



Bulletin 116R-E Metric

REDUCED EUROPEAN MAINTENANCE INSTRUCTIONS

**For EVAPCO Induced Draft and Forced Draft
Closed Circuit Coolers and Evaporative Condensers**



ATC-E / eco-ATC
ATW / eco-ATW



eco-ATWE



LSWA(-H) / LSCE



LRW(-H) / LRC



ESW4



PMCE/Q



PHC-E



**For EVAPCO Authorized Parts and Service,
Contact Your Local Mr. GoodTower® Service Provider
or the EVAPCO Plant Nearest You**

The full version of the Maintenance Instructions 116-E, is available for download at:

www.evapco.eu

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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. It is important to establish a regular maintenance program and be sure that the program is followed.

A clean and properly serviced unit will provide a long service life and operate at peak efficiency. If you should require any additional information about the operation or maintenance of this equipment, you can consult Bulletin 116-E or 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

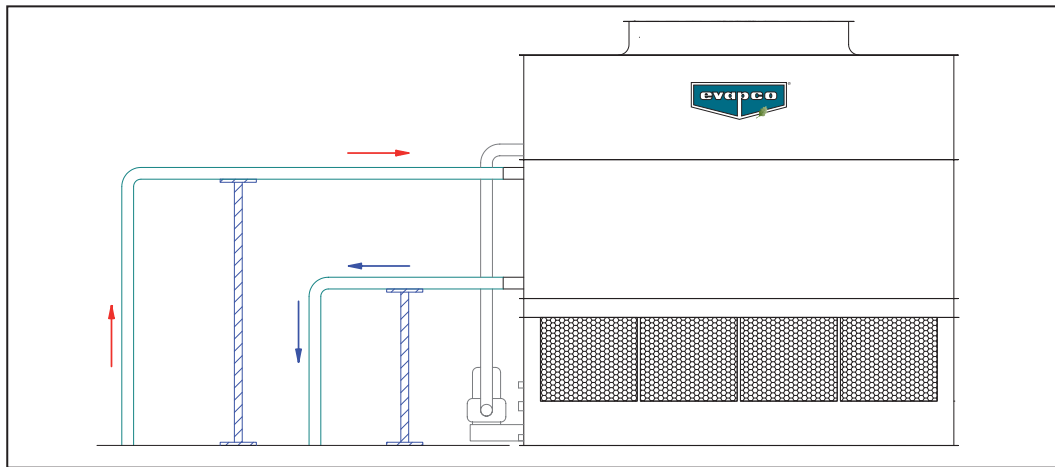
in order to prevent personal injury and/or property damage. The warnings listed below are to be used as guidelines only.

-  **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. 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. 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.
-  **WARNING:** Building water systems receive potable and non-potable water from either a public or private entity for their water supply. This water supply for the building water system can contain various waterborne pathogens, including Legionella bacteria, which can cause or contribute to various illnesses if aspirated, ingested or inhaled. Since evaporative cooling equipment uses the same building water, there is some potential that these pathogens might propagate in the equipment. Therefore, careful consideration should be undertaken with respect to equipment location and the implementation of effective water management, inspection and cleaning protocols. (See Control of Biological Contaminants in these Operation and Maintenance Instructions.)

- ⚠ WARNING:** In order to avoid excessive pressure, proper safety valves should be foreseen in the cooling installation. These safety measures are not delivered by Evapco and are the responsibility of the customer/contractor. The application of these safety measures has to be evaluated for the cooling system as a whole and not limited to the partly completed machinery.
- ⚠ WARNING:** Atmospheric corrosion and corrosion due to the use of corrosive media at the inside/or outside of the coils is forbidden and voids the PED certification.
- ⚠ WARNING:** Every handling that effects the integrity of the pressure vessel (example, but not limited to, welding, grinding, drilling, ...) is forbidden and voids the PED certification.

Installation Precautions

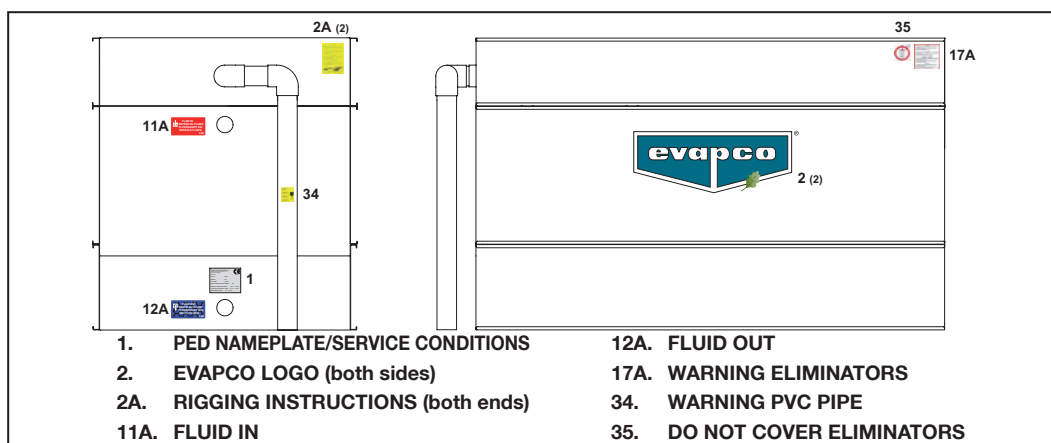
- ⚠ WARNING:** The coil connections are not designed to support piping. The water / glycol / refrigerant piping always need to be supported (by others). See also Bulletin 131-E “Piping Evaporative Condensers”.



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 coil section(s)



- ⚠ WARNING:** Do not operate the pressure vessel at service conditions outside of the PED nameplate located at the coil connection. See position 1 for the location of the PED nameplate.
- ⚠ WARNING:** Maximum working temperature of the pressure vessel as mentioned on the PED nameplate exceeds the nominal operating temperature of the unit. Never apply pressure vessel temperatures above 65°C or consult the factory for approval.
- ⚠ WARNING:** Legal periodic controls of the pressure vessel need to be performed according to the legal requirements of the country.
- ⚠ WARNING:** To avoid damage of the spray system components, the spray water inlet pressure should never exceed 0,7 bar.

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/motor/pump bearings and 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 (or removing the pump motor fan guard), and rotating it several turns.
- If unit sits longer than a few weeks, run gear reducer (if equipped) for 5 minutes weekly.
- If unit sits longer than 3 weeks, completely fill gear reducer with oil. Drain 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 (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.
- If coil sits longer than one month, nitrogen charge the coil.
- Energize fan motors space heaters.

International Building Code Provisions

The International Building Code (IBC) is a comprehensive set of regulations addressing the structural design and installation requirements for building systems – including HVAC and industrial refrigeration equipment. The code provisions require that evaporative cooling equipment and all other components permanently installed on a structure must meet the same seismic design criteria as the building. All items attached to EVAPCO Closed Circuit Coolers or Evaporative Condensers must be independently reviewed and isolated to meet applicable wind and seismic loads. This includes piping, ductwork, conduit, and electrical connections. These items must be flexibly attached to the EVAPCO unit so as not to transmit additional loads to the equipment as a result of seismic or wind forces.

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 operate 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 for recommendations on locking out resonance frequencies.
5. Verify that a water treatment plan has been implemented including passivation of galvanized steel units. See "Water Treatment" section for more details.

6. 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.
7. 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.
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) and pump(s) by hand to insure it turns freely without obstructions.
10. 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.
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 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. For closed circuit coolers only, fill the heat exchanger coil with the specified fluid and "burp" air from the system before pressurizing, using vents on coil inlets. Do not do this for evaporative condensers.
14. 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.

15. Closed hydronic systems connected to either a closed-circuit cooler or dry cooler should be pre-cleaned and flushed to remove debris, grease, flash rust, oil, and other suspended solids prior to operation. Evapco recommends the use of inhibitor chemistry or inhibited glycol to minimize corrosion and scale during normal operation. EVAPCO recommends a minimum of 25% inhibited glycol to minimize corrosion.

For eco-WE & eco-W with optional controls, see controls O&M for proper start up procedure.

After the unit has been energized, check the following:

1. Adjust mechanical float valve as required to the proper water level.
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. 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 should not exceed the motor nameplate full load amp rating taking the service factor into account.
6. Adjust bleed valve to proper flow rate. Consult your qualified water treatment company to fine tune the minimum bleed necessary, see "Water Treatment and Water Chemistry" section.
7. See fan and pump motor manufacturer maintenance and long term storage instructions for more detailed information. The motors should be lubricated and serviced in accordance with manufacturers instructions.

Basic Closed Circuit Cooler / Condenser Sequence of Operation for Wet or Evaporative Mode

System Off / No Load

The system pumps and fans are off. If the basin is full of water a minimum basin water temperature of 40°F (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 recirculation pump turns on. The unit will provide approximately 10% cooling capacity with only the pump running. If the unit has positive closure dampers they should be fully opened before the pumps turn on.

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/Condensing 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 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.

Dry Operation

During colder winter months it is possible to turn off the spray pump, drain the cold water basin, and just cycle the fans. Be sure to leave the basin drain open during this time to prevent collection of rain water, snow, etc. If the unit has positive closure dampers they should be fully opened before the fans turn on. If dry operation will be used on a centrifugal fan, forced draft unit, be sure to verify 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 42° F (6°C).

NOTE: When a unit is provided with a discharge damper assembly, the control sequence should cycle the dampers open and closed once a day regardless of capacity requirements to prevent the assembly from seizing. The fan motor should be shut off whenever the dampers are closed.

NOTE: ESW4 or PHC-E product lines should not operate dry.

NOTE: The eco-ATW/eco-ATWE sequence of operation is unique and is explained in detail in the Sage2, Sage3 Panel Control Manual

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 totally enclosed air over (TEAO) or a totally enclosed fan cooled (TEFC) fan motor. These motors are built to "Cooling Tower Duty" specifications. They are supplied with permanently lubricated bearings and special moisture protection on the bearings, shaft and windings. After extended shut-downs, the motor should be checked with an insulation tester prior to be restarted.

Fan Shaft Ball Bearings

For induced draft units, 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 -29°C and 177°C. (For colder operating temperatures, contact the factory).

- Mobil - Polyrex EM
- Timken Pillowblock Grease
- Chevron - SRI

Feed grease slowly into the bearings or the seals may be damaged. A hand grease gun is recommended for this process. When introducing 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 as shown in **Table 1**.

Fan Shaft Sleeve Bearings (1,2 m LS 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).

Use one of the following industrial grade, non-detergent mineral oils. **Do not use a detergent based oil or oils designated heavy duty or compounded.** Different oils may be required when operating at temperatures below 0°C continuously.

Table 1 provides a short list of approved lubricants for each temperature range.

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 1 – Sleeve Bearing Lubricants

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 (Direct drive units do not require any 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. Belt tension should be checked on a monthly basis. A properly tensioned belt will not "chirp" or "squeal" when the fan motor is started.

Gear Drives

Induced draft units with gear drive systems require special maintenance. Please refer to the gear manufacturers 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.

Coil Inlet

Inspect the top coil, air inlet and spray section on all PHC-E units monthly.

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).

Note: for the eco-ATW with Sage² and eco-ATWE with Sage³ consult the manual.

1. Fan Motor Cycling

Fan Motor Cycling requires the use of a single stage thermostat which senses the fluid temperature (closed circuit coolers) or condensing temperature (evaporative condensers). The contacts of the thermostat are wired in series with the fan motor's starter holding coil. For individual fan motor cyclings interlock fan motors before fan start to prevent issues with reversing idle fans.

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 can cause the fan motor to overheat.

Controls should be set to only allow a maximum of six start/stop cycles per hour.

IMPORTANT:

THE RECIRCULATION PUMP MAY NOT BE USED AS A MEANS OF CAPACTY CONTROL AND SHOULD NOT BE CYCLED MORE THEN SIX START/STOP CYCLES PER HOUR. EXCESSIVE CYCLING CAN LEAD TO SCALE BUILD-UP, RESULTING IN REDUCED WET AND DRY PERFORMANCE.

2. 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 approximately 60% of full speed capacity.

Two-speed capacity control systems require not only a two-speed motor, but also a two-stage thermostat and the proper two-speed motor starter.

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.

3. 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 into an adjustable AC 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.

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 capable motor built in compliance with NEMA standard MG-1.

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. 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.

NOTE: Pump Motors: VFD's should not 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 VFD, motor lead lengths (between the motor and the VFD), conduit runs and grounding can dramatically affect the response and life of the motor. Select a high quality VFD that is compatible with the fan motor(s) in the EVAPCO unit(s). Many variables in the VFD configuration and installation can affect motor and VFD performance. Two particularly important parameters to consider when choosing and installing a VFD are switching frequency and the distance between the motor and VFD often referred to as lead length. Consult the VFD manufacturer's recommendations for proper installation and configuration. The motor lead length restrictions can vary with the vendor. Regardless of motor supplier, minimizing lead length between the motor and drive is good practice.

VFD Lockout Notification

Sequence of Operations / Guidelines for Multi-fan Units with a VFD during Peak Load

For eco-ATWE, see Sage²/Sage³ control Panel O&M:

1. Both fan motors off – Pump running on one cell.
2. Both fan motors off – Pump running on both cells.
3. Both VFDs turn on at the manufacturer's recommended minimum operating speed (25%) – Pump running on both cells.
4. Both VFDs speed up uniformly (they should be synchronized on start-up) – Pump running on both cells.
5. Both VFDs are on full speed – Pump running on both cells.

NOTE: The VFDs need to have a preset shutoff to prevent water temperatures from becoming too cold and to prevent the drive from trying to turn the fan at near zero speed. 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.

Variable Frequency Drive Lock-out Notification

WARNING: Qualified personnel should use proper care, procedures and tools when maintaining the Fan/Drive System in order to prevent personal injury and/or property damage.

WARNING: 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% (15Hz) and 100% (60Hz) 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.

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 approximately 60% of full speed capacity.

Two-speed capacity control systems require not only a two-speed motor, but also 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.

NOTE: 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 30 seconds when switching from high speed to low speed.

Sequence of Operations / Guidelines for Multi-fan Units with a VFD during Peak Load

For eco-ATWE, see Sage²/Sage³ control Panel O&M:

1. Both fan motors off – Pump running on one cell.
2. Both fan motors off – Pump running on both cells.
3. One fan motor on low speed, one fan motor off – Pump running on both cells.
4. Both fan motors on low speed – Pump running on both cells.
5. One fan motor on high speed, one fan motor on low speed – Pump running on both cells.
6. Both fan motors on full speed – Pump running on both cells.

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. Make certain that the strainer is properly located over the pump suction, alongside the anti-vortexing hood.

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 2** for unit specific levels.

Evaporative Condenser Model Number	Closed Circuit Cooler Footprint	Operating Water Level* (inch)	Operating Water Level* (mm)
ATC-E Products 50E to 165E, 170E to 3714E	ATWB, eco-ATW & eco-ATWE Products 3' and 4' wide units** 8.5' wide to "7' wide thru 24' wide"	9" 11"	229 279
ATC-DC 8.5' Wide to 24' Wide		11"	279
eco-ATC Products 122A to 3846A	eco-ATWB-E 8.5' wide thru 24' wide	11"	279
LRC Products 25 to 379	LRWB Products 3' wide thru 8' wide units	8"	203
LSC-E Products 36 to 170 185 to 385 400 to 515, 800 to 1030 550 to 805, 1100 to 1610	LSW Products 4'x6' thru 4'x12' 5.5'x12', 5.5'x18' 8'x12', 8'x24', 10'x12', 10'x24' 8'x18', 8'x36', 10'x18', 10'x36'	11" 11" 12" 15"	279 279 305 381
PMC-E, eco-PMC 175E to 375E, 183 to 387 332E to 2019E, 275 to 2191		10" 14"	254 356
—	ESW4 Products 8.5' and 14' wide units 12' wide unit	9" 10"	229 254
PHC-E Products S-79 to S-1236 D-1224 to D-2826		9" 10"	229 254

* Measured from lowest point on basin floor.

** Not available on eco-ATWE.

Table 2 - 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 level is above the normal operating level and accommodates the volume of water normally in suspension in the water distribution system and the riser piping. 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. The bottom center of the float should be set at 1" (25mm) below the middle of the overflow. At its highest point, float arm should be parallel to the water level.

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 for the mechanical valve 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

Check the water distribution system 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 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 models, lifting handles are provided along the top layer of eliminators. Eliminators can be easily removed

from the access door and the distribution system observed. The diffusers are essentially non-clogging and should seldom need cleaning or maintenance.

If the water diffusers are not functioning properly, it is a sign that the pan or system 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 rapidly 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 branches or header can be removed for cleaning, but do so only if necessary. Check the strainer in the pan to make sure it is in good condition and positioned properly so that cavitation or air entrainment does not occur.

All Evaporative Condensers and Closed Circuit Coolers, except the ESW4 Closed Circuit Cooler, are supplied with ZM II® spray nozzles as standard. The ZM II® spray nozzles do not need to be oriented a specific way to achieve proper coil coverage.

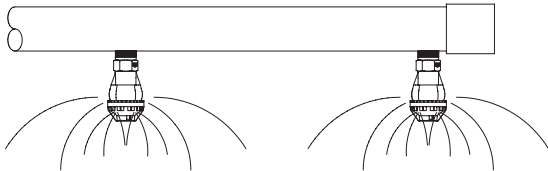


Figure 1 - ZM II® Spray Nozzle Orientation.
All Coil Products except the ESW4

Figure 1 shows the proper spacing of the ZM II® spray nozzles. For the ESW4, wide orifice water diffusers are supplied. When inspecting and cleaning the water distribution system, always check that the orientation of the water diffusers is correct as shown in **Figure 2**.

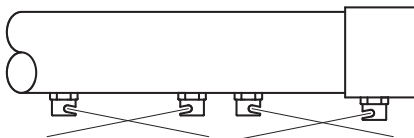


Figure 2 - Proper Water Diffuser Orientation
(2A Nozzles) ESW4 Models

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. Additional information can be found under "Water Treatment and Water Chemistry".

Pump (When Supplied)

The pump and pump motor should be lubricated and serviced in accordance with the pump manufacturer's instructions.

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. On 18' long ESW4's supplied with two pumps per cell, both pumps should be energized at the same time. One pump should not be on while the other pump is off. The pump motor shaft and impeller should be turned by hand if the pump assembly sits idle (for a month or more). Disconnect the power and lockout/tagout the pump disconnect. Remove the pump motor fan guard and rotate the pump fan/shaft several turns by hand. Reassemble the fan guard and return to service.

Note: for the eco-ATW(E), please consult the Sage² and Sage³ manual.

Coils

Contact Evapco in case of damage to the pressure vessel.

Do not affect the integrity of the pressure vessel without approval of Evapco.

Evaporative Coil(s)

Check coil surface periodically, but at least twice a year. Inspect the coil surface for scale and/or corrosion.

Dry Coils (optional)

Depending on outdoor conditions and unit type, the dry coil should be inspected and cleaned at least twice a year. If the unit is located near trees, construction, etc., the required cleaning may be more frequent. The coil should be visually inspected monthly along with inlet louvers and inlet screens. The best cleaning solution for the dry coil is plain water. If the coil has maintained and cleaned at regular intervals, water is sufficient to remove dirt and debris from the fins. Heavy build up on the exterior of the fins can be removed with a brush. If a pressure washer is used, make sure the equipment is set to a low pressure setting and that the nozzle is set to the fan spray, not stream, otherwise damage to the fins could result.

Water Treatment and Water Chemistry

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 bleed rate, 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 CaCO₃) 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.

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 3**.

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

Table 3 - Recommended Water Chemistry Guidelines

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. Flume/equalizer DO NOT ensure proper controlled mixing of water in multiple cells. Operate multiple cells individually.

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 3. 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.

Cold Weather Operation & Ice Management

EVAPCO counterflow evaporative cooling equipment is well suited to operate in cold weather conditions. The counterflow design encases the heat transfer media (fill and/or coils) 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.

More information can be found in Bulletin 116-E, pages 21-26.

Freeze Protection of Recirculating Water

The simplest and most effective way of keeping the recirculated water from freezing is to use a remote sump. With a remote sump, the recirculating water pump is mounted remotely at the sump and whenever the pump is shut off, all recirculating water drains back to the sump. Recommendations for sizing the remote sump tank and recirculating water pumps for coil products are presented for Evaporative Condensers and Closed Circuit Coolers in their respective catalog. The pressure drop through the water distribution system measured at the water inlet is as follows in **Table 4** (See next page).

If a remote sump cannot be used, basin heaters are available to keep the recirculating water from freezing when the pump is turned off. Electric heaters may be used to heat the basin water when the unit is shut down. The make-up water supply, overflow and drain lines, as well as the pump and pump piping up to the overflow level must be heat traced and insulated to protect them from damage. Any other connections or accessories at or below the water level, such as electronic water level controllers, must also be heat traced and insulated.

Note: Using basin heaters will not prevent the fluid in the coils, nor the residual water in the pump or pump piping from freezing.

A condenser or cooler cannot be operated dry (fans on, pump off) unless the water is completely drained from the pan. The pan heaters are sized to prevent pan water from freezing only when the unit is completely shut down.

Evaporative Condenser Model Number		Closed Circuit Cooler Footprint	Required Inlet Pressure (psi)	Required Inlet Pressure (kPa)
ATC-E Products	eco-ATC-A Products	ATWB, eco-ATW & eco-ATWE Products 3' and 4' wide units**		
50E to 165E	122A to 263A	8.5'x7.5'	2.0	13.8
170E to 247E	160A to 326A	8.5'x9'	2.0	13.8
218E to 305E	205A to 504A	8.5'x10.5', 8.5'x12', 8.5'x14'	2.0	13.8
246E to 473E	395A to 671A	8.5'x18'	3.0	20.7
486E to 630E	451A to 804A	8.5'x21'	4.0	27.6
508E to 755E	444A to 1013A	8.5'x24', 28'	2.5	17.2
643E to 950E	441A to 988A	17'x12', 17'x14'	2.5	17.2
639E to 926E	300-501A to 642-1002A	10'x12', 10'x24', 20'x12'	3.7	25.5
XE298E to XC462E, XE596E to XC925E	391-694A to 879-1388A	10'x18', 10'x36', 20'x18'	5.7	39.3
XE406E to XC669E, XE812E to XC1340E	325 to 632A, 408 to 685A, 432 to 923A	12'x12', 12'x14', 12'x18'	3.5	24.1
428E to 892E	650 to 1263A, 770 to 1369A, 1020 to 1847A	12'x24', 12'x28', 12'x36'	2.5	17.2
858E to 1784E	710 to 1264A, 816 to 1370A, 1021 to 1848A	24'x12', 24'x14', 24'x18'	3.0	20.7
857E to 1783E	1293 to 2515A, 1493 to 2654A, 2182 to 3583A	24'x24', 24'x28', 24'x36'	2.5	17.2
1879E to 3459E	585 to 1001A, 1120 to 1993A	12'x20', 12'x40'	3.5	24.1
791E to 967E, 1625E to 1925E	1159 to 1983A, 2247 to 3846A	24'x20', 24'x40'	3.5	24.1
1616E to 1915E, 2855E to 3714E				
CATC Products 181 thru 373 362 thru 504		CATW Products 7.5'x8', 7.5'x12', 7.5'x14' 7.5'x18'	2.0 3.0	13.8 20.7
LRC Products 25 to 72 76 to 114 108 to 183 190 to 246 188 to 379		LRWB Products 3' wide units 5'x6' 5'x9' 5'x12' 8' wide units	1.0 2.0 2.0 2.0 2.0	6.9 13.8 13.8 13.8 13.8
LSC-E Products 36 to 80 90 to 120 135 to 170 185 to 385 400 to 1610		LSWE Products 4'x6' 4'x9' 4'x12', 4'x18' 5.5'x12', 5.5'x18' 10'x12', 10'x18', 10'x24', 10'x36' 8'x12', 8'x18', 8'x24', 8'x36'	1.5 1.5 1.5 2.0 2.5 3.0	10.3 10.3 10.3 13.8 17.2 20.7
-		ESW4 Products 8.5'x6' 8.5'x9' 8.5'x12' 8.5'x18' 12'x12' 12'x18' 14'x22'	3.0 2.5 2.5 3.0 2.0 3.0 2.0	20.7 17.2 17.2 20.7 13.8 20.7 13.7
PMC-E Products 175E to 375E 332E to 1586E 420E to 2019E	eco-PMC Products 183 to 387 275 to 1662 314 to 2191	-	2.0 4.0 3.5	13.7 27.6 24.1
PHC-E Products S79-107E to 161E S712-151E to 210E S718-224E to 335E S1212-282E to 422E, S1224-565E to 844E S1218-414E to 616E, S1218-438E-2P to 652E-2P, S1236-828E to 1232E D1224-718E to 879E, D2424-1436E to 1758E D1426-828E to 1060E, D2826-1656E to 2120E		-	3.5 4.0 3.5 3.0 4.0 5.0 4.5	24 27.6 24 20.7 27.6 34.5 31

For multi-cell units, the inlet pressure shown is per cell.

** Not available as eco-ATWE

Table 4 - Required Recirculating Water Pump Sizing for Remote Sump Application - Coil Products Only

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 minimum flow rate must be maintained on the coil at all times so that the water temperature does not drop below 10°C when the cooler is shut down. See **Table 5** for recommended minimum flow rates.

If an anti-freeze solution is not used, the coil must be drained immediately whenever the pumps are shut down or flow stops. 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.

When the unit is in operation during freezing weather, some type of capacity control is normally required in order to keep water temperatures from dropping below 10°C. Operating dry with a remote sump is an excellent way of reducing unit capacity at low temperatures. Other methods of capacity control include two-speed motors, VFDs and fan cycling. These can be used individually or in combination with dry/remote sump operation.

Closed Circuit Cooler Footprint	Minimum Flows			
	Standard Flow GPM	Series Flow GPM	Standard Flow l/s	Series Flow l/s
ATWB Products, eco-ATW & eco-ATWE				
3'x3 ^{**}	—	26	—	1.6
4' wide units ^{**}	74	37	4.7	2.3
7' wide units	140	70	8.8	4.4
8.5'x7.5'	148	74	9.3	4.7
8.5'x9' to 8.5'x21'	160	80	10	5
17'x12', 17'x14	320	160	20	10
10'x12', 10'x18'	188	94	11.9	5.9
10'x24, 10'x36', 20'x12', 20'x18'	376	188	23.7	11.9
20'x24', 20'x36'	752	376	47.4	23.7
12'x12', 12'x14', 12'x18', 12'x20'	232	116	14.6	7.3
12'x24', 12'x28', 12'x36', 12'x40'	464	232	29.3	14.6
24'x12', 24'x14', 24'x18', 24'x20'	464	232	11	11
24'x24', 24'x28', 24'x36, 24'x40'	928	464	58.5	29.3
LRWB Products				
3' wide units	60	30	3.8	1.9
5' wide units	94	47	5.9	3
8' wide units	148	74	9.3	4.7
LSWE Products				
4'x6', 4'x9', 4'x12', 4'x18'	66	30	66	30
5.5'x12', 5.5'x18'	94	47	94	47
8'x12', 8'x18'	148	74	148	74
8'x24', 8'x36'	296	148	296	148
10'x12', 10'x18'	188	94	188	94
10'x24, 10'x36'	376	188	376	188
ESW4 Products				
8.5'x6'-LP	100	50	6.3	3.2
8.5'x9', 8.5'x12', 12'x12'-LP, 12'x12'-SP	160	80	10.1	5
8.5'x18', 12'x12'-LF, 12'x12'-SF, 12'x18'-LF, 12'x18'X-SF	240	120	15.1	7.6
12'x18'X-LP, 12'x18'X-SP	320	160	20.2	10.1
12'x18'X-LF, 12'x18'X-SF	480	240	30.3	15.1
14'x22'	440	220	27.8	13.9

^{**} Not available as eco-ATWE

Table 5 - Closed Circuit Cooler Minimum Recommended Flow Rate

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 ensures that the cooler or condenser will function properly during cold weather operation.

Cold Water Basin Heaters

Optional basin heaters can be furnished with the unit 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 40°F (4°C) basin water temperature at a 0°F (-18°C) ambient temperature. The heaters are only energized when the recirculating pumps are off and no water is flowing over the heat exchanger coil. As long as there is a heat load and water is flowing over the heat exchanger coil, the heaters do not need to operate. Other types of basin heaters to consider would include: hot water coils, steam coils or 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 recirculating pump is idle. EVAPCO units built for remote sump operation do not include recirculating water pumps.

Electric Water Level Control

Optional electric water level control packages can be furnished to replace the standard mechanical float and valve assembly. The makeup water pressure for electronic water level control should be maintained between 5 and 100 psig (35 and 690 kPa). 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 coolers or condensers require separate guidelines for capacity control during cold weather operation.

The sequence of control for a unit operating at low ambient conditions is much the same as a cooler or condenser 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.

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 recirculation pump is turned off, the basin drained, and air passes over the coil. Instead of using evaporative cooling to cool the process fluid or condense the refrigerant, sensible heat transfer is utilized, so there is no recirculation water to freeze. 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 experienced 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 42°F (6°C) must be maintained for cooler applications. The higher the leaving temperature from the cooler or condenser, the lower the potential for ice formation.

Induced Draft Unit Capacity Control

The simplest method of capacity control is cycling the fan motor on and off in response to the leaving fluid temperature of the cooler or condenser. 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 when water is flowing over the coil. 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 cooler or condenser 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%. 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% 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 cooler or condenser 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 must maintain enough speed to ensure 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 potential damage to 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 while keeping the pump on. During these periods of idle fan operation, the warm water that is absorbing the building load flows thru the coil to help melt the ice that has formed in the coil, basin or louver areas.

NOTE: Using this method during periods of high winds can cause blow through, resulting in splash-out and ice formation. To help prevent blow through and splash-out, maintain a minimum 50% fan speed.

In more severe climates, the incorporation of a defrost cycle can be used to mitigate and/or eliminate any detrimental effects of ice in the unit. During the defrost cycle, the fans are reversed at half speed while the recirculating pump flows water through the unit's water distribution system. Operating the unit in reverse will melt

any ice or frost that may have formed in the unit or on the air intake louvers. 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 cooler or condenser 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 coolers or condensers 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 download a copy of EVAPCO's Engineering Bulletin 23 at evapco.com

**Troubleshooting:
see Bulletin 116-E, pages 31-33**



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. Check sheaves and bushings for corrosion. Scrape and coat with ZRC - annually												
10. Lubricate fan shaft bearings* – every 1000 hours of operation or every three months												
11. Lubricate fan motor bearings – see mfg's instructions. Typically for non-sealed bearings, every 2-3 years												
12. Check belt tension and adjust – monthly												
13. Inspect and grease sliding motor base - annually or as needed												
14. Check fan screens, inlet louvers, fans and (dry) cooler coil. Remove any dirt or debris – monthly												
15. Inspect and clean protective finish – annually - Galvanized: scrape and coat with ZRC - Stainless: clean and polish with a stainless steel cleaner												
16. Check water quality for biological contamination. Clean unit as needed and contact a water treatment program** – regularly												
17. Check coil surface for scale and/or corrosion - every 6 months												
18. Inspect lubrication lines to bearings - quarterly												

OPTIONAL ACCESSORIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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												
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. Clean Dry Coil(s) – semi-annually												
18. Water Level Indicator – Inspect and clean - annually												
19. SUN Solar Panels – Inspect for damage and clean with hose and soft brush - semiannually												

DURING IDLE PERIODS

1. Two or more days: energize motor space heaters or run motor for 10 min twice daily												
2. Few Weeks: Run gear reducer for 5 minutes - weekly												
3. Several Weeks: Completely fill gear reducer with oil. Drain to normal level prior to running. - once												
4. One Month or longer: Rotate motor shaft/fan 10 turns - monthly												
5. One Month or longer: Megger test motor windings - semi-annually												

* 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.

Seasonal Shutdown 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 initial start-up.
6. The makeup water supply, overflow and drain lines, as well as the recirculating pump and pump piping up to the overflow level must be heat traced and insulated to account for any residual water.
7. The finish of the unit should be inspected. Clean and refinish as required.
8. The fan, motor and pump bearings need to be turned at least once a month by hand. This can be accomplished by making sure the unit's disconnect is tagged and locked out, and grasping the fan assembly, rotating it several turns.
9. Energize fan motor space heaters.
10. Closed Circuit Coolers only - If the recommended minimum fluid flows through 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 Cold Weather Operation section of this document for more details.

See fan and pump manufacturer maintenance and long term storage instructions for more detailed instructions.

