



Bulletin 113-E Metric

EUROPEAN OPERATION AND MAINTENANCE INSTRUCTIONS

For EVAPCO Induced Draft and Forced Draft Cooling Towers



AT



UAT



LSTE



LPT



PMTQ



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or the EVAPCO Plant Nearest You**

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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.

Become familiar with your evaporative cooling equipment. Refer to the isometric drawings located on pages 30-39 for information on the arrangement of components in your equipment.

If you should require any additional information about the operation or maintenance of this equipment, contact your local EVAPCO representative. You may also visit www.evapco.eu for more information.

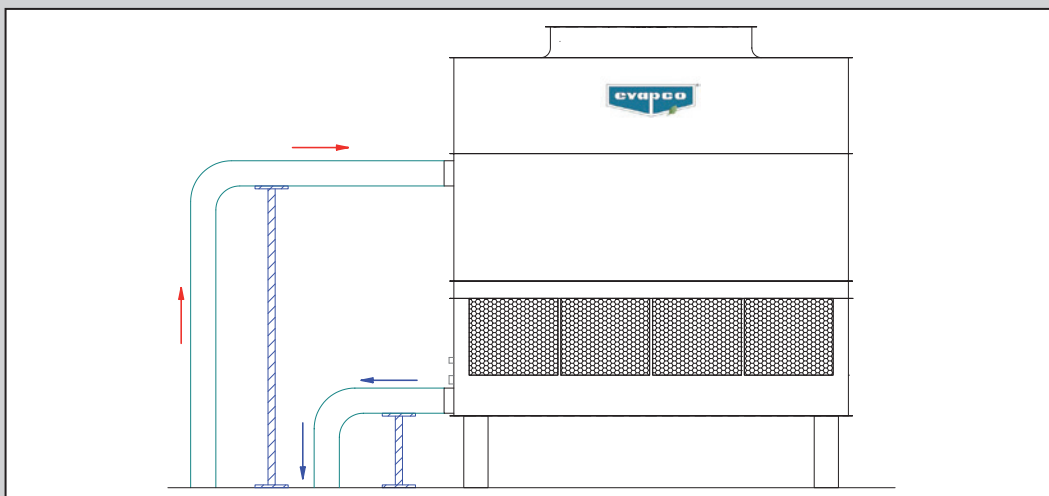
Safety Precautions / Remaining Risks

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:** Evaporative cooling equipment is considered as “Partly completed machinery”. “Partly completed machinery” is a totality which almost forms a machinery but in itself cannot fulfil any particular function. The considered cooling equipment is missing the components to safely connect it to the source of energy and motion in a controlled way. The considered cooling equipment is custom made but is not designed to address the specific needs and safety measures for a specific application. Each application requires a unique designed and integrated operational, control and safety strategy that links all components of the installation and eventually a back-up system in a safe and controlled way.
-  **WARNING:** This equipment should never be operated without fan screens and access doors properly secured, locked and in place.
-  **WARNING:** For assembling or disassembling the unit or unit sections, please follow the rigging instructions or the instructions on the yellow labels on the individual unit sections.
-  **WARNING:** During maintenance operations, the worker must use adequate personal protection equipment (PPE - A minimum, but not limited list of PPE are safety shoes, glasses, gloves, respiration protection, helmet) as prescribed by local authorities.
-  **WARNING:** For any exceptional, non routine work to be carried out, protection and adequate safety measures should be considered and a Last Minute Risks Assessment (LMRA) must be made by an authorized person in accordance with safety requirements of the country.
-  **WARNING:** A lock-out / tag-out procedure, integrated with the Process Control System, must be foreseen by the customer. 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. For any exceptional, non routine work to be carried out on top of the unit, use ladders, PPE and adequate safety measures against the risk of a fall, in accordance with safety requirements of the country in question.
-  **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.
-  **WARNING:** To avoid water and air contamination as a result of biological fouling, the cooling equipment must be maintained in accordance, but not limited to the operating and maintenance instructions. All local legislation related to evaporative cooling equipment must be respected.
-  **WARNING:** Accessories like platform and ladders are optional. In case these options are not taken in consideration, the customer must design the installation to comply with local safety and access requirements and legislation.
-  **WARNING:** Sound reducing options are available. In case these options are not taken in consideration, the customer must design the installation to comply with local sound requirements and legislation.

Installation Precautions

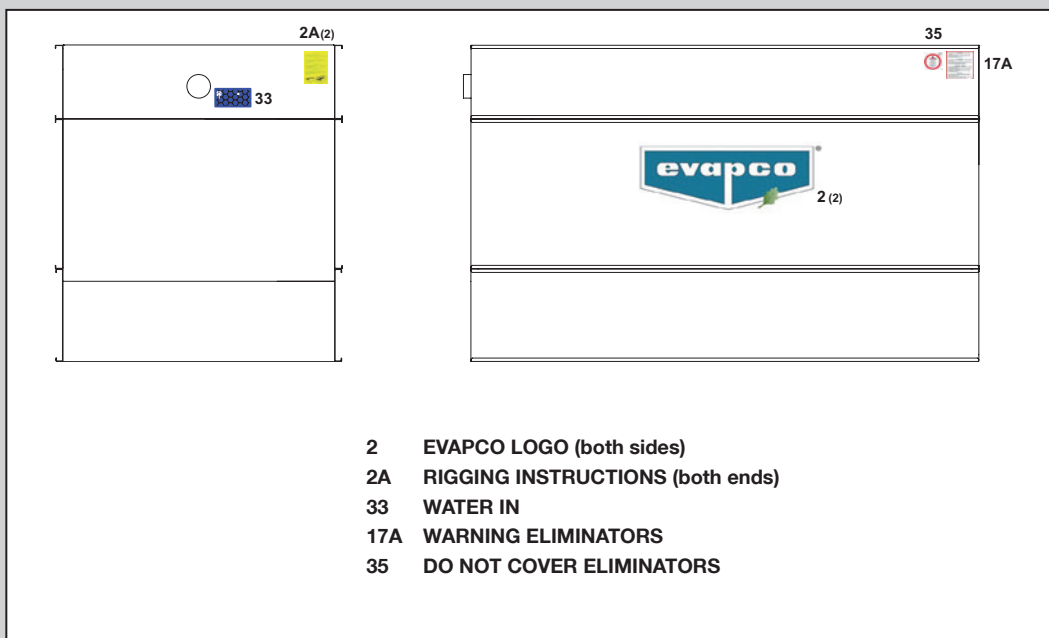
! WARNING: The water inlet and outlet connections are not designed to support piping. The piping always need to be supported (by others).



Storage Precautions

! WARNING: Never use plastic sheets or tarps to protect a unit during storage. This practice can trap heat inside the unit and could potentially cause damage to plastic components.

Label on the casing section(s)



Initial and Seasonal Start-Up Checklist

General

1. Verify that the overall installation reflects the requirements of the installation guidelines found in EVAPCO Bulletin 311 - Equipment Layout Manual, available at www.evapco.eu.
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 and confirm both speeds turn in the same direction.
3. Verify all safety interlocks work properly.
4. For units operating with a variable frequency drive, make certain that minimum speed requirements have been set. Check with VFD manufacturer for recommended minimum speeds and recommendations on locking out resonance frequencies.
5. Verify that the sensor used for fan sequencing and/or 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 including passivation of galvanized steel units. See "Water Treatment" 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 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.
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 could potentially cause damage to plastic components. See your local EVAPCO representative for additional information on unit storage.

**BEFORE BEGINNING ANY MAINTENANCE, BE CERTAIN THAT THE POWER IS
TURNED OFF AND THE UNIT IS PROPERLY LOCKED AND TAGGED OUT!**

Initial and Seasonal Start-Up

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. *(This is not required at initial start-up. The nozzles are clean and set at the factory).*
6. Check to ensure drift eliminators are securely in place and in proper orientation.
7. Adjust fan belt tension as required. See "Fan Belt Adjustment" section.
8. Lubricate fan shaft bearings prior to seasonal start-up.
9. Turn the fan(s) by hand to insure it turns freely without obstructions.
10. Visually inspect the fan blades. Blade clearance should be approximately 10 mm (min. 6 mm) from tip of blade to the fan cowl. The fan blades should be securely tightened to the fan hub.
11. If any stagnant water remains in the system including "dead legs" in the piping, the unit must be disinfected prior to the fans being energized. Please refer to ASHRAE Guideline 12-2000 and CTI Guideline WTP-148 for more information and consult local legislation prior to start-up.
12. Fill the cold water basin manually up to the overflow connection.
13. All new evaporative cooling equipment and associated piping should be pre-cleaned and flushed to remove grease, oil, dirt, debris and other suspended solids prior to operation. Any pre-cleaning chemistry should be compatible with the cooling equipment's materials of construction. Alkaline formulations should be avoided for systems which include galvanized materials of construction ^[EU].

After the unit has been energized, check the following:

1. Adjust mechanical float valve as required.
2. Unit basin should be filled to the proper operating level. See "Recirculating Water System – Operating Levels" section for more details.
3. Verify fan is rotating in proper direction.
4. Measure voltage and current on all three power leads. The current must not exceed the motor nameplate full load amp rating.
5. Adjust bleed valve to proper flow rate. Maximum bleed-off is 3,2 l/min per 100 kW.
Consult your qualified water treatment person to fine tune the minimum bleed necessary.



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. Check operating level in pan and adjust float valve if necessary – monthly												
5. Check water distribution system and spray pattern – monthly												
6. Check drift eliminators – quarterly												
7. Check the fan blades for cracks, missing balancing weights, and vibrations - quarterly												
8. Check sheaves and bushings for corrosion. Scrape and coat with ZRC - annually												
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												
11. Check belt tension and adjust – monthly												
12. Sliding motor base – Inspect and grease – annually or as needed												
13. Check fan screens, inlet louvers and 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												

* See maintenance manual for start-up instructions and lubrication recommendations

** Cooling Towers must be cleaned on a regular basis to prevent the growth of bacteria including Legionella Pneumophila



MAINTENANCE CHECKLIST (optional accessories)



PROCEDURE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. Coupling/Shaft – Inspect flex elements and hardware for tightness, proper torque & crack/deterioration – monthly												
2. Heater Controller – Inspect controller and clean probe ends – quarterly												
3. Heater – Inspect junction box for loose wiring and moisture – one month after start-up and semi-annually												
4. Heater – Inspect elements for scale build-up – quarterly												
5. Electronic Water Level Controller – Inspect junction box for loose wiring and moisture – semi-annually												
6. Electronic Water Level Controller – Clean probe ends of scale build-up – quarterly												
7. Electronic Water Level Controller – Clean inside the standpipe – annually												
8. Solenoid Make-up Valve – Inspect and clean valve of debris – as needed												
9. Vibration Switch (mechanical) – Inspect enclosure for loose wiring and moisture – one month after start-up and monthly												
10. Vibration Switch – Adjust the sensitivity – during start-up and annually												
11. Sump Sweeper Piping – Inspect and clean piping of debris – semi-annually												
DURING IDLE PERIODS:												
1. Two or More Days: Energize motor space heaters – or run motors for 10 minutes twice daily												
2. One Month or longer: Rotate motor shaft/fan 10 turns – bi-weekly												
3. One Month or longer: Megger test motor windings – semi-annually												

Seasonal Shut-Down Checklist

When the system is to be shut down for an extended period of time, the following services should be performed.

1. The evaporative cooling unit cold water basin should be drained.
2. The cold water basin should be flushed and cleaned with the suction strainer screens in place.
3. The suction strainer screens should be cleaned and re-installed.
4. The cold water basin drain should be left open.
5. The fan shaft bearings and motor base adjusting screws should be lubricated. This should also be performed if the unit is going to sit idle prior to start up.
6. The water make up valve needs to be closed. All water make-up piping needs to be drained, if not heat traced and insulated.
7. The finish of the unit should be inspected. Clean and refinish as required.
8. The fan bearings and motor bearings need to be turned at least once a month by hand. This can be accomplished by making sure the unit's disconnect is locked and tagged out, and grasping the fan assembly, rotating it several turns.
9. Energize motor space heaters.

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°C 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 4,5 m 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 27°C), 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 for 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°C.

Fan System

The fan systems of both centrifugal and axial driven units are rugged, however, the fan system must be checked regularly and lubricated at the proper intervals. The following maintenance schedule is recommended.

Fan Motor Bearings

EVAPCO evaporative cooling units use either a T.E.A.O. (Totally Enclosed Air Over) or a T.E.F.C. (Totally Enclosed Fan Cooled) fan motor. These motors are built to "Cooling Tower Duty" specifications. The fan motor bearings for motors up to 30 kW are lubricated for the lifecycle of the bearings, higher motor powers require relubrication (please see motor manual for more detail). All fan motors are supplied with special moisture protection on the bearings, shaft and windings. After extended shut-downs, the motor should be checked with an insulation tester prior to restarting the motor.

Fan Shaft Ball Bearings

Lubricate the fan shaft bearings every 1,000 hours of operation or every three months for induced draft units. Lubricate the fan shaft bearings every 2,000 hours of operation or every six months for forced draft units. Use any of the following synthetic waterproof, inhibited greases which are suitable for operation between -40°C and 120°C. (For colder operating temperatures, contact the factory).

Chevron - Multifak Premium 3
Shell Alvanius

Total - Ceran WR2 or similar

Feed grease slowly into the bearings or the seals may be damaged. A hand grease gun is recommended for this process. When introducing a new grease, all grease should be purged from the bearings.

Most EVAPCO units are supplied with extended grease lines to allow easy lubrication of the fan shaft bearings.

Unit Description	Location of Lube Line Fittings
Induced Draft Units – 2,4 m wide	Located just beside the fan casing access door
Induced Draft Units – 2,6 m wide	Located just beside the fan casing access door
Induced Draft Units – 3 m wide and 6 m wide	Located inside the fan casing access door
Induced Draft Units – 3,6 m wide and 7,2 m wide	Located inside the fan casing access door
Induced Draft Units – 4,2 m wide and 8,4 m wide	Located inside the fan casing access door
LSTE Forced Draft Units	Located on the front of the unit
LPT Forced Draft Units	Located on the front of the unit
PMTQ Forced Draft Units	Located on the front of the unit

Table 1 – Location of Grease Lube Line Fittings for Belt Driven Units

Please note, the removal of the fan screens is not necessary on forced draft units to access the extended lube line fittings.

Fan Shaft Sleeve Bearings – (1,2 m wide LSTE units only)

Lubricate the intermediate sleeve bearing(s) 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 occurs 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. **Do not use a detergent based oil or those designated heavy duty or compounded.** Different oils may be required when operating at temperatures below -1°C continuously. Table 2 provides a short list of approved lubricants for each temperature range. 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.

Ambient Temp.	Texaco	Mobil	Exxon	Total
-32°C to 0°C	-	DTE Heavy	-	-
-17°C to 43°C	-	-	-	-
0 to 38°C	Regal R&O 220	DTE Oil BB	Teresstic 220	-

Table 2 - Sleeve Bearing Lubricants

Oil drippage may result from over-oiling or from using too light an oil. Should this condition persist with correct oiling, it is recommended that the next heavier weight oil be used.

All bearings used on EVAPCO equipment are factory adjusted and self aligning. Do not disturb bearing alignment by tightening the sleeve bearing caps.

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 13 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 basis. A properly tensioned belt will not “chirp” or “squeal” when the fan motor is started.

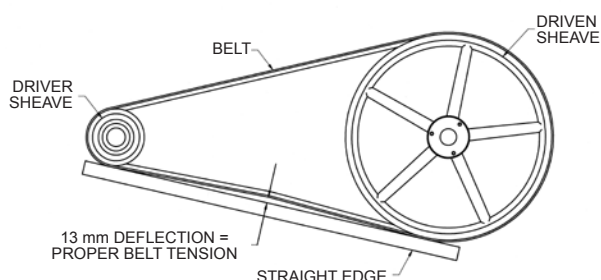


Figure 1 – Method 1

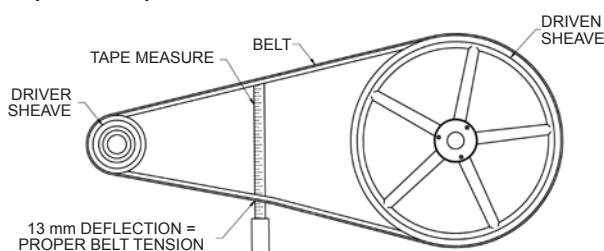


Figure 2 – Method 2

On induced draft belt driven units provided with externally mounted motors (2,4 and 2,6 m wide units), Figure 3, LSTE forced draft units, Figure 4, and PM forced draft units, Figure 7, both J-type adjustment bolts on the adjustable motor base should have an equal amount of exposed thread for proper sheave and belt alignment.

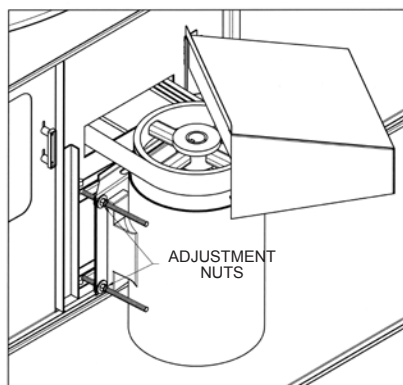


Figure 3 – Externally Mounted Motors

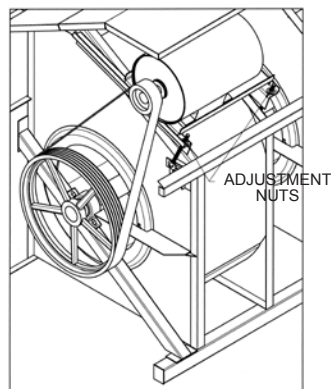


Figure 4 – LSTE Externally Mounted Motor

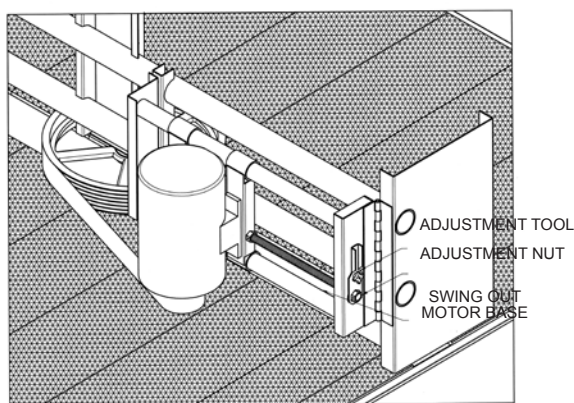


Figure 5 – Internally Mounted Motors

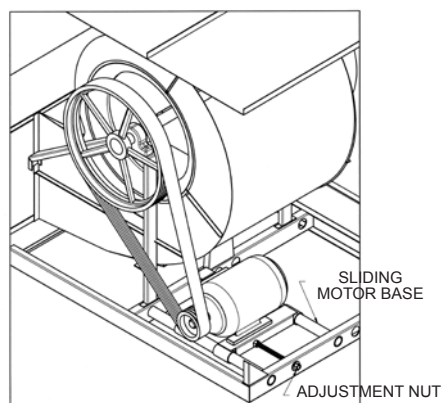


Figure 6 – LPT Motor Adjustment

On induced draft belt driven units with internally mounted motors (3 m; 3,6 m; 4,2 m; 6 m; 7,2 m and 8,4 m wide units) as shown in Figure 5, LPT units as shown in Figure 6 and PM units as shown in Figure 7, a motor adjustment tool is provided. The tool will be found on the adjustment nut. To use, place the hex end over the adjustment nut. Tension the belt by turning the nut counterclockwise. When the belts are properly tensioned, tighten the lock nut.

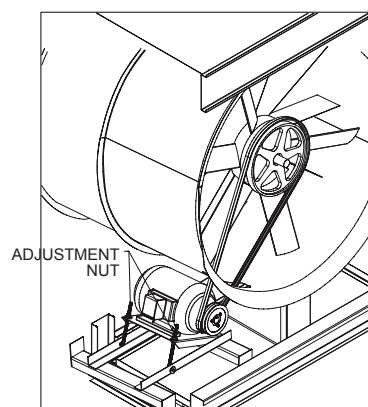


Figure 7 – PM Style Motor Adjustment

Fan System — Capacity Control

There are several methods for capacity control of the evaporative cooling unit. Methods include: Fan motor cycling, the use of two speed motors and the use of variable frequency drives (VFD's). In all cases, if motors are idle for extended periods of time with water still being directed over the 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 water temperature. 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, rapid cycling of the fan motors can cause the fan motor to overheat. **Controls should be set to only allow a maximum of six (6) start/stop cycles per hour.**

IMPORTANT

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 REDUCES THE PERFORMANCE. FREQUENT CYCLING OF THE SPRAY PUMP, WITHOUT THE FANS IN OPERATION, WILL PROVOKE DRIFT AND SPRAY WATER MIGRATION OVER THE AIR INLET LOUVERS, WHICH IS PROHIBITED IN MOST COUNTRIES. PLEASE CONSULT YOUR LOCAL LEGISLATION.

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 will provide 60% of full speed capacity.

Two speed capacity control systems require not only a two speed motor, but a two stage thermostat and the proper two speed motor starter. The most common two speed motor is a single winding type. This is also known as a consequent pole design. Two speed two winding motors are also available. All multi-speed motors used in evaporative cooling units should be variable torque design.

It is important to note that when two speed motors are to be used, the motor starter controls must be equipped with a decelerating time delay relay. The time delay should be a minimum of a 30 second delay when switching from high speed to low speed.

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 Frequency Drives

The use of a variable frequency drive (VFD) provides the most precise method of capacity control. A VFD 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 VFD technology can also benefit the life of the mechanical components with fewer and smoother motor starts and built in motor diagnostics. VFD 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 VFD for capacity control must also use an inverter duty motor built in compliance with IEC. This is an available option from EVAPCO. The standard fan motors supplied by EVAPCO are not intended for use with VFD's. The type of motor, manufacturer of the VFD, motor lead lengths (between the motor and the VFD), 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 VFD During Peak Load

1. The VFDs should all be synchronized to speed up and slow down uniformly.
2. The VFDs 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 VFD supplier if operating below 25% is possible.

Identify and Lock-out Harmful Resonant Frequencies

A Variable Frequency Drive (VFD) fan system, unlike traditional fixed-speed systems, is designed to operate between 25% (13Hz) and 100% (50Hz) speeds, which creates an opportunity for operation where resonant frequencies exist. Sustained operation at resonant frequencies may lead to excessive vibration, fatigue of structural components and/or drive system noise and failure. Owners and operators must anticipate the existence of resonant frequencies and lock out frequencies during start-up and commissioning in order to prevent drive system operational problems and structural damage. As a part of the normal start-up and commission processes, resonant frequencies should be identified and locked-out in the VFD's software.

The unit's supporting structure, external piping, and accessories contribute to the overall harmonic make-up and stiffness of the system. The choice of VFD will also have a significant influence on how the system behaves. Consequently, not all resonant frequencies can be determined in advance at the manufacturer's factory during final inspection and testing. Relevant resonant frequencies (if they occur) can only be identified accurately after the installation in the system.

To check for resonant frequencies in the field, a run-up and run-down test must be performed. Additionally, VFD carrier frequencies should be adjusted to best align the VFD with the electrical system. Refer to your drive's start-up procedures for additional information and instruction.

The procedure of checking for resonant frequencies requires stepping through the VFD's operating range at (2) Hz intervals from the lowest operating frequency to full speed. At each step, pause long enough for the fan to reach steady-state. Note changes in unit vibration during this time. Repeat from full speed to minimum speed. Should vibration-inducing frequencies exist, the run-up and run-down test will isolate the resonant frequencies which then must then be locked-out in the VFD programming.

Recirculated Water System – Routine Maintenance

Suction Strainer in Cold Water Basin

The pan strainer should be removed and cleaned monthly or as often as necessary. The suction strainer is the first line of defense in keeping debris out of the system. Make certain that the strainer is properly located over the pump suction, alongside the anti-vortexing hood.

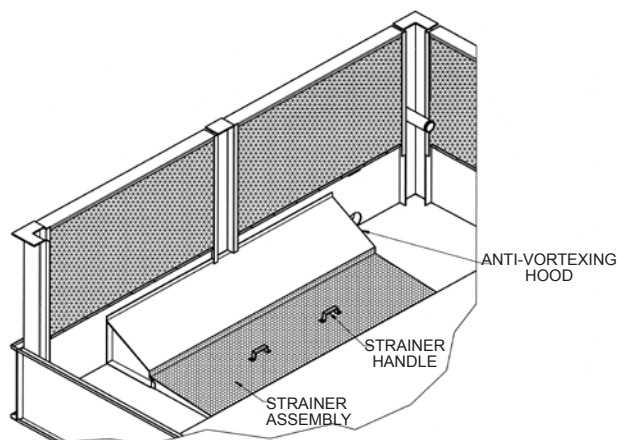


Figure 8 – Single Strainer Assembly

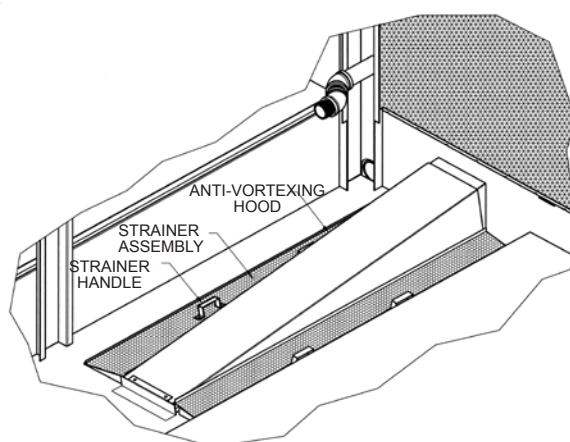


Figure 9 – Dual Strainer Assembly

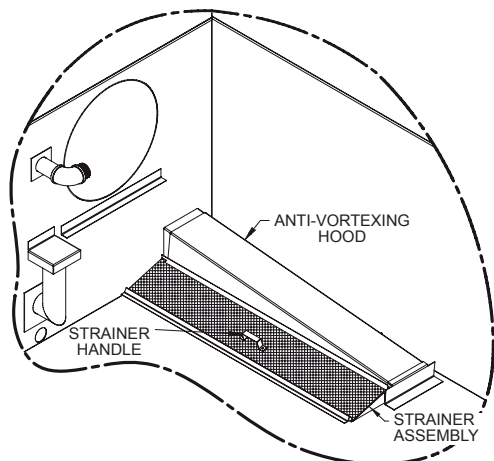


Figure 10 – LSTE / PMTQ Strainer Assembly

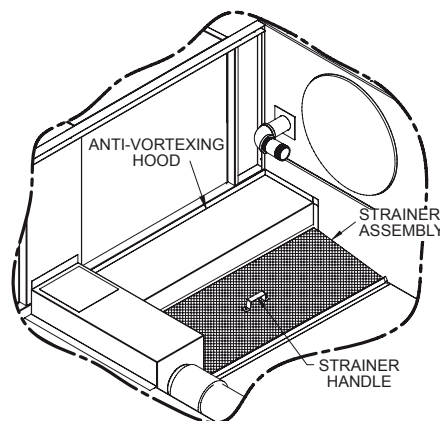


Figure 11 – LPT Strainer Assembly

Cold Water Basin

The cold water basin should be flushed out quarterly, and checked monthly or more often if necessary, to remove any accumulation of dirt or sediment which normally collects 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 Water in Cold Water Basin

The operating level should be checked monthly to make sure the water level is correct. Refer to Table 3 for unit specific levels.

Model Number				Operating Level*
AT	14-64	through	14-912	180 mm
AT	18-49	through	38-942	230 mm
AT	19-56	through	19-98	230 mm
AT	110-112	through	310-954	230 mm
AT	112-012	through	312-960	230 mm
AT	114-0124	through	314-1272	280 mm
AT	26-517	through	28-917	230 mm
AT	212-59	through	212-99	230 mm
AT	215-29	through	215-99	230 mm
AT	216-49	through	216-914	230 mm
AT	220-112	through	220-918	230 mm
AT	224-018	through	224-920	230 mm
AT	228-0124	through	428-1248	280 mm
AT	420-124	through	424-936	280 mm
LSTE	416	through	4612	230 mm
LSTE	5112	through	5718	230 mm
LSTE	8P-112	through	8P-536	230 mm
LSTE	10-112	through	10-636	330 mm
LPT	316	through	8812	200 mm
PMTQ	10112	through	12924	330 mm

*Measured from lowest point in the basin

Table 3 – Recommended Operating Water Level

At initial start up or after the unit has been drained, the unit must be filled to the overflow level. Overflow is above the normal operating level and accommodates the volume of water normally in suspension in the water distribution system and some of the piping external to the unit.

The water level should always be above the strainer. Check by running the pump with the fan motors off and observing the water level through the access door or remove the air inlet louver.

Water Make Up Valve

A mechanical float valve assembly is provided as standard equipment on the evaporative cooling unit (unless the unit has been ordered with an optional electronic water level control package or the unit is arranged for remote sump operation). The make up valve is easily accessible from outside the unit through the access door or removable air inlet louver. The make up 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. Refer to Figure 12 for details.

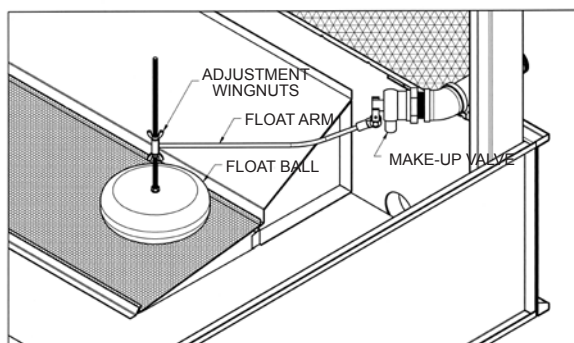


Figure 12 – Mechanical Water Make Up Valve

The make up valve assembly should be inspected monthly and adjusted as required. The valve should be inspected annually for leakage and if necessary, the valve seat should be replaced. The make up water pressure should be maintained between 140 and 340 kPa.

Drift Eliminators

Check the drift eliminators quarterly to make sure the drift eliminators are still in the correct position and not clogged by any debris.

If required after inspection, drift eliminators must be removed, cleaned and reinstalled correctly. On forced draft models, the worker must use personal precautions and adequate safety measures against the risk of a fall, in accordance with local regulations. Remove one or two eliminator sections from the top of the unit, protect the fill by use of a hard board before entering the unit and walking on the fill. Never walk on the eliminators! Once standing on the fill, the remaining drift eliminators can be removed.

On induced draft models, lifting handles are provided along the top layer of eliminators. Remove one or two eliminator sections, protect the fill by use of a hard board before entering the unit and walking on the fill. Never walk on the eliminators! Once standing on the fill, the remaining drift eliminators can be easily removed through the access door.

Pressurized Water Distribution Systems

All EVAPCO cooling towers are supplied with wide orifice water diffusers. The water distribution system should be checked monthly to make sure it is operating properly. Always check the spray system with the pump on and the fans off (locked and tagged out).

On forced draft units (LSTE, LPT and PMTQ models), remove one or two eliminator sections from the top of the unit and observe the operation of the water distribution system.

On induced draft units (AT and UAT models), lifting handles are provided on several sections of eliminators within reach of the access door. Eliminators can be easily removed from outside of the unit to observe the water distribution system. The diffusers are essentially non-clogging and should seldom need cleaning or maintenance.

If the water diffusers are not functioning properly, in most cases it is a sign that the suction strainer has not been working properly and that foreign matter or dirt has accumulated in the water distribution pipes. The nozzles can be cleared by taking a small pointed probe and moving it back and forth in the diffuser opening, with the pump(s) running and the cooling load and fan(s) off.

If an extreme build up of dirt or foreign matter occurs, remove the end cap in each branch to flush the debris from the header pipe. The spray branches and header can be removed for cleaning, but should only be done if absolutely necessary.

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 that the orientation of the water diffusers is correct as shown below for LPT and LSTE models in Figure 13 and as shown in Figure 14 for AT/UAT and PMTQ models. The top of the EVAPCO logo on the nozzle is parallel with the top of the water distribution pipe.

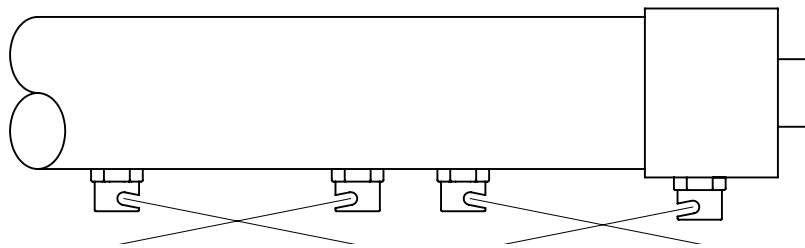


Figure 13 – LSTE / LPT Water Distribution

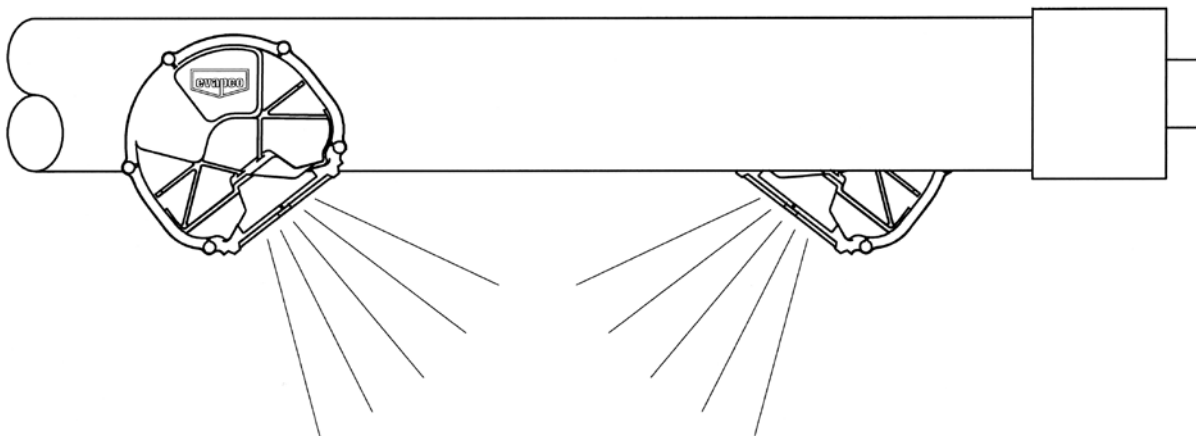


Figure 14 – AT / UAT / PMTQ Water Distribution

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

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 the 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 the 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 the 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 harmful 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 color. 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.
- Re-passivation 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 EVAPCO's Engineering Bulletin 36.

Water Chemistry Parameters

The water treatment program designed for evaporative cooling equipment must be compatible with the unit's materials of construction, as well as other equipment and piping used in the system. Control of corrosion and scale will be very difficult if the recirculating water chemistry is not consistently maintained within the ranges noted in Table 4. 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 4 – Recommended Water Chemistry Guidelines

Property	Z-725 Galvanized Steel	Type 304 Stainless Steel	Type 316 Stainless Steel
pH	7.0 – 8.8	6.0 – 9.5	6.0 – 9.5
pH During Passivation	7.0 – 8.0	N/A	N/A
Total Suspended Solids (ppm)*	<25	<25	<25
Conductivity (Micro-Siemens/cm) **	<2,400	<4,000	<5,000
Alkalinity as CaCO ₃ (ppm)	75 - 400	<600	<600
Calcium Hardness CaCO ₃ (ppm)	50 - 500	<600	<600
Chlorides as Cl ⁻ (ppm) ***	<300	<500	<2,000
Silica (ppm)	< 150	< 150	< 150
Total Bacteria (cfu/ml)	<10,000	<10,000	<10,000

* Based on standard EVAPAK® fill

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

*** Based on maximum coil fluid temperatures below 49°C

If a chemical water treatment program is used, all chemicals selected must be compatible with the 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 destructive 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 to protect the unit from increased corrosion potential.

The use of acids for cleaning should also be avoided. If acid cleaning is required, extreme caution must be exercised and only inhibited acids recommended for use with the 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 the 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. The 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.

Gray Water and Reclaimed Water

The use of water reclaimed from another process as a source of makeup water for evaporative cooling equipment can be considered as long as the resultant recirculating water chemistry conforms to the parameters noted in Table 4. 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 the site specific treatment plan.

Air Contamination

Evaporative cooling equipment draws in air as part of normal operation and can scrub particulates out of the air. Do not locate the 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 the 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.

Stainless Steel

Stainless steel is the most cost effective material of construction available to extend the life of an evaporative cooling unit.

The stainless steel sheet material utilized by EVAPCO is Type 304L and Type 316L with a No. 2B unpolished finish. Type 304L stainless steel is a basic chromium-nickel austenitic stainless steel and is suitable for a wide range of applications. It is readily available throughout the world and is easy to form during the fabrication process. Type 316L stainless steel offers more corrosion resistance than Type 304L due to the addition of molybdenum and a higher nickel content, which provides greater resistance to pitting and crevice corrosion in the presence of chlorides. As a result, Type 316L stainless steel is desirable in heavy industrial, marine environments and where make up water quality requires it.

Stainless steel provides its superior corrosion resistance by developing a surface film of chromium oxide during the manufacturing process. In order to ensure maximum corrosion protection, stainless steel must be kept clean and have an adequate supply of oxygen to combine with the chromium in the stainless steel to form "chromium-oxide", a protective passivation layer. The protective layer of chromium-oxide develops during routine exposure to the oxygen content in the atmosphere. This occurs during the milling process and continuously as the stainless is formed and shaped for its final use.

Maintaining the Appearance of Stainless Steel

It is a common misconception that stainless steel is stain and rust proof, making surface maintenance not required at all. This is simply not true. Like mill galvanized steel, stainless steel is most effective when kept clean. This is especially true when located in atmospheres with chloride salts, sulfides or other rusting metals. In these environments, stainless steel can discolor, rust or corrode.

Once the unit arrives at the job site, the most effective way of maintaining the stainless steel finish is to keep it clean! Always protect the stainless steel components from contamination with steel or other rusting materials. The most common ways of contamination are due to grinding and welding in the vicinity of the stainless steel tower or steel particles collected in the piping connecting the tower to the cooling system. At a minimum, the unit should be washed down annually to reduce residual dirt or surface deposits on the stainless steel. In addition, this wash down will keep the stainless steel components free from the corrosive elements in the atmosphere including chlorides and sulfides which are damaging to stainless steel.

Cleaning of Stainless Steel

Routine Maintenance – Mild Cleaning

Simple pressure washing (of sheet metal components only), using household cleaners, detergents or ammonia annually (more frequently in marine or industrial environments) will help maintain the finish and keep it free of atmospheric contaminants.

Minor Surface Dirt – Mildly Aggressive Cleaning

Use of a sponge or bristle brush with a non-abrasive cleaner is recommended. After cleaning, rinse with warm water from a hose or pressure washer. Towel dry cleaned area and coat area with a high quality wax to provide extra protection.

More Aggressive Cleaning – Removal of Fingerprints or Grease

Repeat processes 1 and 2, then use a hydro-carbon solvent like Acetone or alcohol. As with any hydro-carbon solvent, caution must be taken when using the product. Do not use in confined spaces or while smoking. Keep solvents out of contact with hands and skin. Household glass cleaner, Spic n' Span are other options for cleaners. After cleaning, towel dry and apply a coat of high quality wax for extra protection.

Aggressive Cleaning – Removing Stains or Light Rust

If iron contamination or surface staining is suspected, immediately remove the stain or rust using a chrome, brass or silver cleaner. The use of mild non-scratching creams and polishes are also recommended. When the cleaning procedure is complete; use a high quality wax for extra protection.

Most Aggressive Cleaning – Removing Heavy Rust Deposits, Iron Contamination, Spot Weld Discoloration and Weld Spatter using Acid

First try processes 1 through 4. If the stain or rust is not removed, the following should be used as a last resort. Rinse the surface with hot water. Use a saturated solution of oxalic or phosphoric acid (10 to 15% acid solution). This should be applied with a soft cloth and allowed to stand for a few minutes – do not rub. This acid should etch out the iron particles. Follow this with an ammonia and water rinse. Rinse the surface again with hot water; coat with a high quality wax for added protection. Use extreme caution when working with acids! Synthetic rubber gloves should be used, goggles and aprons are advisable.

DO NOT USE THIS METHOD IF THE UNIT HAS GALVANIZED STEEL COMPONENTS.

As a minimum, these guidelines should be followed to maintain and clean the stainless steel unit. When cleaning stainless steel, NEVER use coarse abrasives or steel wool, NEVER clean with mineral acids and NEVER leave stainless in contact with iron or carbon steel.

For more information on cleaning stainless steel, please request a copy of EVAPCO'S Engineering Bulletin 40.

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. These include: unit layout; unit piping; 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 recirculation. Recirculation can result in condensation freezing the inlet louvers, fans and fan screens. The buildup 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 - Bulletin 311.

Unit Piping

All external piping (water make up lines, equalizers, riser piping) that is not drained needs to 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.

The use of a bypass should also be considered. Typically, winter loads are less than peak summer loads. When this is the case, a cooling tower bypass needs to be incorporated into the system design to allow water to "bypass" the tower's water distribution system as a means of capacity control. 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.

Please note: bypasses should be periodically flushed to minimize stagnant water conditions, unless the bypass is piped directly into the unit's cold water basin.

Unit Accessories

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 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 5° C basin water temperature at -18° C, -29° C and -40° 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.

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 cold 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 to or failure of the drive system.

Capacity Control Methods for Cold Weather Operation

Induced draft and forced draft cooling towers require separate guidelines for capacity control during cold weather operation.

The sequence of control for a cooling tower operating at low ambient conditions is much the same as a cooling tower operating under summer conditions provided that the ambient temperature is above freezing. When the ambient temperatures are below freezing, additional precautions must be taken to avoid the potential for damaging ice formation.

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 6° 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.

Induced Draft Unit Capacity Control

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 frequency drive (VFD). 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 VFD 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 VFD be set at 50 percent of full speed to minimize the potential for ice to form in the unit.

Forced Draft Unit Capacity Control

The most common methods of capacity control are cycling the single speed fan motors, using two speed motors or pony motors and utilizing variable frequency drives to control the tower fans. Although capacity control methods for forced draft units are similar to those used for induced draft units, there are slight variations.

The simplest method of capacity control for forced draft units is to cycle the fan(s) on and off. However, this method of control results in larger temperature differentials and periods of time with the fans off. When the fans are cycled off, the water falling through the unit can draw air flow into the fan section. During extremely low ambient conditions, this moist air may condense and freeze on the cold components of the drive system. When conditions change and cooling is needed, any amount of ice that has formed on the drive system can severely damage the fans and fan shafts. **Therefore, fans MUST be cycled during low ambient operation to avoid long periods of idle fan operation. Excessive cycling can damage the fan motors; limit the number of cycles to a maximum of six per hour.**

Two speed or pony motors offer a better method of control. This additional step of capacity control will reduce water temperature differentials and the amount of time that the fans are off. This method of capacity control has proven effective for applications where load variations are excessive and cold weather conditions are moderate.

The use of a variable frequency drive provides the most flexible method of capacity control for forced draft units. The VFD control system allows the fans to run at nearly an infinite range of speeds to match the unit capacity to the system load. During periods of reduced load and low ambient temperatures, the fans can be maintained at a minimum speed which will ensure a positive air flow through the unit. This positive air flow in the unit will prevent moist air from migrating towards the cold fan drive components reducing the potential for condensation to form and freeze on them. The VFD control system should be implemented for applications that experience fluctuating loads and severe cold weather conditions.

Ice Management

When operating an evaporative cooling unit in extreme ambient conditions, the formation of ice is inevitable. 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 buildup 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 help melt the ice that has formed in the fill, basin or louver areas.

WARNING

Using this method will cause blow thru, resulting in splash-out and ice formation. **To help prevent blow thru and splash-out, maintain a minimum 50% fan speed, consult your local legislation as described in the section “Capacity Control”.**

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 frequency 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.**

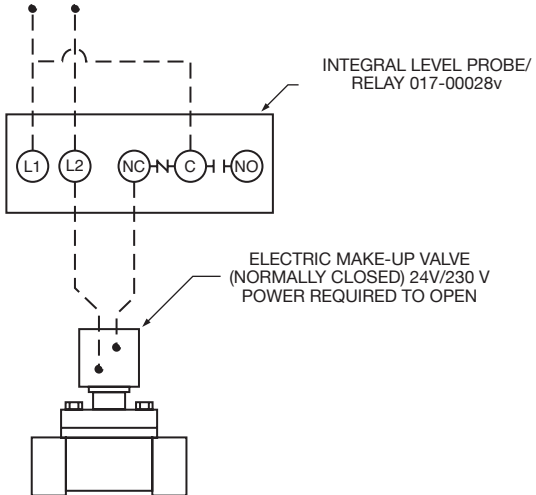
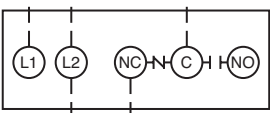
Forced Draft Units

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 potential for freezing the fan drive components. Therefore, the defrost cycle is an inappropriate method of ice management for forced draft units. However, low speed fan operation or variable frequency drives maintain a positive pressure in the unit which helps prevent ice formation on the fan drive components.

For more information on cold weather operation, please request a copy of EVAPCO's Engineering Bulletin 23

Problem	Possible Cause	Remedy
Overramping Fan Motors	Reduction in air static pressure	<ol style="list-style-type: none"> 1. On a forced draft unit verify that the pump is on, and water is flowing over the coil. If the 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. Verify the correct pump rotation direction. If the pump is rotating incorrectly, it will result in less water flow, and therefore less overall static pressure. 4. Check the basin water level against the recommended level. <p>Note: Air density directly affects AMP reading.</p>
	Electrical issue	<ol style="list-style-type: none"> 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.
	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.
	Pump running backwards (remote sump)	Visually verify pump rotor rotation by turning pump off and then on. Verify amp draw.
	Inadequate pump flow for remote sump	Confirm inlet pressure at header meets recommended valves.
	Strainer clogged	Remove strainer and clean

Problem	Possible Cause	Remedy
Fan Noise	Blade rubbing inside of fan cylinder (induced draft models)	Adjust cylinder to provide blade tip clearance.
Scaled Inlet Louvers on AT Units	Improper water treatment, insufficient bleed rates or excessive cycling of the fan motors, or simply high concentrations of solids in water.	This is not necessarily an indication that there is something wrong with the unit, or with the water treatment. 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.
Makeup Valve Will Not Shut Off	Make-up water pressure too high	Mechanical make-up valve water pressure must be between 140 and 340 kPa. If pressure is too high, the valve will not close. A pressure reducing valve can be added to lower the pressure. For the 3 Probe Electronic Water Level Control Package, the electrical actuator has a 35 to 700 kPa bar water pressure requirement.
	Debris in solenoid	Clean out solenoid of any debris.
	Frozen float ball	Inspect, and if so, float or valve may need to be replaced.
	Float ball is full of water	Check ball for leaks and replace.
Water <u>Constantly</u> Blowing Out Overflow Connection	This can happen on forced draft units due to the positive pressure in the casing section. Overflow connection has not been piped at all or 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 <u>Intermittently</u> Blowing Out Overflow Connection	This is normal	The bleed line for the unit is piped to the overflow connection
Cooling Tower Cold Water Basin Overflowing	Problem with make-up line.	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.

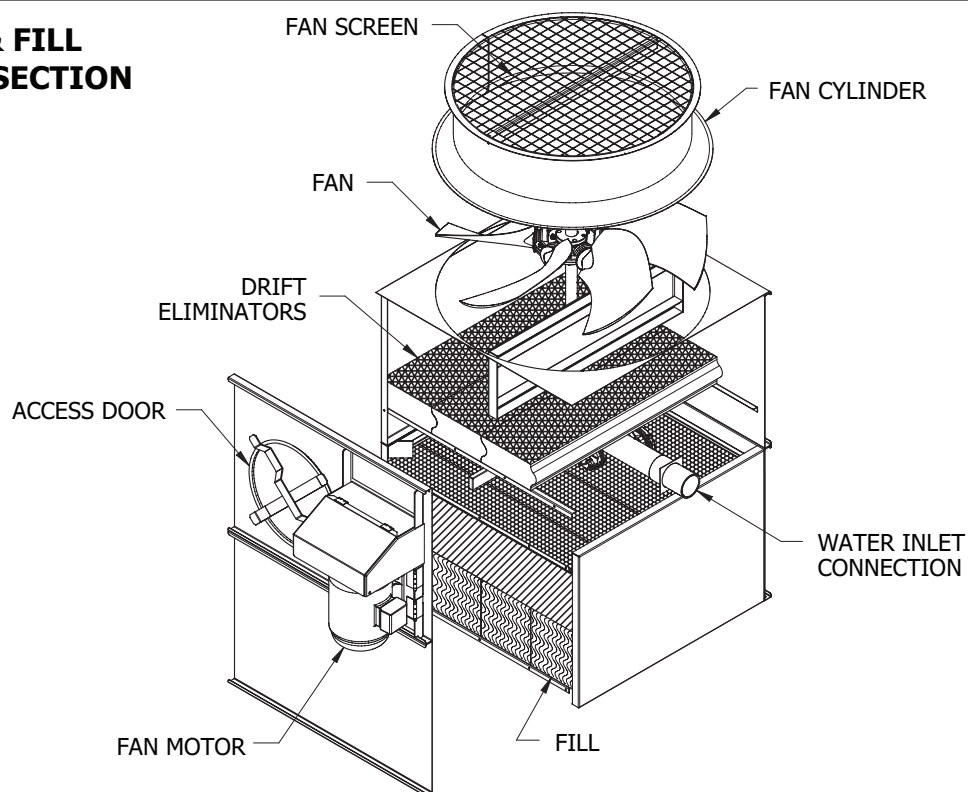
Problem	Possible Cause	Remedy
Low Pan Water Level	Electronic Water Level Control	See EWLC Section
	Float Bulb not set correctly	Adjust float ball up or down to obtain proper water level. Note: The float ball is set to the operating level at the factory.
Rusting Stainless Steel	Foreign material on surface 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 cleaning. EVAPCO recommends using a good stainless steel cleaner in conjunction with a Scotch-Brite pad. Maintenance of the unit's surface should be done on a regular basis.
Electric Water Level Control Not Working 	The valve won't open or close	<ol style="list-style-type: none"> 1. Verify that water pressure is above 0,35 bar and below 7,0 bar. 2. Verify wiring with wiring diagram. Check supply voltage. 3. Verify that there is not a blockage in the Y-Strainer 4. Confirm the probes are not dirty. 5. Check Red LED on circuit board. If it is on, the valve should be closed.  <p>For a 3-Probe Assembly:</p> <p>Simulate "Low Water Condition" - LED OFF After cleaning the probes, lift probe assembly out of the stand pipe. This will simulate a "low water condition". Check the contacts for proper position.</p> <ul style="list-style-type: none"> - The contact between "C" and "NC" should now be closed and water makeup valve should be energized (valve open) <p>Simulate "High Water Condition" - LED ON</p> <ul style="list-style-type: none"> - Connect a jumper wire between the longest probe and the shortest probe. The contact between "C" and "NC" should now be open and the water makeup valve should be de-energized (valve closed)

Replacement Parts

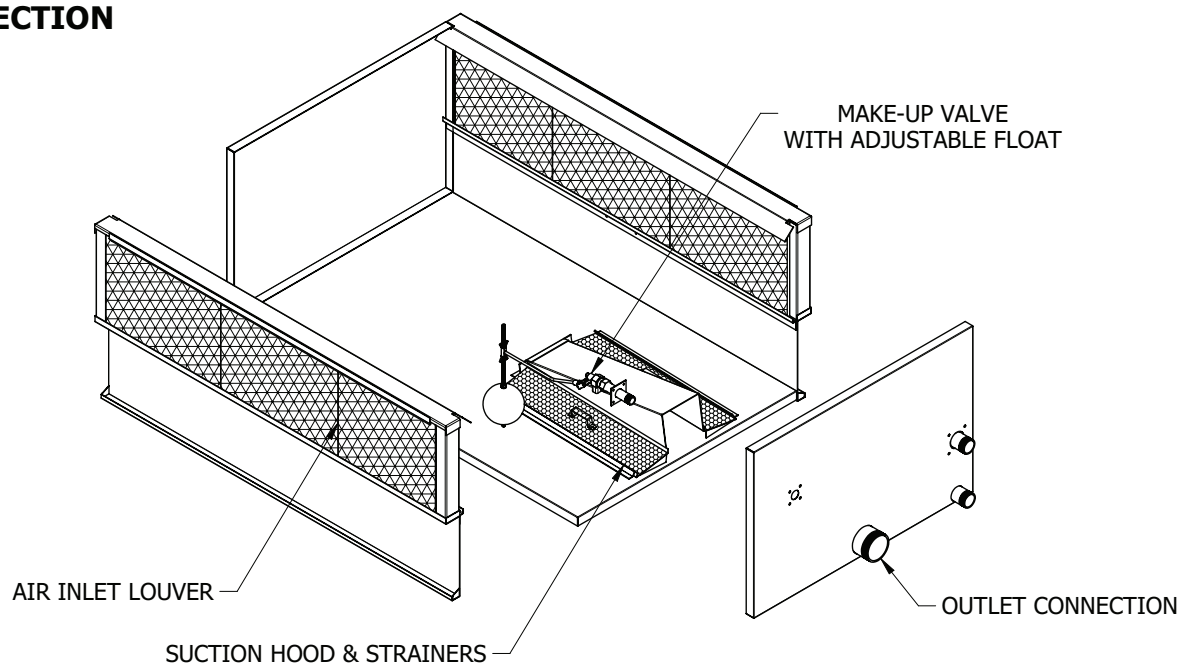
EVAPCO has replacement parts available for immediate shipment.
Most orders ship within 24 hours from time of order!

To order replacement parts, please visit **www.evapco.eu** to find your local contact.

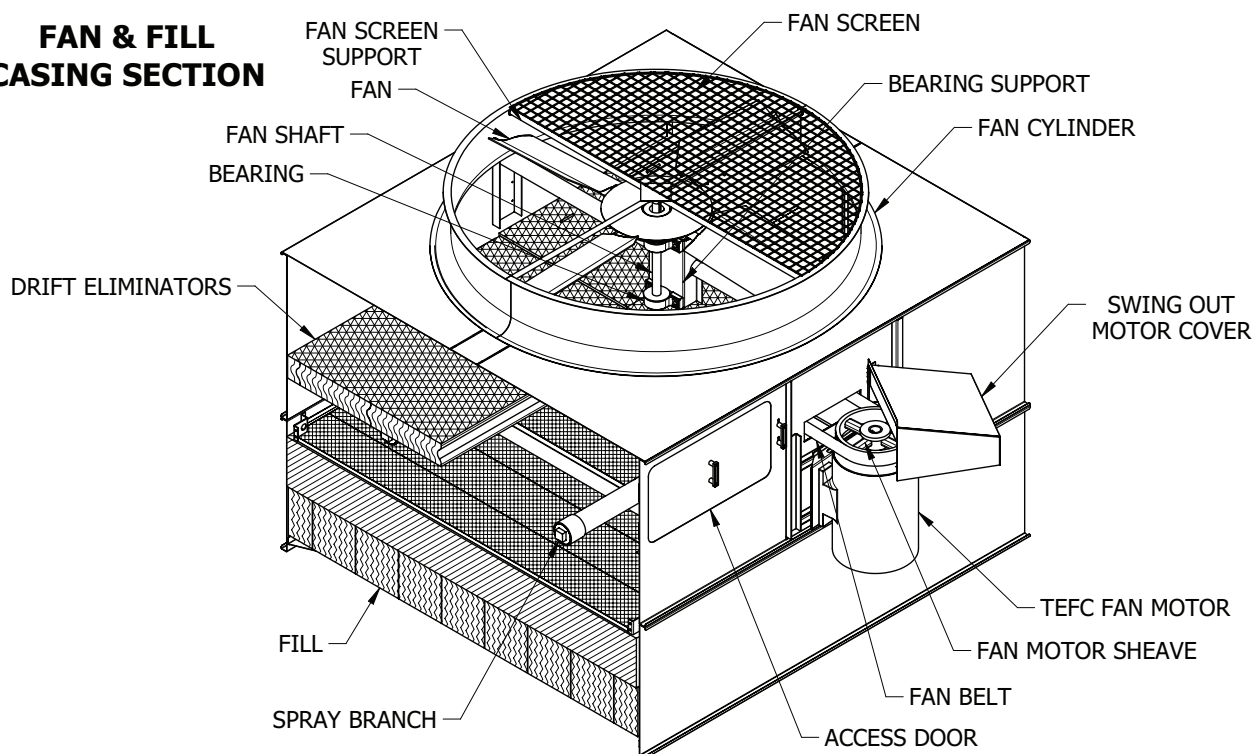
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CASING SECTION**



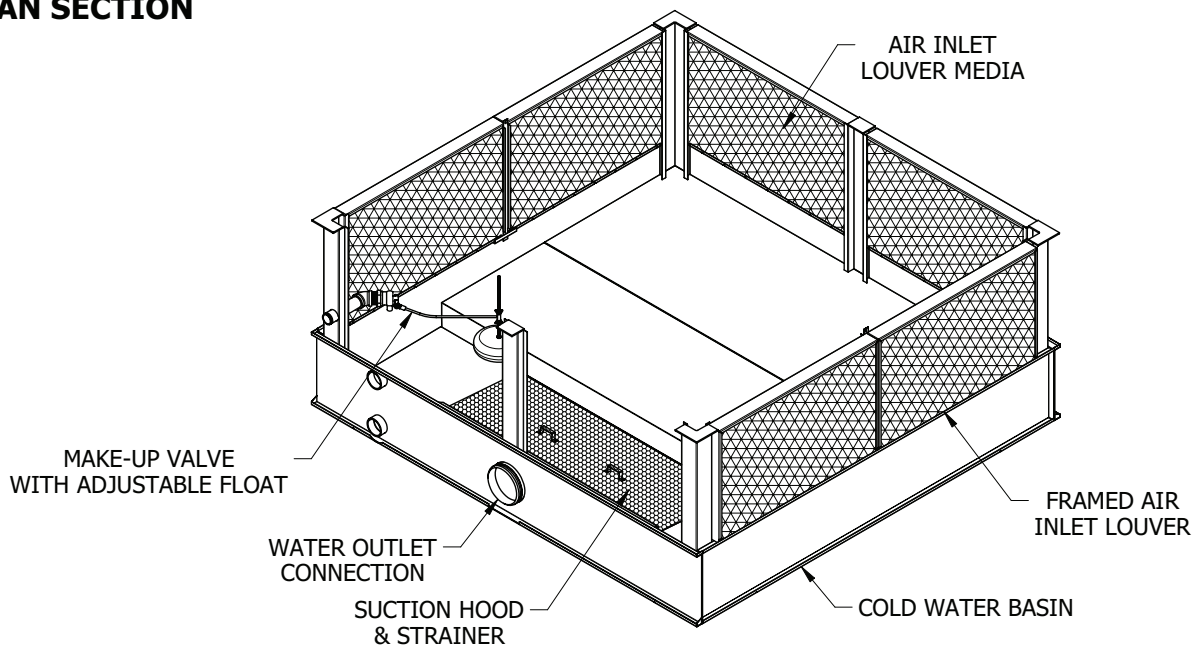
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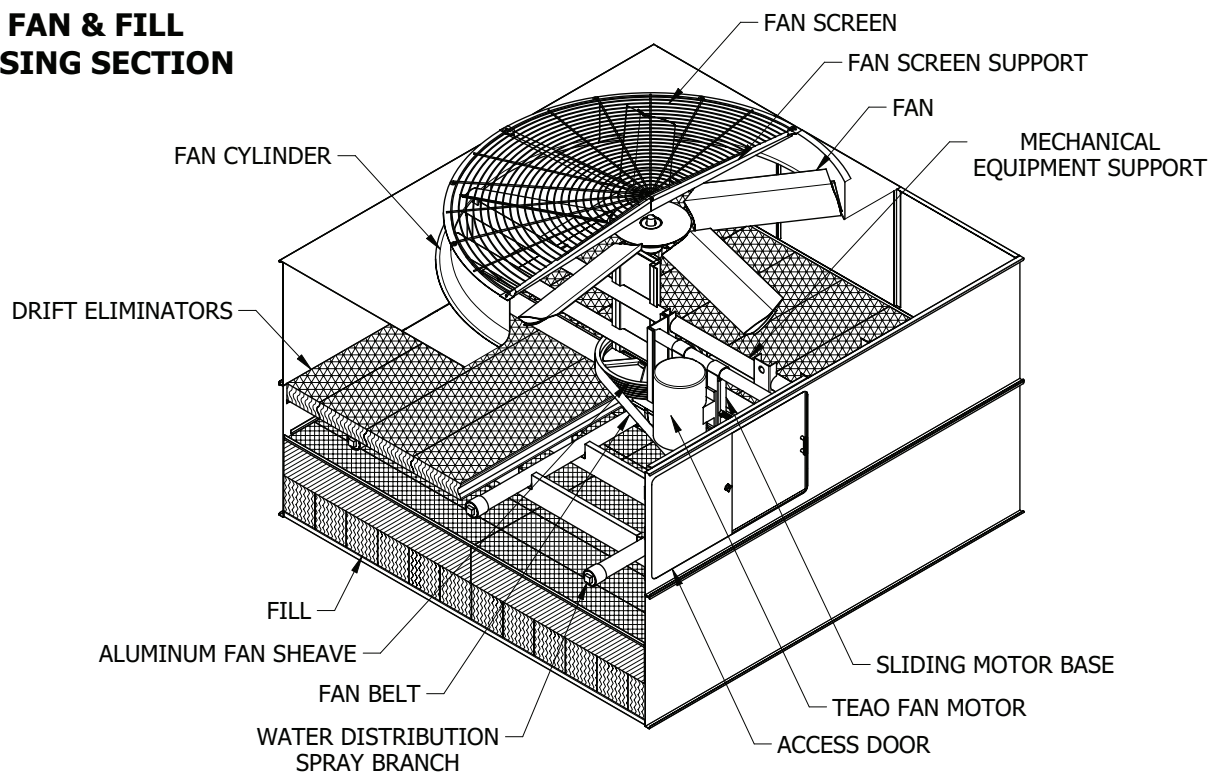
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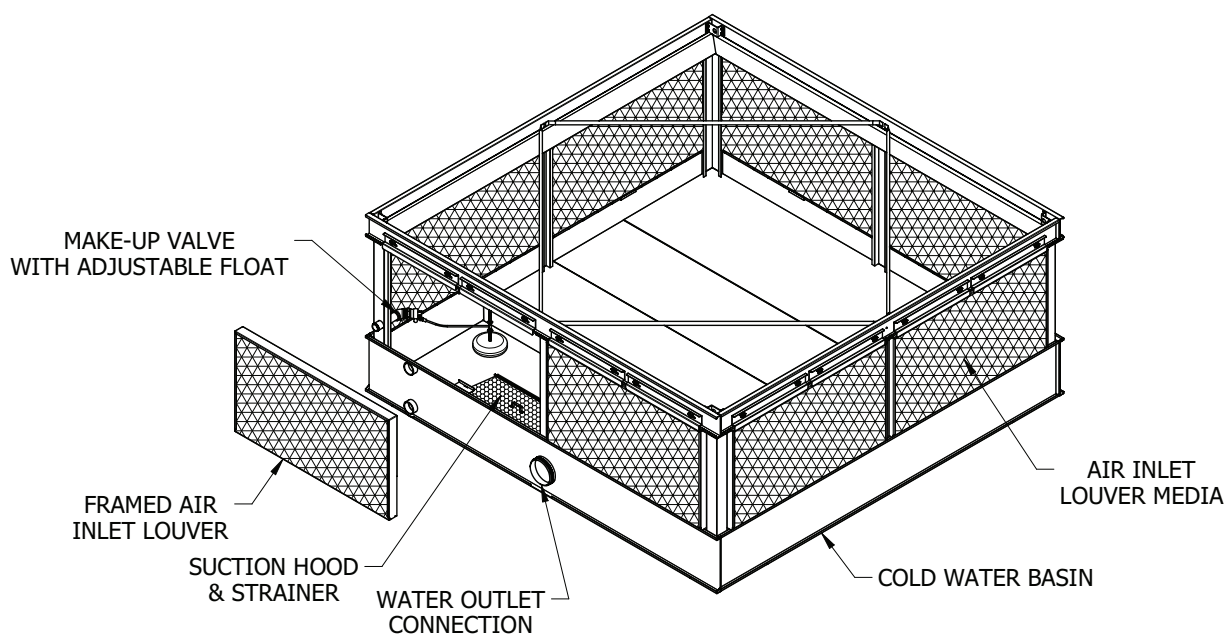
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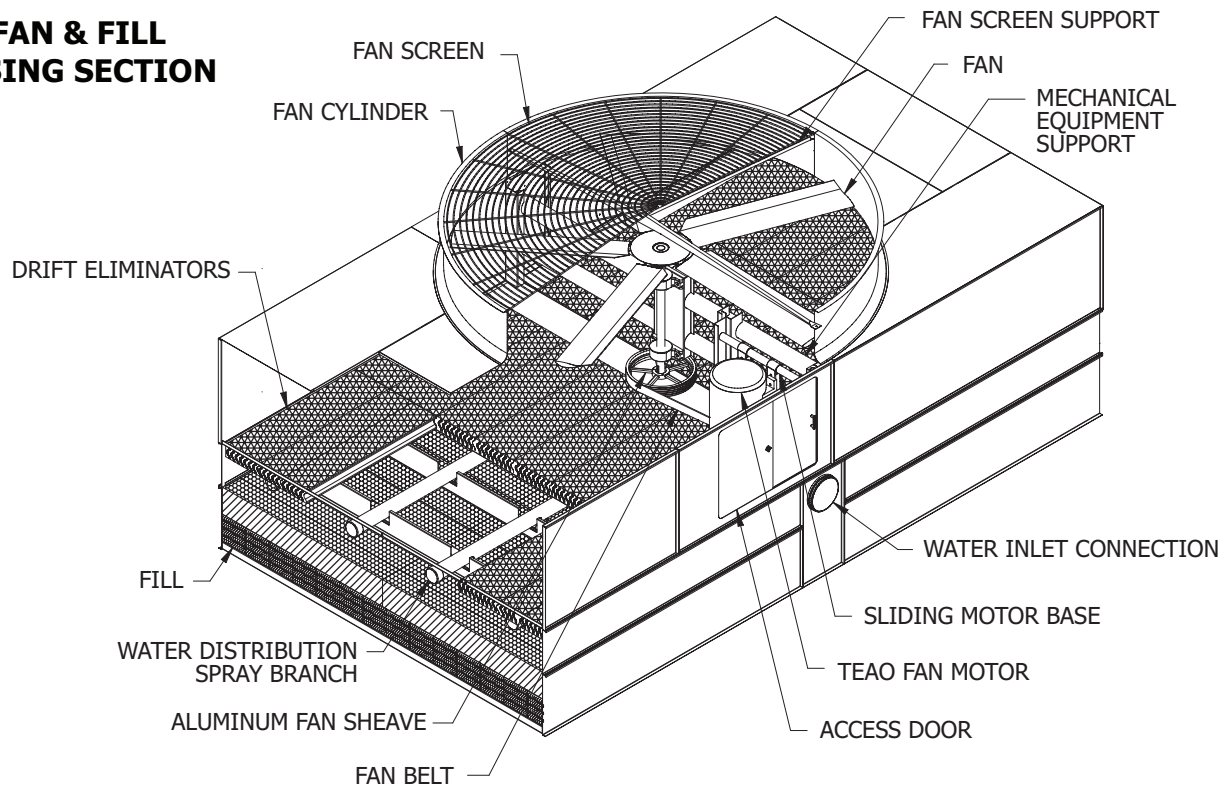
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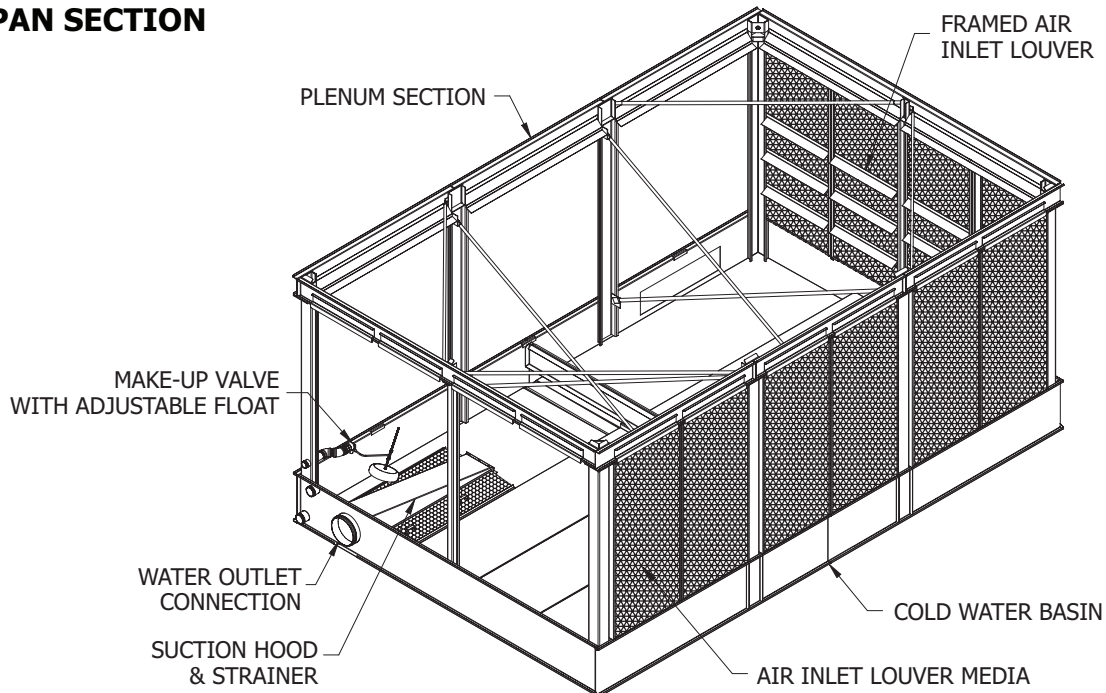
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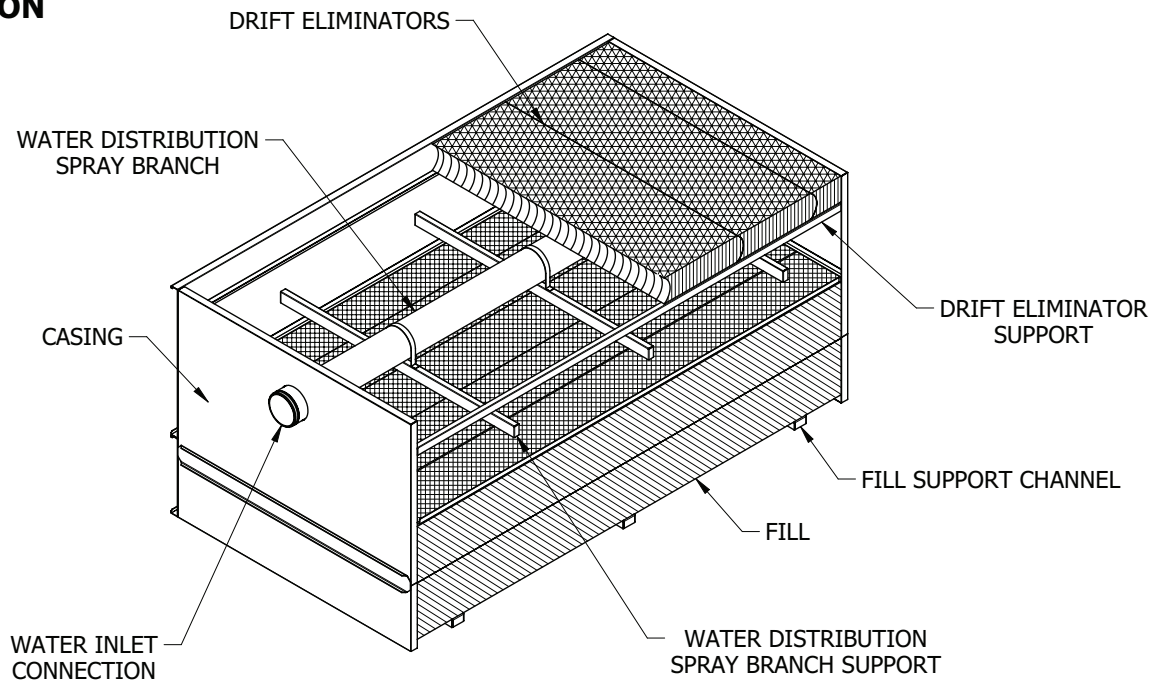
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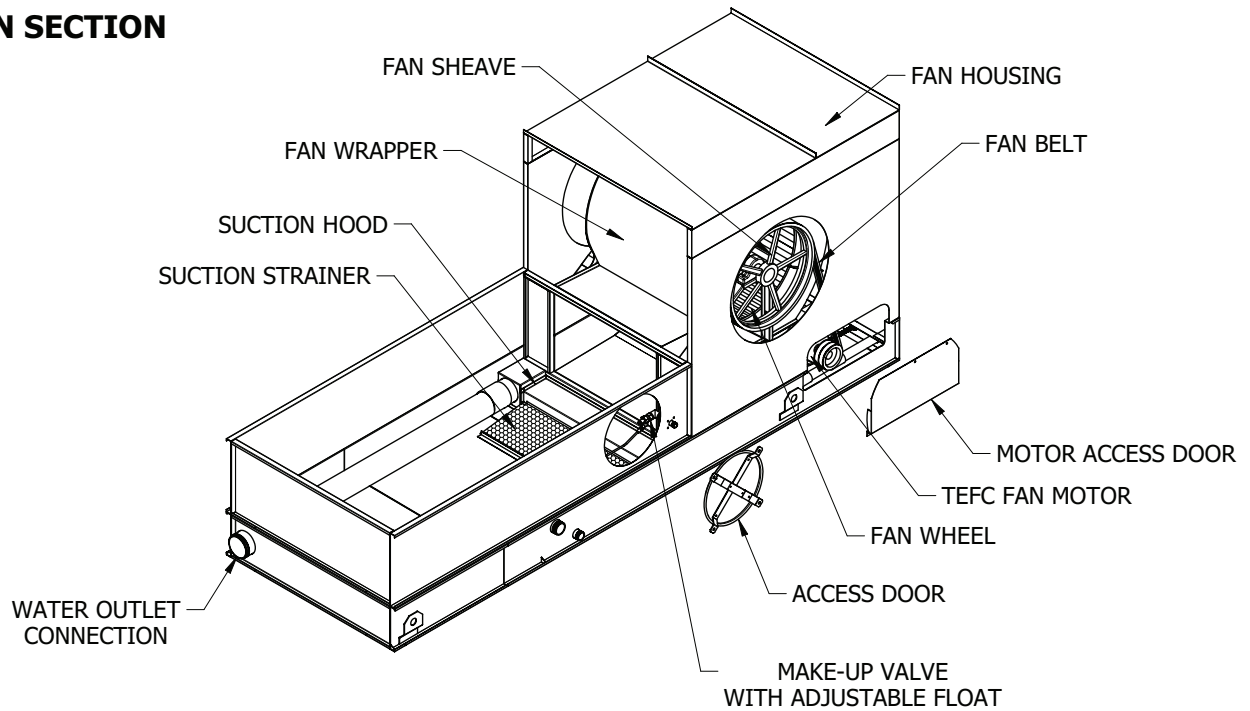
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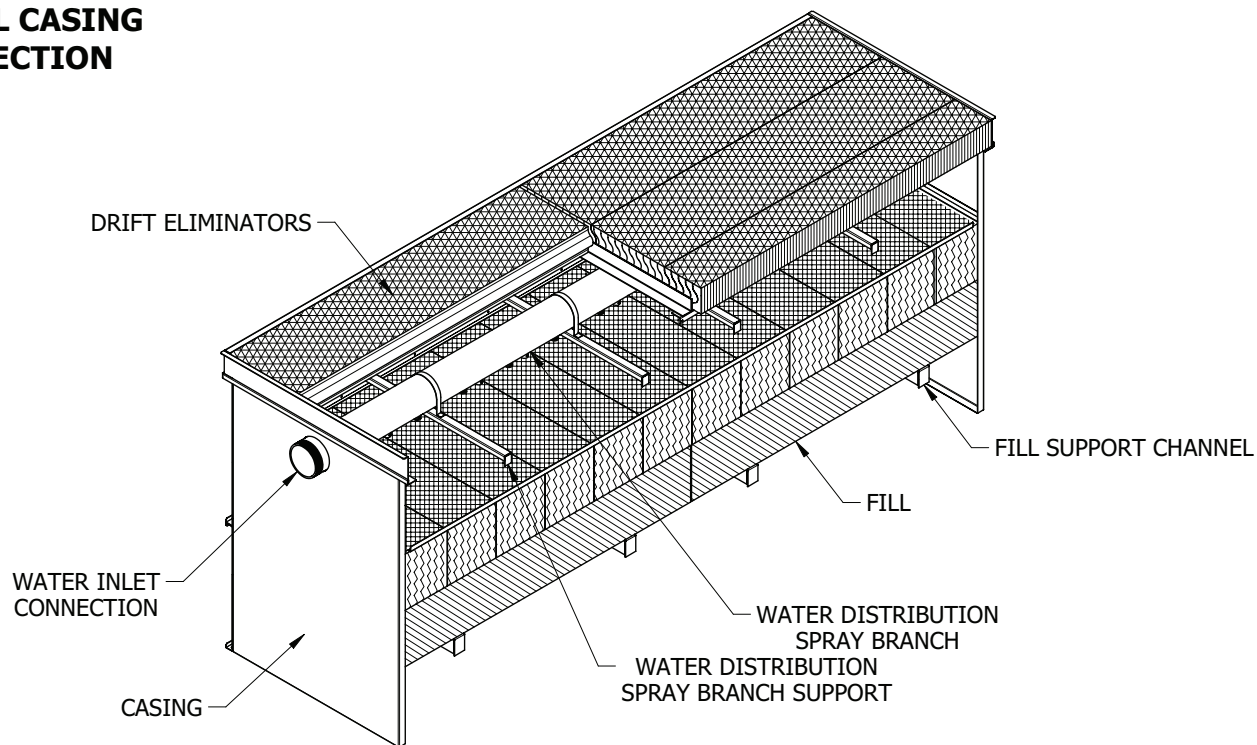
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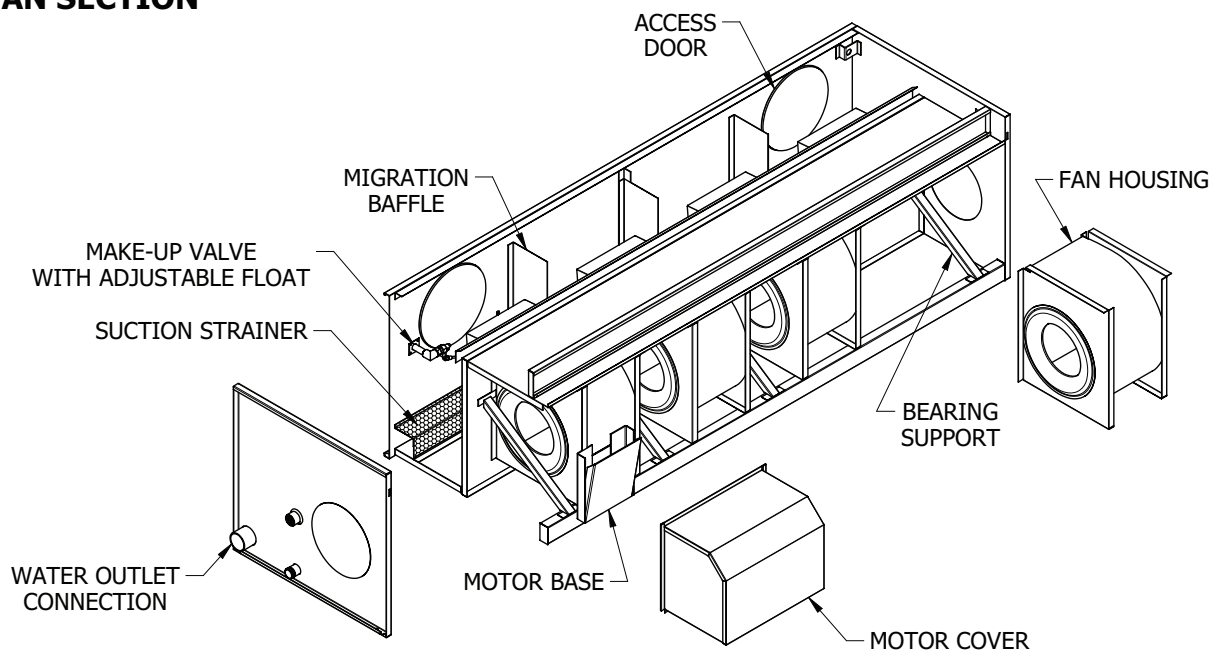
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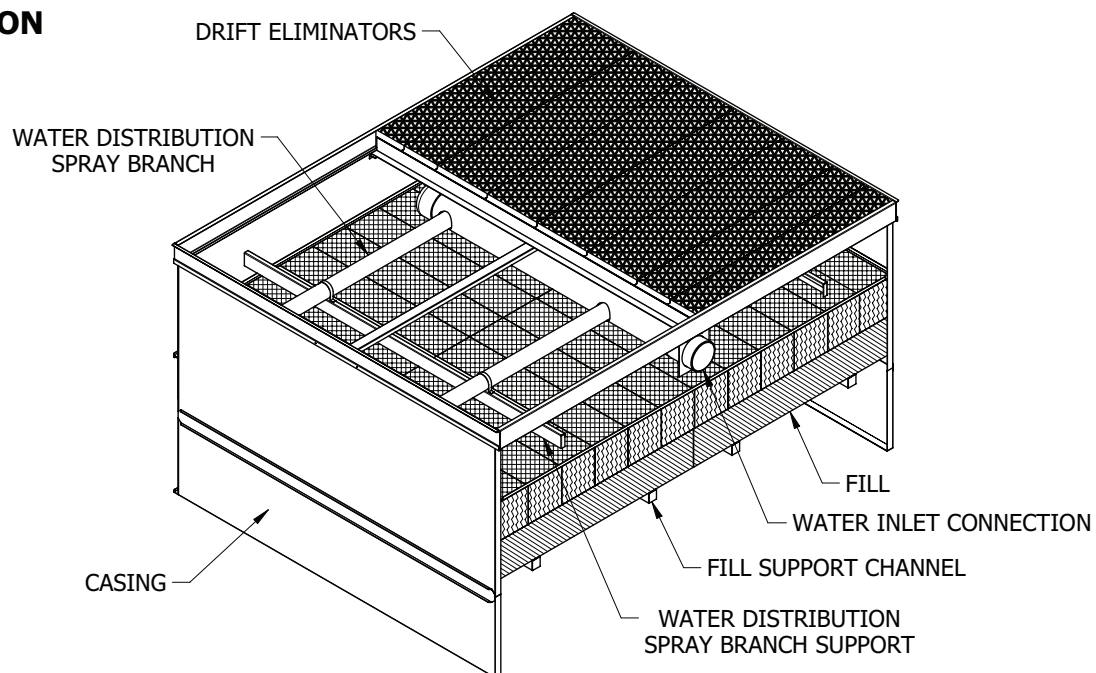
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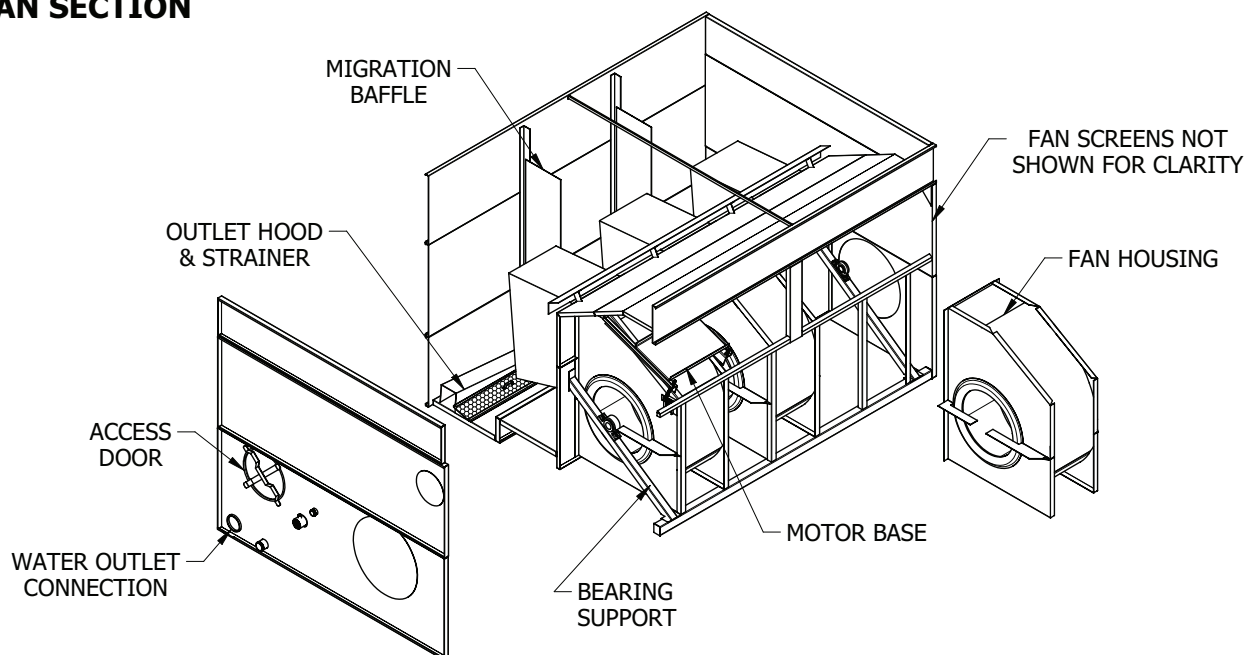
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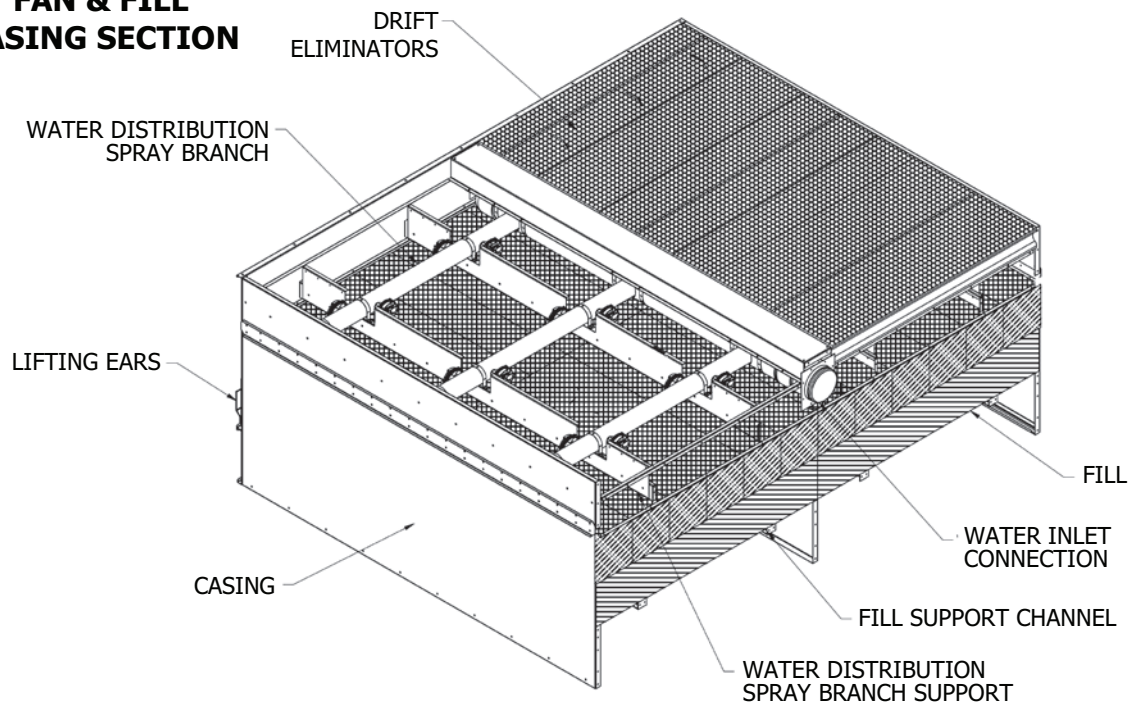
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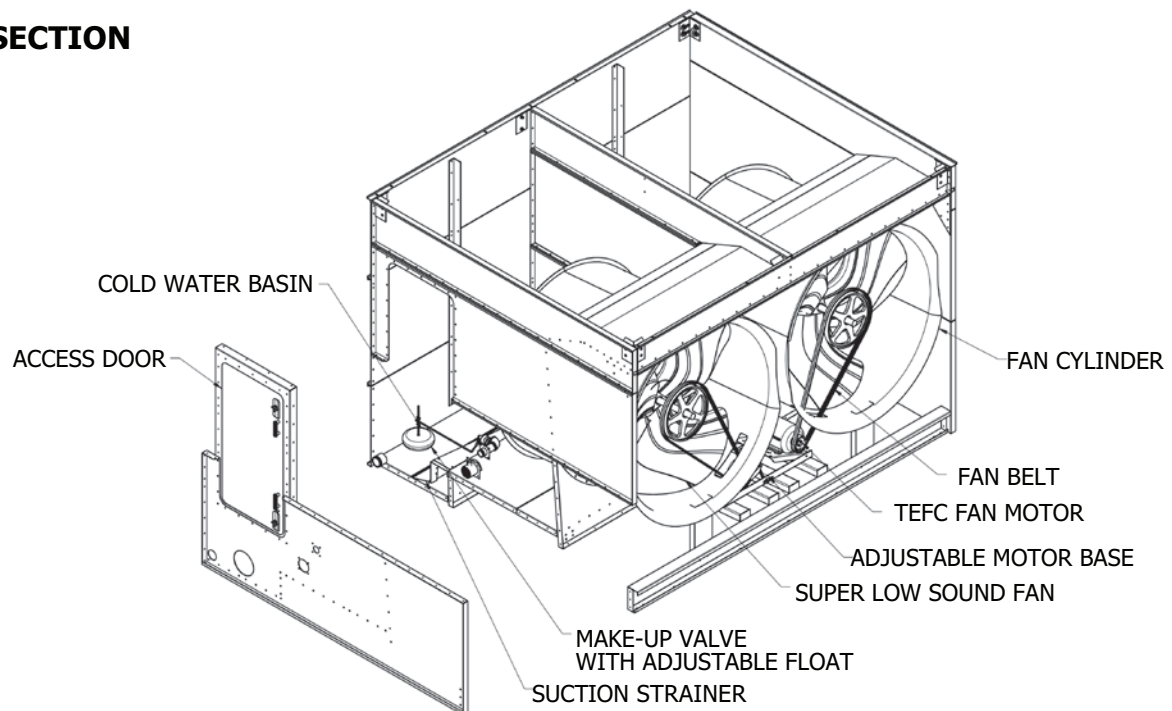
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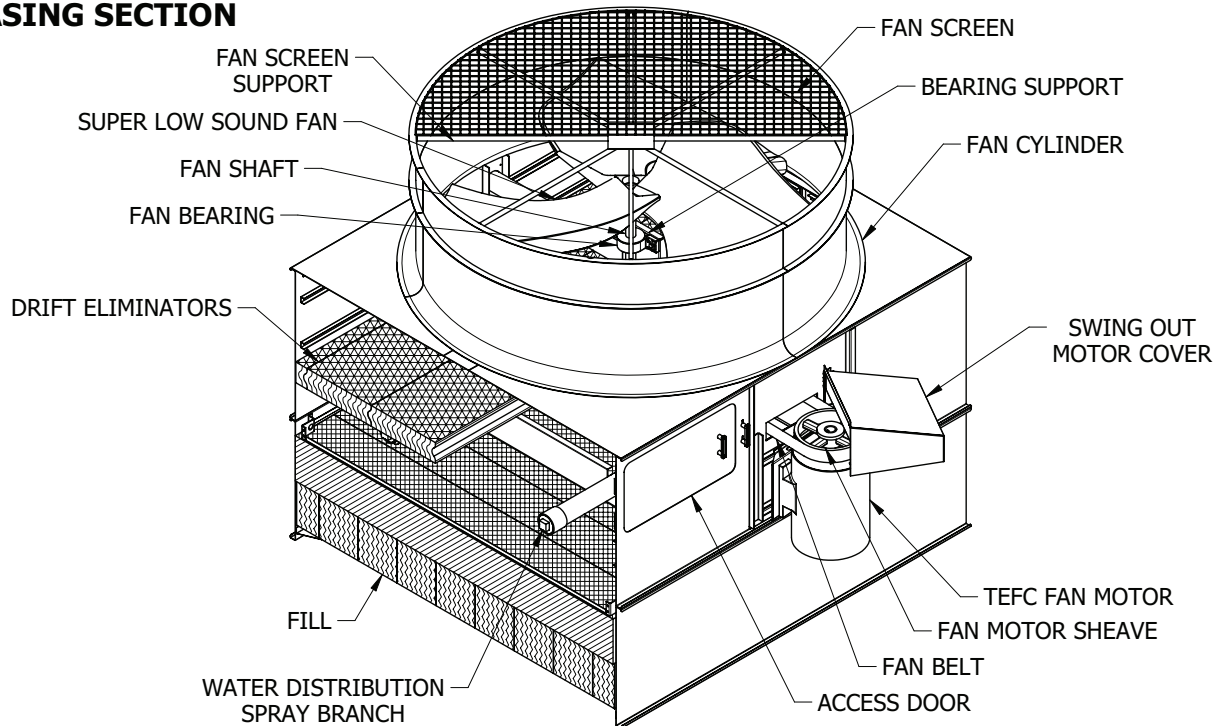
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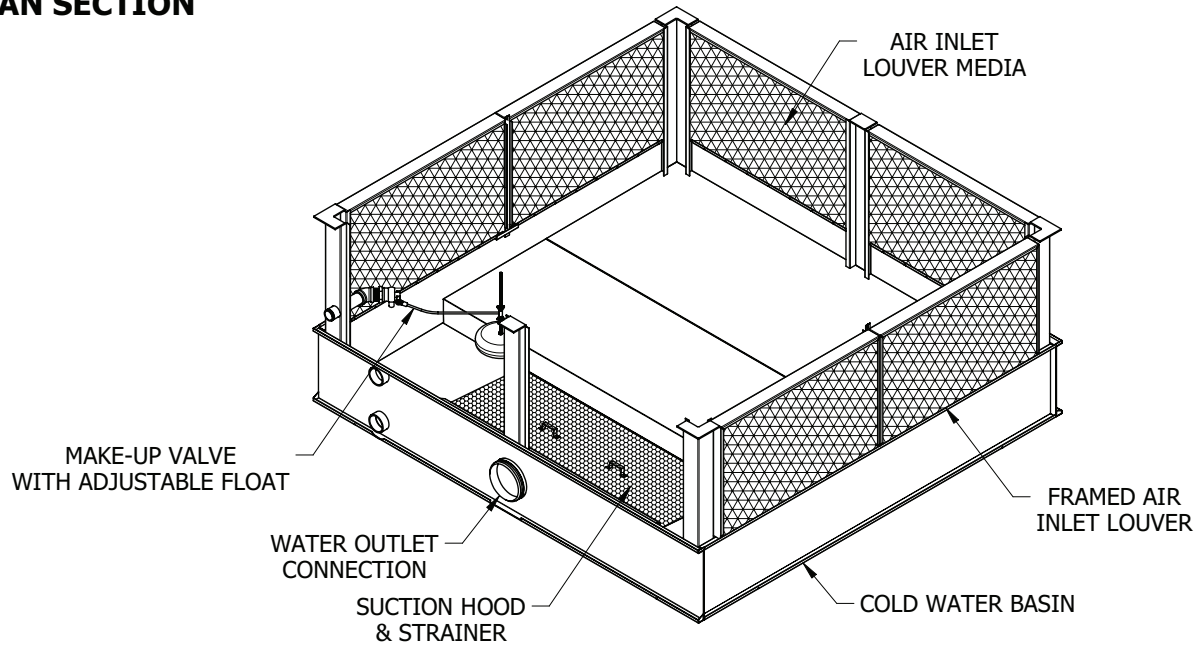
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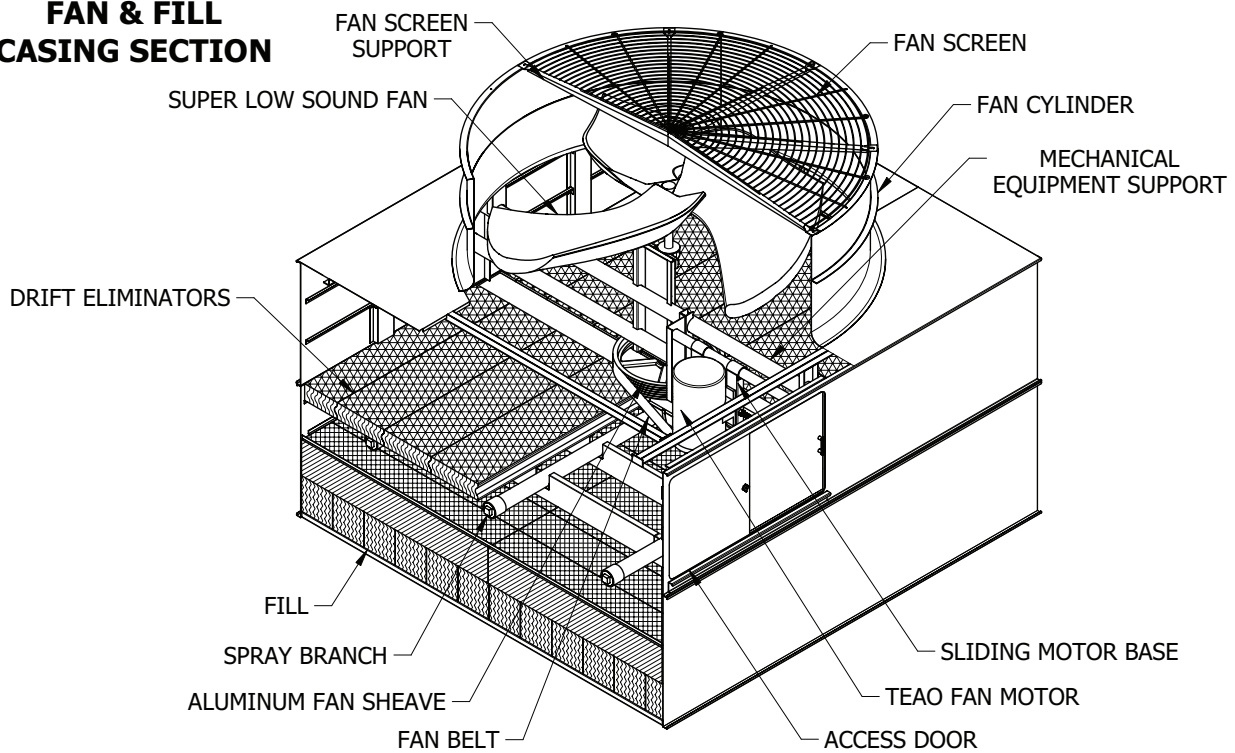
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