and fans are idle. If the basin is full of water it must be maintained at 5.5 ºC or greater to prevent freezing. In some climates it may be necessary to use basin water heaters. See the "Cold Weather Operation" section of this bulletin for more details on cold weather operation and maintenance.

System / Condensing Temperature Rises

The spray pump(s) energises. The unit provides approximately 10% of cooling capacity with the spray pump energised and the fan idle. If the unit has closure dampers they should be fully opened before the spray pump(s) become energised.

As the system temperature continues to rise the fan is energised. For a system having variable speed fan control, the fans begin at minimum speed. See the "Fan System Capacity Control" section of this bulletin for more details on fan speed control options. The fan speed increases with increasing system heat load.

Note: In freezing weather conditions the fan speed should be 50% of greater to prevent ice formation on inlet louvers. For multi-cell units all fans should be operated simultaneously to prevent ice formation on the fan blades.

System Temperature Stabilizes

Control the leaving fluid temperature (closed circuit coolers) or condensing temperature (evaporative condensers) by modulating the fan speeds with variable speed drives or by cycling fans on and off with single or two-speed drives.

System / Condensing Temperature Drops

Decrease the fan speed as required.

System Off / No Load

The system pump turns off. The starter interlock should energise basin heaters (if applicable) in cold weather. The spray pump should not be used as a means of capacity control, and should not be cycled frequently. Excessive cycling can lead to scale build-up on the coils.

Dry Operation

During colder winter months it may be possible to turn off the spray pump, drain the basin, and operate fans only. Be sure to leave the basin drain open during this time to prevent collection of rain water, snow, or any other precipitation. If the unit has closure dampers they should be fully opened before the fan(s) are energised. If dry operation is to be used on centrifugal fan units make sure that the motor and drives have been properly sized to handle the reduction in static pressure experienced when the spray water is turned off.

NOTE: MINIMUM CONTROL POINT FOR PROCESS FLUID SHOULD NEVER BE LOWER THAN 5.5º C.

NOTE: WHEN A UNIT IS PROVIDED WITH CLOSURE DAMPERS, THE CONTROL SEQUENCE SHOULD CYCLE THE DAMPERS OPEN AND CLOSED ONCE A DAY REGARDLESS OF CAPACITY REQUIRMENTS TO PREVENT THE ASSEMBLY FROM SEIZING. THE FAN MOTOR SHOULD BE DE-ENERGISED WHENEVER THE DAMPERS ARE IN THE CLOSED POSITION.

Fan System

The fan drive systems must be properly maintained in order to provide longevity in operation. The following maintenance schedule is recommended.

Fan Motor Bearings

Standard fan motors are IP56 rated and suitable for use in cooling towers, closed circuit coolers, and evaporative condensers. Each motor should be inspected to determine if it has greasable or permanently lubricated and sealed bearings. If the motor has greasable bearings then follow the motor manufacture recommendation for greasing interval. If the motor is provided with sealed bearings then no greasing is required. After extended shut-down periods the motor should be checked with an insulation tester prior to restarting the motor.

Fan Shaft Ball Bearings

The vast majority of EVAPCO products use ball type fan shaft bearings. On induced draft units lubricate the fan shaft bearings every 1,000 hours of operation or every three months, whichever comes first. On forced draft units lubricate the fan shaft bearings every 2,000 hours of operation or every six months, whichever comes first. High temperatures or poor environmental conditions may necessitate more frequent lubrication.

Use any of the following synthetic waterproof, polyurea inhibited greases which are suitable for operation between -7°C and 170°C (for colder operating temperatures, contact the factory).

Table 1: Ball bearing lubricants

Brand	Type
Mobil	Polyrex EM
Chevron	SRI
Timkin	Pillowblock Grease

Feed grease slowly into the bearings to avoid damaging the seals. A hand grease gun is recommended for this process. When introducing a new type of grease, all previous grease should be purged from the bearings.

Fan Shaft Sleeve Bearings

A limited number of forced draft EVAPCO products use sleeve type fan shaft bearings at intermediate points along the fan shaft. These intermediate sleeve bearing(s) require different grease and must be lubricated before unit start up. The reservoir should be checked several times during the first week to ensure that the oil reserve is brought to full capacity. After the first week of operation lubricate the bearing(s) every 1,000 hours of operation or every three months, whichever comes first. High temperatures or poor environmental conditions may necessitate more frequent lubrication. The oil reservoir consists of a large felt packed cavity within the bearing housing. It is not necessary to maintain the oil level within the filler cup. Use one of the following industrial grade, non-detergent mineral oils.

Table 2: Sleeve bearing lubricants

Brand	Type for Ambient Temperature -30°C to 0°C	Type for Ambient Temperature 0°C to 38°C
Texaco	Capella WF 32	Regal R&O 220
Drydene	Refrig. Oil 3G	Paradene 220
Exxon	N/A	Terrestic 220

Do not use a detergent based oil or those designated heavy duty or compounded. Most automotive oils are detergent based and may not be used. Detergent oils will remove the graphite in the bearing sleeve and cause bearing failure.

All bearings used on EVAPCO equipment are factory adjusted and self aligning. Do not disturb bearing alignment by tightening the sleeve bearing caps. Oil Drippage may result from over-oiling or from using too light of an oil. Should this condition persist with correct oiling it is recommended that a heavier weight oil be used.

Fan Belt Adjustment

The fan belt tension should be checked at start up and again after the first 24 hours of operation to correct for any initial stretch. To properly adjust the belt tension, position the fan motor so that the fan belt will deflect approximately 10 mm when moderate pressure is applied midway between the sheaves. Figure 1 and Figure 2 show two ways to measure this deflection. Belt tension should be checked on a monthly basin. A properly tensioned belt will not “chirp” or “squeal” when the fan motor is started.

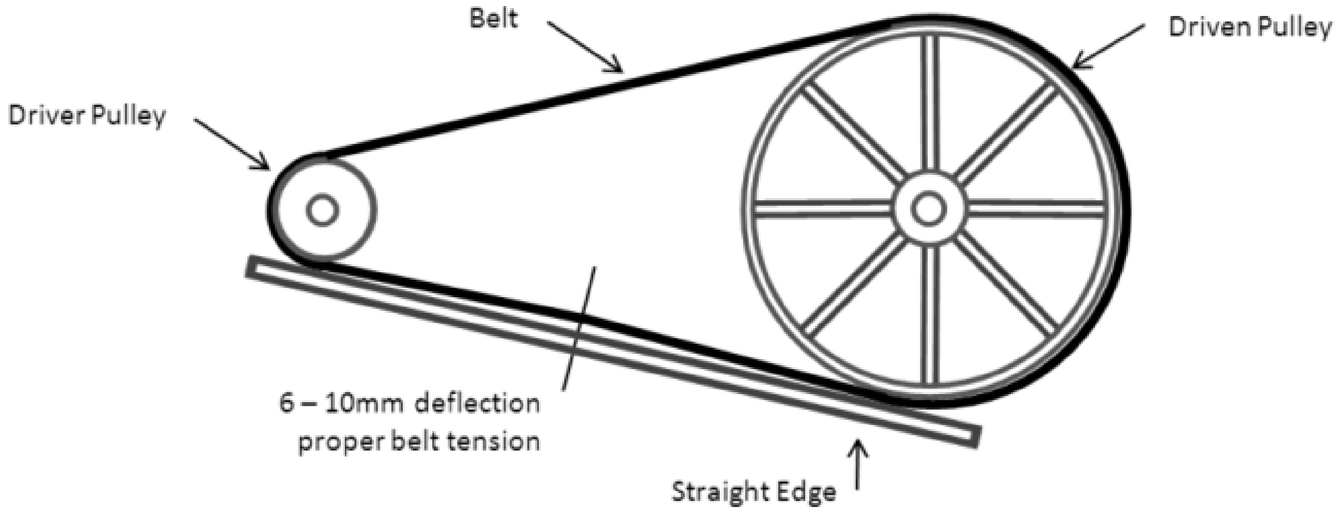

Figure 1: Belt adjustment method 1

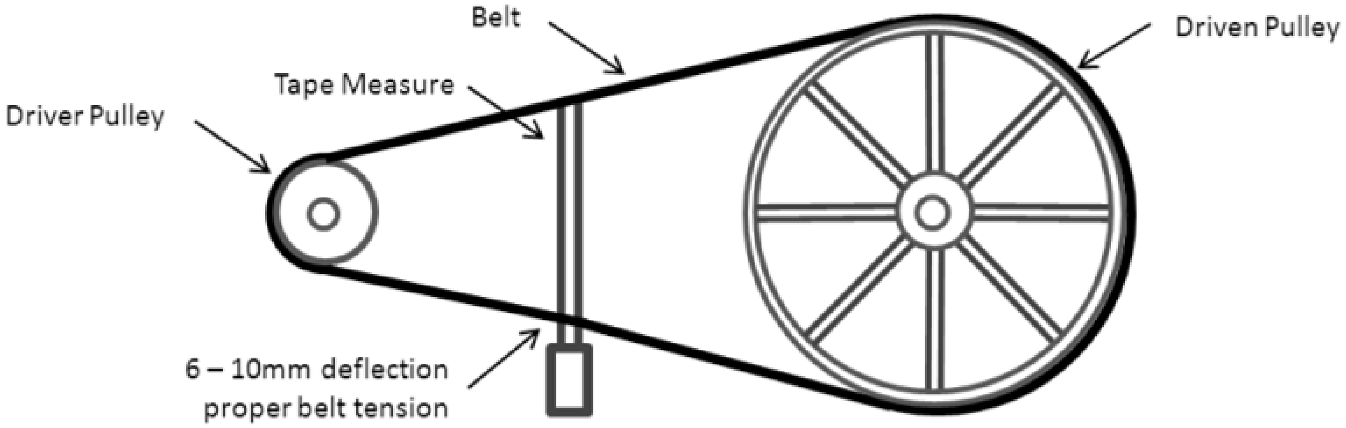

Figure 2: Belt adjustment method 2

On induced draft units provided with a belt drive arrangement as shown in Figure 3 all belt-tensioning bolts on the adjustable motor base should have an equal amount of exposed thread for proper pulley and belt alignment. On induced draft units provided with a direct drive arrangement as shown in Figure 4 no belts are provided and no adjustment is required.

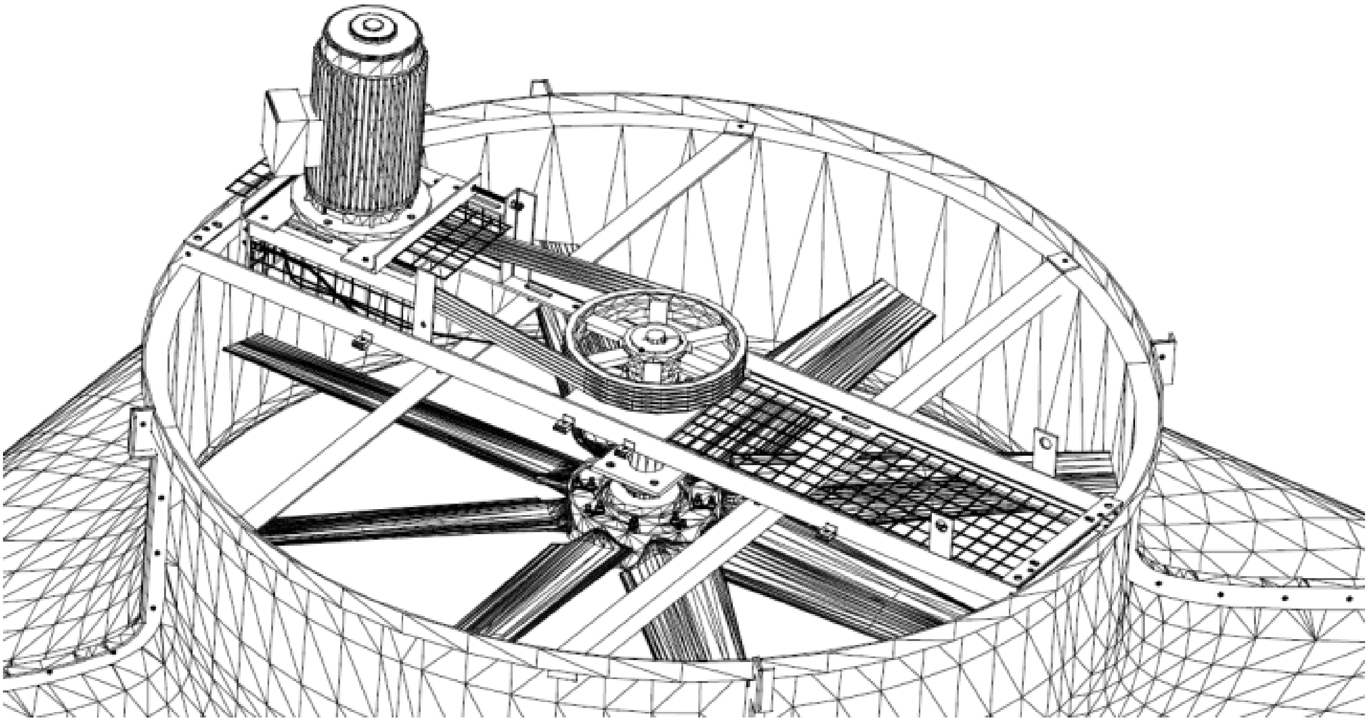

Figure 3: Belt Drive Arrangement

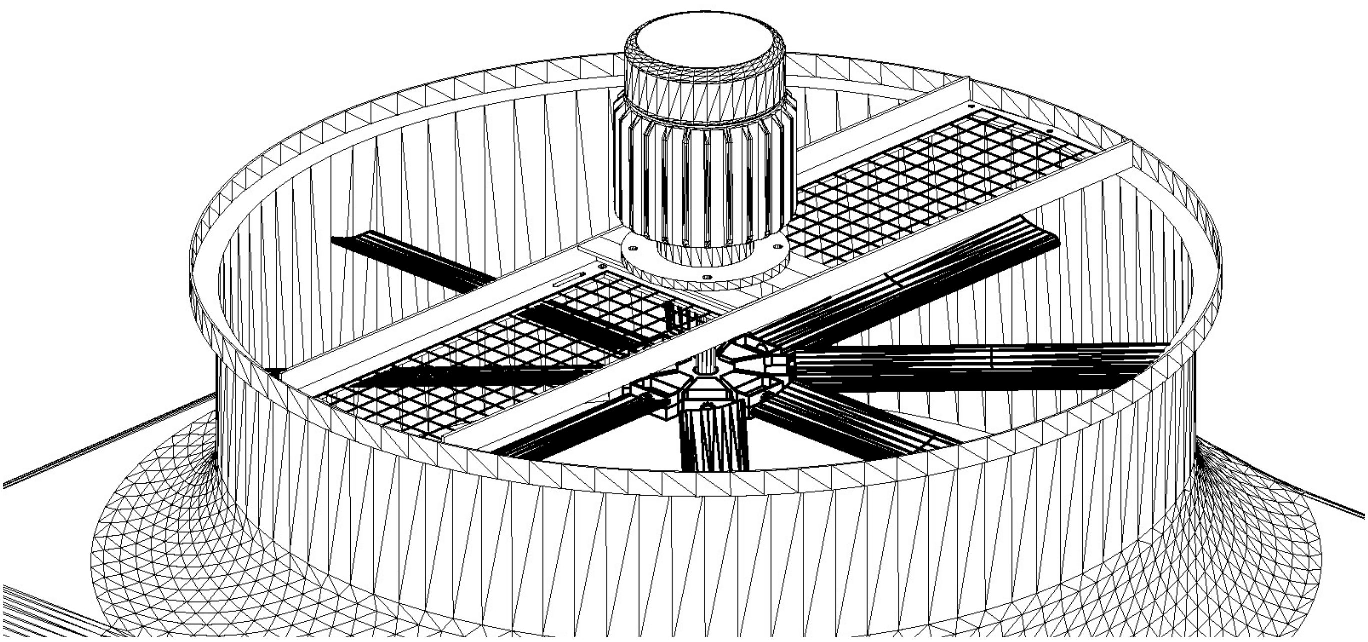

Figure 4: Direct Drive Arrangement

On forced draft units the belt tension is adjusted by turning the adjustment nut as circled below. Tension the belt by turning the nut counter-clockwise.

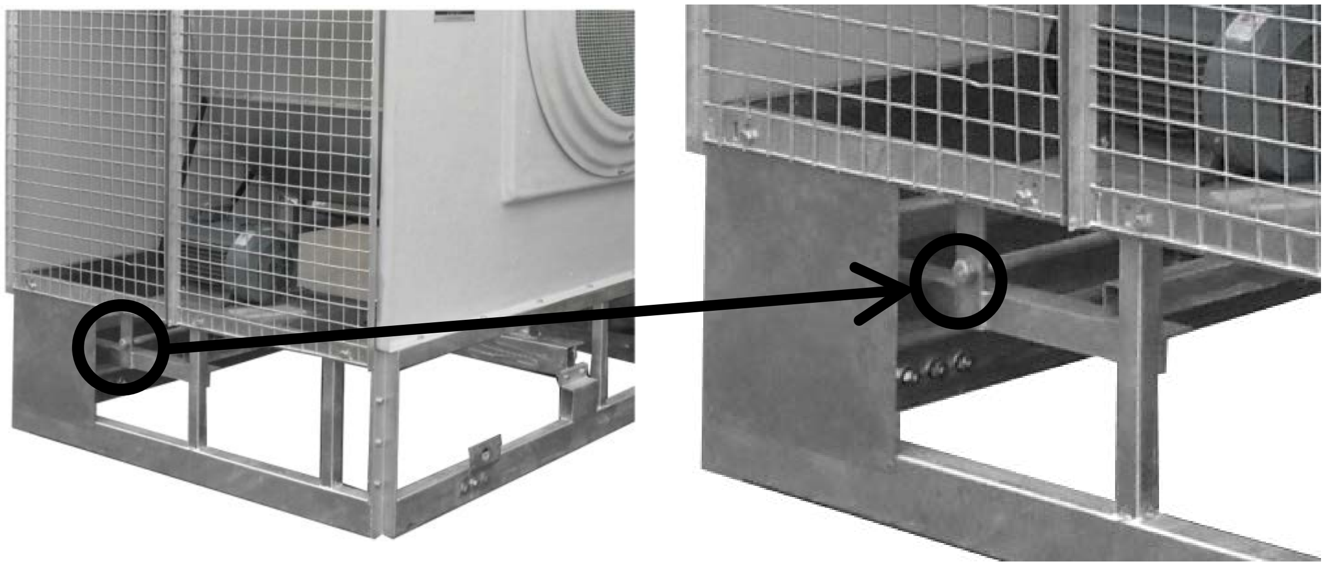

Figure 5: Forced draft belt drive arrangement

Gear Drives

Induced draft units with gear drive systems require special maintenance. Please refer to the gear manufacturer's recommended maintenance instructions. These will be enclosed and shipped with the unit.

Air Inlet

Inspect the air inlet louvers (induced draft units) or fan screens (forced draft units) monthly to remove any paper, leaves or other debris that may be blocking airflow into the unit.

Fan System Capacity Control

Capacity control can be achieved by (a) cycling of single speed motors, (b) two speed motors, or (c) variable speed drives. In all cases, if motors are idle for extended periods of time with water still being directed over heat transfer media, motor space heaters are suggested.

Fan Motor Cycling

Fan motor cycling requires the use of a single stage thermostat which senses the leaving water temperature (cooling towers), leaving fluid temperature (closed circuit cooler), and condensing temperature (evaporative condensers). The contacts of the thermostat are wired in series with the fan motor's starter holding coil. Fan motor cycling is often found to be inadequate where the load has a wide fluctuation. In this method, there are only two stable levels of performance: 100% of capacity when the fan is on and approximately 10% of capacity when the fan is off. Please note that rapid cycling of the fan motors should be avoided as it can damage the motor. **Controls should be set to limit a maximum of six (6) start/stop cycles per hour.**

Two Speed Motors

The use of a two speed motor provides an additional step of capacity control when used with the fan cycling method. The low speed of the motor provides about 60% of full speed capacity.

Two speed capacity control systems require a two speed motor, a two stage thermostat, and the proper two speed motor starter. The most common two speed motor is a variable torque single winding/consequent pole type. Two speed motors are also available with two internal windings. Be sure to select the proper starter that matches either a single or two winding variable torque motor. For any two speed motor the starter controls must be equipped with a decelerating time delay relay in order to prevent damage to the motor. The time delay when switching from high speed to low speed should be a minimum of 30 seconds.

Sequence of Operation for Two Fan Units with Two Speed Motors during Peak Load

1. Both fan motors on full speed – full water flow over both cells
2. One fan motor on high speed, one fan motor on low speed – full water flow over both cells
3. Both fan motors on low speed – full flow over both cells
4. One fan motor on low speed, one fan motor off – full water flow over both cells
5. Both fan motors off – full water flow over both cells
6. Both fan motors off – full single cell flow through one cell

Variable Speed Drives

The use of a variable speed drive (VSD) provides the most precise method of capacity control. A VSD is a device that converts a fixed AC voltage and frequency and changes it into an AC adjustable voltage and frequency used to control the speed of an AC motor. By adjusting the voltage and frequency, the AC induction motor can operate at many different speeds.

The use of VSD technology can also benefit the life of the mechanical components with fewer and smoother motor starts and built in motor diagnostics. VSD technology has particular benefit on evaporative cooling units operating in cold climates where airflow can be modulated to minimize icing and reversed at low speed for de-icing cycles. Applications using a VSD for capacity control must also use a motor designed for inverter application. The standard fan motors supplied by EVAPCO are not intended for use with VSD’s.

NOTE: VSD's should <u>not</u> be used on pump motors. The pumps are designed to be operated at full speed and are not intended to be used as capacity control

The type of motor, manufacturer of the VSD, motor lead lengths (between the motor and the VSD), conduit runs and grounding can dramatically affect the response and life of the motor. The motor lead length restrictions vary with the motor vendor. Regardless of motor supplier, minimizing motor lead length between the motor and the drive is good practice.

Sequence of Operation for Multi-fan Units with a VSD during Peak Load

1. The VSDs should all be synchronized to speed up and slow down uniformly.
2. The VSDs need to have a pre-set shutoff to prevent water temperatures from becoming too cold and to prevent the drive from trying to turn the fan at near zero speed.
3. Operating below 25% of motor speed achieves very little return in fan energy savings and capacity control. Check with your VSD supplier if operating below 25% is possible.

For more details on the use of variable speed drives, please request a copy of EVAPCO’s Engineering Bulletin on variable speed drives from your local representative.

Recirculated Water System Routine Maintenance

Suction Strainer in Cold Water Basin

The water basin strainer should be removed and cleaned at least monthly. The strainer is the first line of defence in keeping debris out of the system. Make certain that the strainer is properly located over the pump suction.

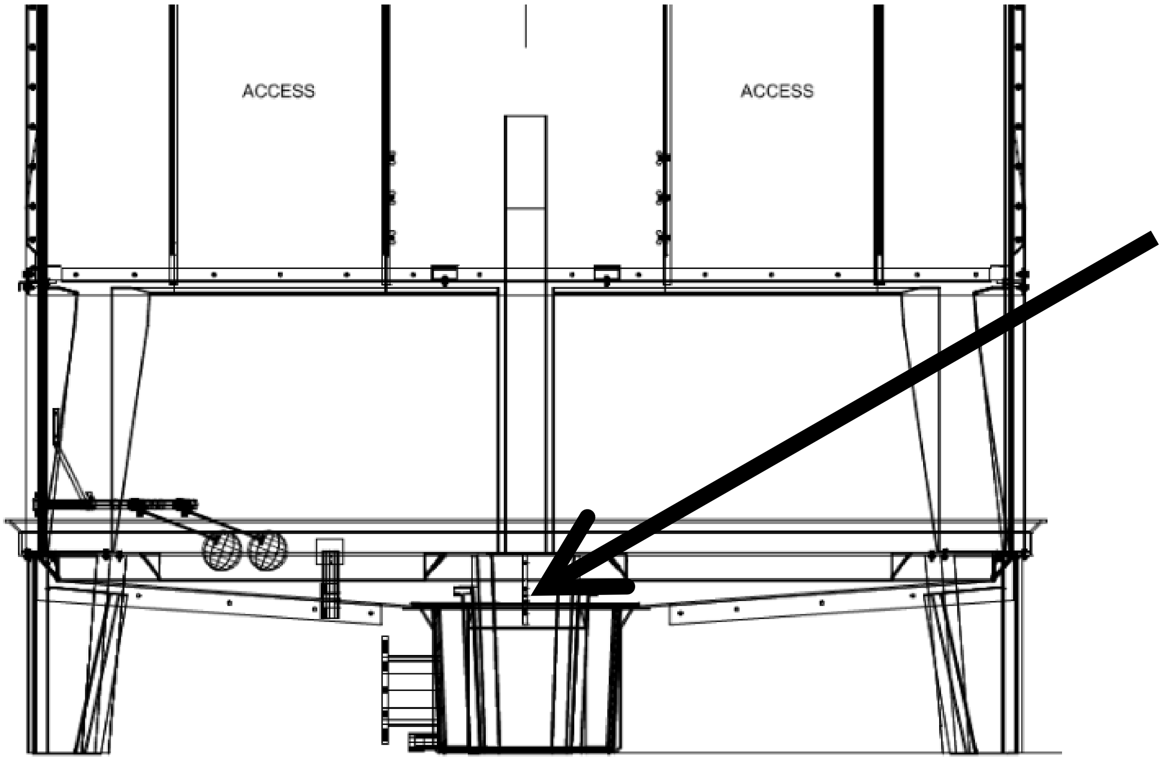

Figure 6: Elevation view of cold water basin on an induced draft, counterflow unit. Suction strainer location is indicated by black arrow.

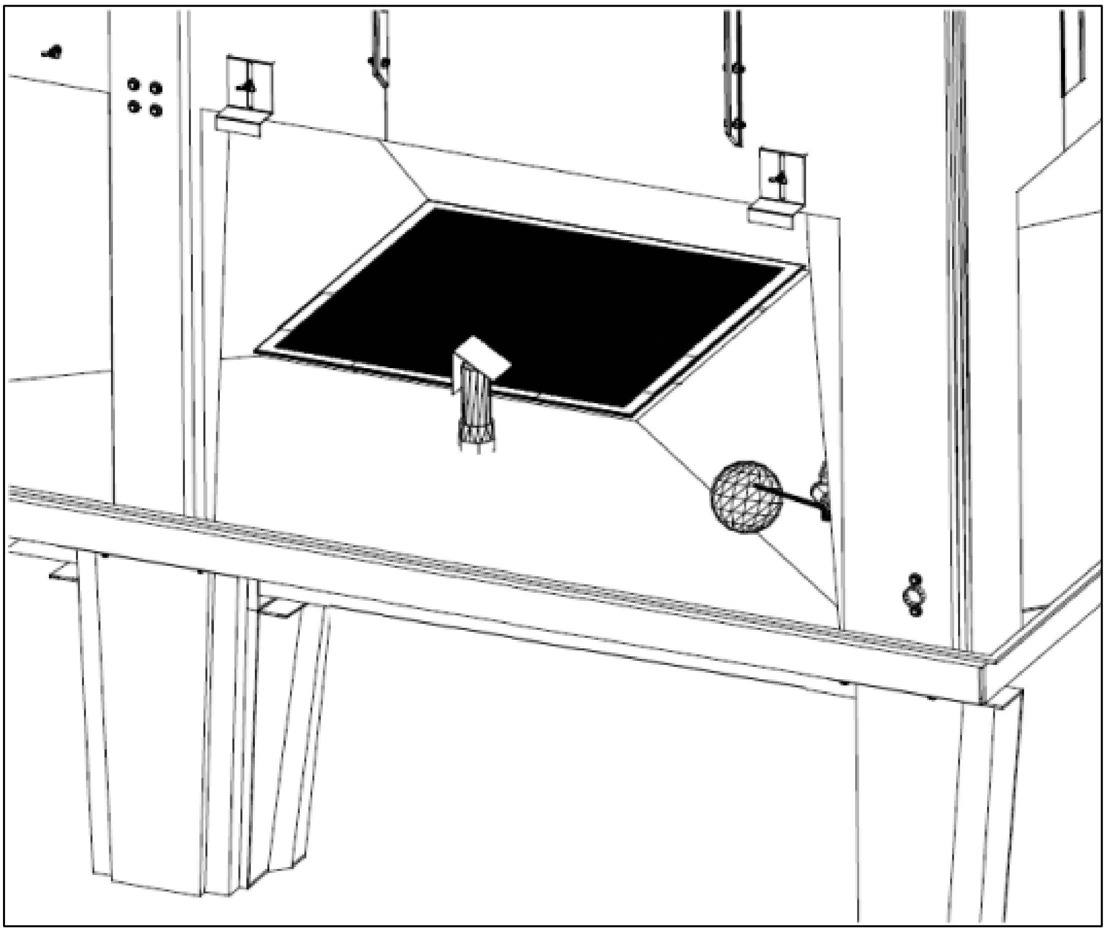

Figure 7: Close up view of cold water basin. Suction strainer is depicted as a black square.

The water basin should be checked monthly and flushed quarterly to remove any accumulation of dirt or sediment which normally accumulates in the basin. Sediment can become corrosive and cause deterioration of basin materials. When flushing the basin, it is important to keep the suction strainers in place to prevent any sediment from entering the system. After the basin has been cleaned, the strainers should be removed and cleaned before refilling the basin with fresh water.

Operating Level of Cold Water Basin

During initial or seasonal start-up the cold water basin must be filled up to the overflow level. After the initial fill the pump may be started and the float valve should be adjusted to set the operating level for the unit. The normal operating level for MSS and AFT units is about 140 mm below the bottom of the air inlet louvre frames.

The operating water level in the basin will vary slightly depending on the system specifics. The system load, bleed rate and make-up water pressure can all affect the operating level. If there are significant variations in seasonal ambient temperatures, it is possible that the water level may be higher in the winter time due to less load and evaporation. If an overflow condition occurs in the winter time it may be necessary to re-adjust the float valve to a slightly lower setting until overflowing no longer occurs when the pump(s) cycle off.

The operating water level should be checked monthly and the float adjusted as necessary to maintain the recommended operating level. The ideal setting for operating level should yield a water level that rises to within 25 mm of the overflow when the pumps cycle off.

Water Make Up Valve

A mechanical float valve assembly is provided as standard unless the unit has been ordered with an optional electronic water level control or for use with field constructed basin. The makeup valve is easily accessible from outside the unit through the access door or removable air inlet louver. The makeup valve is a bronze valve connected to a float arm assembly and is activated by a large foam filled plastic float. The float is mounted on an all thread rod held in place by wing nuts. The water level in the basin is adjusted by repositioning the float and all thread using the wing nuts.

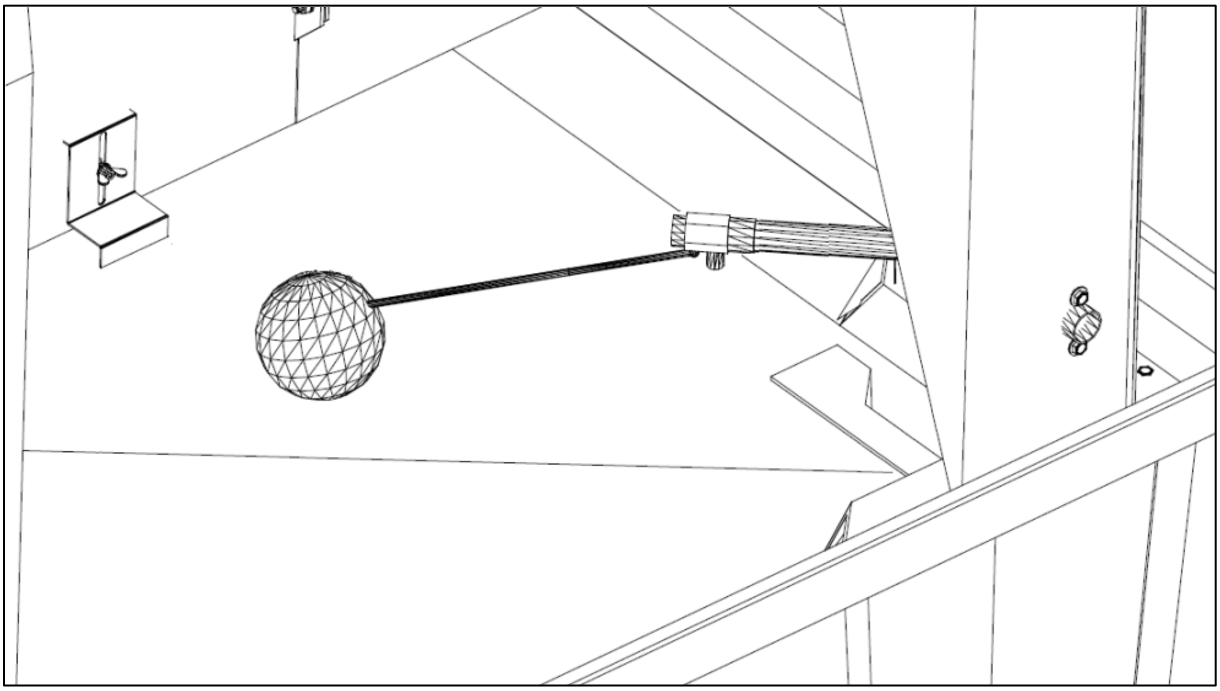

Figure 8: Mechanical make up valve assembly

The float position can be adjusted up or down as needed to achieve the correct operating level. The make-up valve and assembly should be inspected monthly and adjusted as necessary. If the valve shows signs of leakage the valve seal may need to be replaced. It is important to note that the make-up valve is sized to operate with supply pressures between 140 kPa and 350 kPa. If subjected to make-up water pressures in excess of 350 kPa the valve seals may fail prematurely. If make-up pressure is greater than 350 kPa it is suggested to install a pressure reducing valve ahead of the make-up valve.

Pressurized Water Distribution System

All EVAPCO units expect for AQXD and AQXS are supplied with wide orifice spray nozzles which should seldom need cleaning or maintenance however the water distribution should be inspected on a monthly basis to make sure that it is operating properly.

Before doing anything, make sure the fan system is off and properly locked-out to prevent it from automatically or accidentally starting.

The spray system can be checked for proper spray pattern with the pumps on, The spray system on LRTF, LRCF, and LRWF units can be seen after removing a few of the eliminators. For MSS, MEC and MFC the spray system can be viewed after opening the access port.

If the spray nozzles appear to be getting low flow it may be due to a blocked strainer in the basin or debris that has lodged in the spray piping. If the nozzles have a build-up on them they can be cleared by using a metal spatula or flat-head screw driver to dislodge the accumulation.

If an extreme build up of dirt or foreign matter occurs remove the spray branches to flush the debris from the header pipe.

After the water distribution system has been cleaned the suction strainer should be checked to make sure it is in good operating condition and positioned properly so that cavitation or air entrapment does not occur.

When inspecting and cleaning the water distribution system always check for proper orientation of the nozzles such that they are sprayed over the fill and not directed at the sidewall.

Bleed-Off Valve

The bleed-off valve, whether factory or field installed, must be checked weekly to make sure it is functioning and set properly. Keep the bleed-off valve wide open unless it has been determined that it can be set partially open without causing scaling or corrosion.

Pump (When Supplied)

Evaporative condensers and closed circuit fluid coolers are normally provided with a spray pump. The pump and pump motor should be lubricated and serviced in accordance with the pump manufacturer’s instructions as supplied with the unit. The spray pump should not be used with a VSD or as a means of capacity control. Excessive cycling of the spray pump increases the tendency for scale formation.

Water Treatment and Water Chemistry of the Recirculated Water System

Proper water treatment is an essential part of the maintenance required for evaporative cooling equipment. A well designed and consistently implemented water treatment program will help to ensure efficient system operation while maximizing the equipment’s service life. A qualified water treatment company should design a site specific water treatment protocol based on equipment (including all metallurgies in the cooling system), location, makeup water quality, and usage.

Bleed or Blowdown

Evaporative cooling equipment rejects heat by evaporating a portion of the recirculated water into the atmosphere as warm, saturated discharge air. As the pure water evaporates it leaves behind the impurities found in the system's makeup water and any accumulated airborne contaminants. These impurities and contaminants, which continue to recirculate in the system, must be controlled to avoid excessive concentration which can lead to corrosion, scale, or biological fouling.

Evaporative cooling equipment requires a bleed or blowdown line, located on the discharge side of the recirculating pump, to remove concentrated (cycled up) water from the system. Evapco recommends an automated conductivity controller to maximize the water efficiency of your system. Based on recommendations from your water treatment company, the conductivity controller should open and close a motorized ball or solenoid valve to maintain the conductivity of the recirculating water. If a manual valve is used to control the rate of bleed it should be set to maintain the conductivity of the recirculating water during periods of peak load at the maximum level recommended by your water treatment company.

Galvanized Steel – Passivation

'White Rust' is a premature failure of the protective zinc layer on hot dip or mill galvanized steel which can occur as a result of improper water treatment control during the start-up of new galvanized equipment. The initial commissioning and passivation period is a critical time for maximizing the service life of galvanized equipment. Evapco recommends that your site specific water treatment protocol includes a passivation procedure which details water chemistry, any necessary chemical addition, and visual inspections during the first six (6) to twelve (12) weeks of operation. During this passivation period, recirculating water pH should be maintained above 7.0 and below 8.0 at all times. Since elevated temperatures have a deleterious effect on the passivation process, the new galvanized equipment should be run without load for as much of the passivation period as is practical.

The following water chemistry promotes the formation of white rust and should be avoided during the passivation period:

1. pH values in the recirculating water greater than 8.3.
2. Calcium hardness (as $CaCO_3$) less than 50 ppm in the recirculating water.
3. Anions of chlorides or sulfates greater than 250 ppm in the recirculating water.
4. Alkalinity greater than 300 ppm in the recirculating water regardless of pH value.

Changes in water chemistry control may be considered after the passivation process is complete as evidenced by the galvanized surfaces taking on a dull gray colour. Any changes to the treatment program or control limits should be made slowly, in stages while documenting the impact of the changes on the passivated zinc surfaces.

- Operating galvanized evaporative cooling equipment with a water pH below 6.0 for any period may cause removal of the protective zinc coating.
- Operating galvanized evaporative cooling equipment with a water pH above 9.0 for any period may destabilize the passivated surface and create white rust.
- Repassivation may be required at any time in the service life of the equipment if an upset condition occurs which destabilizes the passivated zinc surface.

For more information on passivation and white rust please request a copy of Engineering Bulletin #36 from your local EVAPCO representative.

Water Chemistry Parameters

The water treatment program designed for your evaporative cooling equipment must be compatible with the unit's materials of construction. Control of corrosion and scale will be very difficult if the recirculating water chemistry is not consistently maintained within the ranges noted in Table 3. In mixed metallurgy systems, the water treatment program should be designed to ensure protection of all the components used in the cooling water loop.

Table 3: Guidelines for Recommended Water Chemistry

					FRP Evaporative Condensers & Fluid		
Property	Galvanised Steel	Stainless Steel Type 304	Stainless Steel Type 316	FRP Towers	Galvanised Coil	Copper Coil	304 Stainless Coil
pH	7.0 – 8.8	6.0 – 9.5	6.0 – 9.5	6.5 – 9.0	6.5 – 8.3	6.5 – 9.0	6.5 – 9.0
pH During Passivation	7.0 – 8.0	NA	NA	NA	?	NA	NA
Hardness as CaCO3 (ppm)	50 - 500	<600	<600	< 300	50 to 300	50 to 300	< 300
Alkalinity as CaCO3 (ppm)	75 - 400	<600	<600	< 500	50 to 300	50 to 300	< 500
Total Suspended Solids (ppm) *	<25	<25	<25	< 25	< 25	< 25	< 25
Total Bacteria (cfu/ml)	<10,000	<10,000	<10,000	< 10,000	<10,000	<10,000	<10,000
Conductivity (micro-mhos/cm) **	<2,400	<4,000	<5,000	< 5,000	< 2,400	< 4,000	< 5,000
Chlorides as Cl (ppm) ***	<300	<500	<2,000	< 4,000	< 250	< 400	< 400
Chlorides as NaCL (ppm)				< 6,600	< 410	< 660	< 660
Sulfates (ppm)				< 1,000	< 250	< 400	< 500
Silica (ppm)	<150	<150	<150	< 150	<150	<150	<150

Note: galvanised coils may require routine passivation if continuously operating with pH above 8.3

* Based on standard EVAPAK® fill

** Based on clean metal surfaces. Accumulations of dirt, deposits, or sludge will increase corrosion potential

*** Based on maximum temperatures below 120F (49C)

If a chemical water treatment program is used, all chemicals selected must be compatible with your unit's materials of construction as well as other equipment and piping used in the system. Chemicals should be fed through automatic feed equipment to a point which ensures proper control and mixing prior to reaching the evaporative cooling equipment. Chemicals should never be batch fed directly into the basin of the evaporative cooling equipment.

EVAPCO does not recommend the routine use of acid due to the pernicious consequences of improper feeding; however, if acid is used as part of the site specific treatment protocol, it should be pre-diluted prior to introduction into the cooling water and fed by automated equipment to an area of the system which ensures adequate mixing. The location of the pH probe and acid feed line should be designed in conjunction with the automated feedback control to ensure that proper pH levels are consistently maintained throughout the cooling system. The automated system should be capable of storing and reporting operational data including pH reading and chemical feed pump activity. Automated pH control systems require frequent calibration to ensure proper operation and protect your unit from increased corrosion potential.

The use of acids for cleaning should be avoided. If acid cleaning is required extreme caution must be exercised and only inhibited acids recommended for use with your unit's materials of construction should be used. Any cleaning protocol, which includes the use of an acid, shall include a written procedure for neutralizing and flushing your evaporative cooling system at the completion of the cleaning.

Control of Biological Contamination

Evaporative cooling equipment should be inspected regularly to ensure good microbiological control. Inspections should include both monitoring of microbial populations via culturing techniques and visual inspections for evidence of biofouling.

Poor microbiological control can result in loss of heat transfer efficiency, increase corrosion potential, and increase the risk of pathogens such as those that cause Legionnaires ' disease. Your site specific water treatment protocol should include procedures for routine operation, startup after a shut-down period, and system lay-up, if applicable. If excessive microbiological contamination is detected, a more aggressive mechanical cleaning and/or water treatment program should be undertaken.

It is important that all internal surfaces, particularly the basin, be kept clean of accumulated dirt and sludge. Additionally, drift eliminators should be inspected and maintained in good operating condition.

Drift Eliminators

Orientation of the eliminator sections on induced draft units is not critical. Note though, that the eliminator sections must fit tightly together within the fan section of the unit.

The drift eliminators on forced draft units should be oriented such that the direction of air discharge is away from the air intake so as to minimize the chance of recirculation. Drift eliminators must be correctly replaced whenever they are removed for service.

The eliminator sections for all units are constructed of PVC and are not designed to support the weight of a person or to be used as a work surface for any equipment or tools. Use of these eliminators as a walking surface or working platform may result in injury to personnel or damage to the equipment.

Gray Water and Reclaimed Water

The use of water reclaimed from another process as a source of makeup water for your evaporative cooling equipment can be considered as long as the resultant recirculating water chemistry conforms to the parameters noted in Table 4 above. It should be noted that using water reclaimed from other processes may increase the potential of corrosion, microbiological fouling, or scale formation. Gray water or reclaimed water should be avoided unless all of the associated risks are understood and documented as part of your site specific treatment plan.

Air Contamination

Evaporative cooling equipment draws in air as part of normal operation and can scrub particulate out of the air. Do not locate your unit next to smokestacks, discharge ducts, vents, flue gas exhausts, etc. because the unit will draw in these fumes which may lead to accelerated corrosion or deposition potential within the unit. Additionally, it is important to locate your unit away from the building's fresh air intakes to prevent any drift, biological activity, or other unit discharge from entering the building's air system.

Disinfection

If concentrations of aerobic bacteria and/or Legionella exceed regulation levels it may be necessary to disinfect the evaporative cooler. Disinfection should also be performed before a cleaning if the system is suspected of high bacteria levels. Some authorities also recommend a disinfection cycle prior to initial start up, after a prolonged shut down, after routine cleaning operations or when significant alterations have been made to the cooling system. Follow all local requirements for disinfection.

Soft Water

The use of soft water with units having a galvanized coil is not recommended. Soft water is corrosive to galvanized steel.

In general, fibreglass, Type 304, and Type 316 stainless steel exhibit good corrosion resistance to soft water. However soft water is usually generated from water softeners which typically use a brine solution (concentrated salt water) to regenerate. After regeneration this brine is flushed. If the softener is out of adjustment not all the brine will flush out and this salt (NaCl) will be carried out with the finished water. This poses the risk of high chlorides in the unit's recirculated water. Type 304 stainless steel is susceptible to corrosion at high chloride levels. Fibreglass and Type 316 stainless steel are significantly more resistant to chloride attack.

Cold Weather Operation

EVAPCO counterflow evaporative cooling equipment is well suited to operate in cold weather conditions. The counterflow cooling tower design encases the heat transfer media (fill) completely and protects it from the outside elements such as wind which can cause freezing in the unit.

When the evaporative cooling unit is going to be used during cold weather conditions several items need to be considered including unit layout, recirculating water, unit recirculating piping, unit heat transfer coils, unit accessories and capacity control of the units.

Unit Layout

Adequate unobstructed air flow must be provided for both the intake and discharge from the unit. It is imperative that the equipment minimize the risk of discharge air recirculation. Discharge air recirculation can result in condensation freezing the inlet louvers, fans and fan screens. The build-up of ice on these areas can adversely affect air flow and in more severe cases, lead to failure of these components. Prevailing winds can create icing conditions on the inlet louvers and fan screens adversely affecting airflow to the unit.

For additional information on unit layout, please refer to EVAPCO's Equipment Layout Manual available online or through your local representative.

Freeze Protection of Recirculating Water

The most common method to protect the basin water from freezing is to use basin heaters. The basin heaters should be controlled by thermostat to energize when the water temperature drops to 5.5 C and the spray pump is off. In addition to basin heaters, any external water lines, standpipes and pump volutes should be heat traced and insulated to prevent freezing.

With regards to fluid coolers or condensers, the basin may be drained and the unit operated for partial cooling by operation of fan only. The unit should not be run in dry mode unless the basin has been fully drained; basin heaters are sufficient prevent freezing only when the unit is completely shut down.

Note: Using basin heaters will not prevent the fluid in the coil(s) nor the residual water in the pump or pump piping from freezing.

Freeze Protection of Closed Circuit Cooler Coils

The simplest and most effective way of protecting the heat exchanger coil from freezing is to use an inhibited ethylene or propylene glycol anti-freeze. If this is not possible, an auxiliary heat load and reduced flow rate must be maintained on the coil at all times so that the water temperature does not drop below 50°F when the cooler is shut down. Please contact the factory for the minimum flow rate to particular units.

If an anti-freeze solution is not used, the coil must be configured so that it drains if the fluid temperature reaches 4.5C while the system pump is off. This can be accomplished by having automatic drain valves and air vents in the piping to and from the cooler. Care must be taken to ensure that the piping is adequately insulated and sized to allow the water to flow quickly from the coil. This is not a recommended method of protection and should be used only in emergency situations. Coils should not be drained frequently or for extended periods of time, as internal corrosion may occur.

Unit Piping

All external piping (water make up lines, equalizers, riser piping) that is not drained should be heat traced and insulated to make certain it does not freeze. All piping should be fitted with drain valves to avoid dead legs which can lead to Legionella contamination. System piping accessories (make up valves, control valves, water circulation pumps and water level control packages) also require heat tracing and insulation.

If any of these items are not properly heat traced and insulated, the ensuing ice formation may result in component failure and cause a shutdown of the cooling unit.

For cooling towers, the use of a bypass should also be considered for handling reduced winter loads. EVAPCO recommends that the cooling tower bypass be installed in the condenser water piping system. Bypasses installed in this manner require a section of piping between the condenser water supply and return leading to and from the cooling tower.

Never use a partial bypass during cold weather operation. Reduced water flow can result in uneven water flow over the heat transfer media (fill), which can cause ice formation. Also note that bypasses should be periodically flushed to minimize stagnant water conditions.

Unit Accessories for Freezing Climates

The appropriate accessories to prevent or minimize ice formation during cold weather operation are relatively simple and inexpensive. These accessories include cold water basin heaters, the use of a remote sump, electric water level control and vibration cut out switches. Each of these optional accessories helps to ensure that the cooling tower will function properly during cold weather operation.

Cold Water Basin Heaters

Optional basin heaters can be furnished with the cooling tower to prevent the water from freezing in the basin when the unit is idle during low ambient conditions. The basin heaters are designed to maintain 4.5° C basin water temperature at a -17° C ambient temperature. The heaters are only energized when the condenser water pumps are off and no water is flowing over the tower. As long as there is a heat load and water is flowing over the tower, the heaters do not need to operate. Other types of basin heaters to consider include hot water coils, steam coils and steam injectors.

Remote Sumps

A remote sump located in an indoor heated space is an excellent way to prevent freezing in the cold water basin during idle or no load conditions because the basin and associated piping will drain by gravity whenever the circulating pump is idle. EVAPCO can provide connections in the water basin to accommodate for remote sump installations.

Electric Water Level Control

Optional electric water level control packages can be furnished to replace the standard mechanical float and valve assembly. The electric water level control eliminates the freezing problems experienced by the mechanical float. In addition, it provides accurate control of the basin water level and does not require field adjustment even under varying load conditions. Please note: the standpipe assembly, make up piping and solenoid valve must be heat traced and insulated to prevent them from freezing.

Vibration Cut Out Switches

During severe cold weather conditions, ice can form on the fans of cooling towers causing excessive vibration. The optional vibration switch shuts the fan off avoiding potential damage or failure of the drive system.

Capacity Control Methods in Freezing Weather Conditions.

Cooling Towers: It is very important to maintain close control of the cooling tower during winter operation. EVAPCO recommends that an absolute MINIMUM leaving water temperature of 5.5° C must be maintained; obviously, the higher the water temperature from the tower, the lower the potential for ice formation. This assumes that proper water flow over the tower is maintained.

Closed Circuit Coolers and Evaporative Condensers: The most effective way to avoid ice formation in and on a closed circuit cooler or condenser during the winter is to run the unit DRY. In dry operation, the spray pump is turned off, the basin drained, while the fan operates drawing air over the coil.

If this method will be used on a forced draft unit, be sure to verify that the motor and drives have been properly sized to handle the reduction in static pressure that occurs when the spray water is turned off.

It is very important to maintain close control of the cooler or condenser during winter operation. EVAPCO recommends that an absolute MINIMUM leaving water temperature of 5.5° C must be maintained for cooler applications.

Fan Control in Freezing Climates

The simplest method of capacity control is cycling the fan motor on and off in response to the leaving water temperature of the tower. However, this method of control results in larger temperature differentials and longer periods of down time. During extremely low ambient conditions, the moist air may condense and freeze on the fan drive system. **Therefore, fans must be cycled during extremely low ambient conditions to avoid long periods of idle time whether water is flowing over the fill or in bypass. The number of start/stop cycles must be limited to no more than six per hour.**

A better method of control is the use of two speed fan motors. This allows an additional step of capacity control. This additional step reduces the water temperature differential, and therefore, the amount of time the fans are off. In addition, two speed motors provide savings in energy costs, since the tower has the potential to operate on low speed for the reduced load requirements.

The best method of capacity control during cold weather operation is the use of a variable speed drive (VSD). This allows the closest control of the leaving water temperature by allowing the fan(s) to run at the appropriate speed to closely match the building load. As the building load decreases, the VSD control system may operate for long periods of time at fan speeds below 50 percent. Operating a low leaving water temperature and low air velocity through the unit can cause ice to form. It is recommended that the minimum speed of the VSD be set at 50 percent of full speed to minimize the potential for ice to form in the unit.

Ice Management

Ice formation is inevitable when operating an evaporative cooling unit in freezing conditions. The key to successful operation is to control or manage the amount of ice that builds up in the unit. If extreme icing occurs, it can lead to severe operational difficulties as well as potentially damaging the unit. Following these guidelines will minimize the amount of ice that forms in the unit leading to better operation during the cold weather season.

Induced Draft Units

When operating an induced draft unit during the cold weather season, the control sequence must have a method to manage the formation of ice in the unit. The simplest method of managing the amount of ice build-up is by cycling the fan motors off. During these periods of idle fan operation, the warm water that is absorbing the building load flows over the unit to the ice that has formed in the fill, basin or louver areas.

In more severe climates, the incorporation of a defrost cycle can be used to manage the formation of ice in the unit. During the defrost cycle, the fans are reversed at **half speed** while the system pump flows water through the unit’s water distribution system. Operating the unit in reverse will melt any ice that has formed in the unit or on the air intake louvers.

Please note that the fans may need to be cycled off prior to a defrost cycle to allow the water temperature to rise. **The defrost cycle requires the use of two speed motors with reverse cycle starters or reversible variable speed drives.** All motors supplied by EVAPCO are capable of reverse operation.

The defrost cycle should be incorporated into the normal control scheme of the cooling tower system. The control system should allow for either a manual or automatic method of controlling frequency and length of time required to completely defrost the ice from the unit. The frequency and length of the defrost cycle is dependent on the control methods and ambient cold weather conditions. Some applications will build ice quicker than others which may require longer and more frequent defrost periods. **Frequent inspection of the unit will help "fine tune" the length and frequency of the defrost cycle.**

Forced Draft Units

Defrost cycles are NOT recommended for forced draft units, since allowing the leaving water temperature set point to rise causes the fans to be off for very long periods of time. This is not recommended for forced draft towers because of the greater potential for freezing the fan drive components. However, low speed fan operation or variable speed drives maintain a positive pressure in the unit is a good method which helps to prevent ice from building on the fan drive components.

For more information on cold weather operation, please request a copy of EVAPCO's Cold Weather Engineering Bulletin.

Troubleshooting

Problem	Possible Cause	Remedy
Overamping Fan Motors	Reduction in air static pressure	1. On a forced draft unit verify that the system pump is on, and water is flowing over the fill. If the system pump is off, and the unit was not sized for dry operation, the motor may over-amp. 2. If the forced draft unit is ducted, verify that the design ESP matches the actual ESP. 3. Check the basin water level against the recommended level. Note: Air density directly affects AMP reading. Low air density can cause the fans to spin faster, thus increasing the amp draw.
	Electrical issue	1. Check voltage across all three legs of the motor. 2. Verify that the motor is wired per the wiring diagram, and connections are tight.
	Fan rotation	Verify that the fan is rotating in the correct direction. If not, switch the leads so it runs correctly.
	Mechanical failure	Verify that the fan and motor turn freely by hand. If not, there may be damage to the internal motor components or bearings.
	Belt tension	Check for proper belt tension. Extreme belt tension can cause the motor to overamp.
Unusual Motor Noise	Motor running single phase	Stop motor and attempt to start it. Motor will not start again if single phased. Check wiring, controls and motor.
	Electrical imbalance.	Check voltages and currents of all three phases. Correct if required.
	Motor leads connected incorrectly	Check motor connections against wiring diagram on motor.
	Bad bearings	Check lubrication. Replace bad bearings.
	Electrical unbalance	Check voltage and current of all three lines. Correct if required.
	Air gap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
	Cooling fan hitting end bell guard	Reinstall or replace fan.
Incomplete Spray Pattern	Nozzles clogged	Remove nozzles and clean. Flush water distribution system.
	Strainer clogged	Remove strainer and clean.
	Pump running backwards	Visually verify pump rotor rotation by turning pump off and then on. Verify amp draw.
Fan Noise	Blade rubbing inside of fan cylinder (induced draft models)	Adjust cylinder to provide blade tip clearance.

Problem	Possible Cause	Remedy
Cold Water Basin Overflowing	Problem with make-up line.	Clear any blockage in make-up piping. Refer to Makeup Valve or Electronic Water Level section.
	If multi-cell unit, there may be an elevation problem.	Make sure that multi-cell units are installed level to one another. If they are not, it can cause overflowing in one cell.
Scale on Inlet Louvers	Improper water treatment, insufficient bleed rates or excessive cycling of the fan motors, or high concentrations of solids in water.	Scale should not be removed using a power washer or wire brush because it could damage the louvers. Remove the louver assemblies and let them soak in the cold water basin of the unit. The water treatment chemicals in the unit will neutralize and dissolve the buildup of scale. Please note that the time required for soaking the inlet louvers depends on the severity of the scale buildup. Note: This assumes chemicals are being used.
Overamping Pump Motors	Initial start-up	If the unit has only run for a few hours, the pump may overamp until the pump wear ring has worn in. In this case, it would only be small percentages, not 15 or 20%. Normally, after a few hours, the pump amp readings will reduce and level off.
	Mechanical failure	Verify that the pump can turn freely by hand. If not, pump most likely needs to be replaced.
	Electrical issue	Verify that the pump has been wired properly. Verify that the voltage supplying the pump is correct.
	Misconception of head increase or decrease	Note: Increase or decrease in pump flow as a result of clogged or blown out nozzles or headers should NOT cause the pump to over amp.
Makeup Valve Will Not Shut Off	Make-up water pressure too high	Mechanical make-up valve water pressure must be between 20 and 50psi. If pressure is too high, the valve will not close. A pressure reducing valve can be added to lower the pressure. For electronic solenoid valves the makeup pressure should be from 5 to 100 psi.
	Debris in solenoid	Clean out solenoid of any debris.
	Immovable float ball	Float or valve may need to be replaced.
	Float ball is full of water	Check ball for leaks and replace.
Water Constantly Blowing Out Overflow Connection	This can happen on forced draft units due to the positive pressure in the casing section. Or overflow connection has not been piped at all or piped properly	Pipe the overflow with a P-trap to an appropriate drain.
	Incorrect water level	Verify actual operating level versus O&M recommended levels.
Water Intermittently Blowing Out Overflow Connection	This is normal	This is normal. The bleed line for the unit is piped to the overflow connection.

Problem	Possible Cause	Remedy
Low Basin Water Level	Float Ball not set correctly	Adjust float ball up or down to obtain proper water level. Note: The float ball is set to the operating level at the factory. Contact Evapco if using electric water level control.
Electric Water Level Control Not Working	The valve won't open or close	Verify that water pressure is above 5psi and below 100psi. Contact Evapco for assistance.
Rusting Stainless Steel	Foreign material on surface of SS	Rust spots that show up on the surface of the unit are typically not signs of the base stainless steel material corroding. Often, they are foreign material, such as welding slag, that has collected on the surface of the unit. The rust spots will be located around where there has been welding. These areas may include the coil connections, the cold water basin near the support steel, and around field erected platforms and catwalks. The rust spots can be removed with a good stainless cleaning agent. Maintenance of the unit's surface should be done on a regular basis.
Excessive water drift (rain effect)	Missing, displaced, or damaged eliminators.	Check to ensure all eliminators are present, correctly installed, and free of damage.
	Incorrect eliminators were fitted during any replacement.	Fit correct eliminators.
Water splash-out from tower	Air inlet louvers are installed upside-down	Check orientation of air inlet louvers. While staring at the air inlet louvre from outside the unit, each honeycomb shaped pathway should slope downwards into the cold water basin.
	Hot water distribution is uneven.	Visually inspect distribution and check for any nozzle or pipe blockage in spray water system.

Reference Publications

The publications listed below are applicable to the operation, maintenance/service, and site management of evaporative cooling equipment. Attention to these matters will help ensure correct operation and satisfactory performance of the water cooling system whilst aiming to ensure compliance with relevant statutory requirements.

Australian/New Zealand Standards/Handbooks

These Standards are available from the local State Office of Standards Australia.

- AS/NZS 3666.1 (2002): Air-handling and water systems of buildings, Microbial control, Part 1-Design, installation and commissioning
- AS/NZS 3666.2 (2002): Air-handling and water systems of buildings, Microbial control, Part 2-Operation and maintenance
- AS/NZS 3666.3 (2000): Air-handling and water systems of buildings, Microbial control, Part 3-Performance based maintenance for water cooling systems.
- AS 1006 (1995): Solid stem, general purpose thermometers.
- AS 1055 (1997): Acoustics-Description and measurement of environmental noise.
- AS 1319 (1994): Safety signs for the occupational environment.
- AS 1345 (1995): Identification of the contents of piping, conduit and ducts.
- AS 1470 (1986): Health and safety at work-Principles and practice.
- AS 1768 (1991): Lightning protection.
- AS 2659 (1998): Guide to the use of sound measuring equipment.
- AS 2784 (2002): Endless wedge belt and V-belt drives.
- AS/NZS 2845.3 (1993): Water supply-Backflow prevention devices, Part 3-Field testing and maintenance.
- AS 3806 (1998): Compliance programs.
- SAA/NZS HB 32 (1995): Control of microbial growth in air-handling and water systems of buildings.

Mandatory Codes of Practice:

- BCA 96: “Building Code of Australia”. ISBN 1 86264 875.
    - Published by The Australian Building Codes Board, Canberra and referenced in legislation which is administered by the local building authority. The Code is available from the Australian Commonwealth Government Bookshops in the main capital cities.
- CUPDR Code of Practice: “NSW Code of Practice-Plumbing and Drainage”, (1999). ISBN 0-7310 6495
    - Published by the CUPDR (Committee for Uniformity of Plumbing and Drainage Regulations in NSW) which operates within the Department of Infrastructure, Planning and Natural Resources, Parramatta.
    - This Code is referenced in the legislation which is administered by the water supply and drainage authorities in NSW and is available from the NSW Government Information Bookshops in Sydney and Parramatta.

- Pages 41 and 62, detail the plumbing and drainage requirements for cooling towers.

NSW Health Circulars

These Circulars are published by the NSW Department of Health and are available from the Internet at www.health.nsw.gov.au

- Circular No: 2001/36 issued 8 May, 2001:" Microbial Control ".

AIRAH Publications:

Published by The Australian Institute of Refrigeration, Air-conditioning and Heating (Inc), Melbourne and referenced in AS/NZS3666.1. See also www.airdh.org.au

- DA17: Cooling Towers. ISBN 0 949436 18 6
- DA18: Water Treatment. ISBN 0 949436 23 2
- DA19: Maintenance of HVAC&R Systems (Includes cooling towers). ISBN 0 949436 25 9

ASHRAE Handbooks.

Published by The American Society of Heating, Refrigerating and Air-conditioning Engineers (Inc), Atlanta, USA and available from AIRAH.

- "HVAC Systems and Equipment", (2000) – Chapter 13 (Condenser Water Systems) and Chapter 36 (Cooling Towers). ISBN 1 883413 81 8
- "HVAC Applications", (2003) – Chapter 38 (Operation and Maintenance Management). ISBN 1 931862 23 0

NATSPEC Building and Services Reference Specification

Published by Construction Information Systems Australia Pty Ltd, Milsons Point, NSW and referenced in AS/NZS3666.1. See also www.natspec.info. ISBN 0 9586187 6 3 Relevant engineering services specifications:

- Cooling Towers
- Mechanical General Requirements
- Water Treatment
- Mechanical maintenance

Replacement Parts

EVAPCO has replacement parts available for immediate shipment. Most orders ship within 24 hours from time of order! To order replacement parts, please contact your local EVAPCO representative or Mr GoodTower Service Centre. The EVAPCO representative with contact information is located on the unit's nameplate or can be found by visiting either www.evapco.com.au or www.mrgoodtower.com.au The local EVAPCO representative or Mr GoodTower Service Centre can provide FREE unit inspections to help ensure your equipment operates at peak performance regardless of the original manufacturer!

http://www.mrgoodtower.com.au