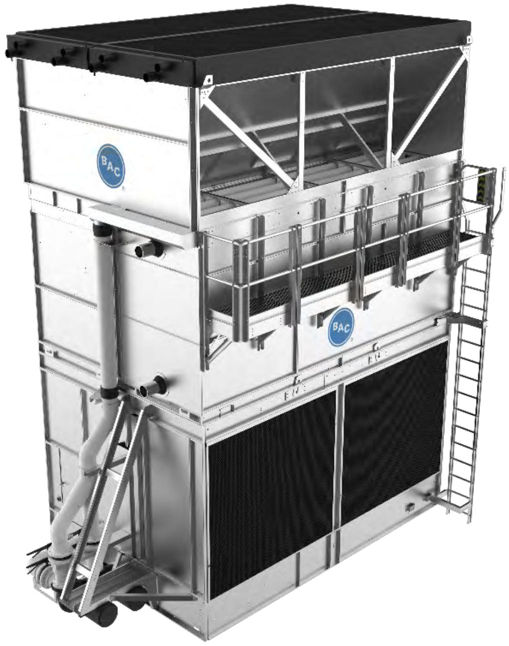
BALTIMORE
AIRCOIL COMPANY



HXV Hybrid Cooler

OPERATION & MAINTENANCE MANUAL

Recommended **Maintenance** Intervals[1]

Inspect and clean as necessary:	Start-Up	Monthly	Quarterly	Annually	Shutdown
Inspect general condition of the unit[2] and check unit for unusual noise or vibration	✓	✓			
Inspect cold water basin	✓		✓		
Flush water distribution system/Inspect spray nozzles	✓		✓		
Drain basin and piping	✓				✓
Inspect the CIS combined inlet shields, fill and eliminators	✓		✓		
Inspect the CIS hail guards on top of the unit; safe access to be provided by others				✓	
Check and adjust water level in the cold water basin	✓	✓			
Check operation of make-up valve	✓	✓			
Check and adjust bleed rate	✓	✓			
Verify the operation and function of electric immersion heaters and controls	✓		✓		
Inspect if lifting lug access hole covers are installed after unit installation; refer to the Rigging Manual for more details	✓			✓	
Inspect unit finish				✓	

Mechanical equipment system:	Start-Up	Monthly	Quarterly	Annually	Shutdown
Check belt condition	✓	✓			
Adjust belt tension[3]	✓		✓		
Lubricate fan shaft bearings	✓		✓		✓
Lubricate motor base and adjusting screw	✓		✓		✓
Check drive alignment				✓	
Check motor voltage and current	✓		✓		
Check motor davit arm is locked in place and away from air stream[4]	✓				
Clean fan motor exterior	✓		✓		
Check fan motor for proper rotation	✓				
Check general condition of the fan	✓		✓		
Check fan for uniform pitch			✓		
Check fan for rotation without obstruction	✓		✓		
Check and recoat steel shafts with RUST VETO®	✓		✓		✓
Test vibration cutout switch	✓			✓	

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

NOTES:

1. Recommended service intervals are the minimum for typical installations. Different environmental conditions may dictate more frequent servicing.
2. When operating in ambient temperatures below freezing, the unit should be inspected more frequently. Refer to "Cold Weather Operation" on **page 29** for more details.
3. Tension on new belts must be readjusted after the first 24 hours of operation and quarterly, thereafter.
4. Check at start-up and after each motor service.

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OPERATION & MAINTENANCE » HXV HYBRID CLOSED CIRCUIT COOLING TOWER

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Safety Precautions

DANGER

- **DANGER:** Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.
- **DANGER:** On installations where there are multiple adjacent cells which may be traversed to gain access to another cell, all fan motors must be disconnected, locked out and tagged out, including those on adjacent cells, before performing any service on or near the fans and drive systems, and before traversing adjacent cells. Failure to follow this instruction may result in serious injury or death caused by contact with rotating equipment.

WARNING

- **WARNING:** The top horizontal surface of the unit is not intended to be used as a walking surface or working platform. If access to the top of the unit is desired, the purchaser/end-user is cautioned to use appropriate means complying with applicable safety standards related to working on elevated surfaces. If access to the top of the coil is required, place a piece of plywood at least 1/2 inch thick on top of the coil to protect the surface while performing the recommended maintenance. When finished, carefully remove the plywood.
- **WARNING:** Hail guards are not designed to support the weight of a person or to be used as a storage or work surface for any equipment or tools. Use of these hail guards as walking, working or storage surfaces may result in injury to personnel or damage to equipment. Units with hail guards should not be covered with a plastic tarpaulin
- **WARNING:** When the fan speed of the unit is to be changed from the factory set speed, including changes achieved by the use of a variable fan speed device, steps must be taken to avoid operation at or near the fan's "critical speed" which could result in fan failure and possible personal injury or damage.
- **WARNING:** The recirculating water system may contain chemicals or biological contaminants, including Legionella, which could be harmful if inhaled or ingested. Personnel exposed directly to the discharge airstream and the associated drift mists, generated during operation of the water distribution system and/or fans, or mists produced by high pressure water jets or compressed air (if used to clean components of the recirculating water system), must wear respiratory protection equipment approved for such use by governmental occupational safety and health authorities.
- **WARNING:** All electrical, mechanical, and rotating machinery are potential hazards, particularly for those not familiar with their design, construction, and operation. Accordingly, use appropriate lockout procedures. Adequate safeguards (including the use of protective enclosures where necessary) should be taken with this equipment both to safeguard the public from injury and to prevent damage to the equipment, its associated system, and the premises.
- **WARNING**: A lockable disconnect switch should be located within sight of the unit for each fan motor associated with this equipment. Before performing any type of service or inspection, make certain that all power has been disconnected, and the switch is locked out in the "OFF" position.
- **WARNING**: Dangerous voltages are present in this equipment. Disconnect the electrical service of the source and follow proper lock out and tag out procedures to de-energize the circuit before servicing or replacing components.
- **WARNING**: To prevent possible contamination of the make-up water supply, install a backflow prevention method in accordance with applicable local and national codes

CAUTION

- **CAUTION:** The operation, maintenance, and repair of this equipment shall be undertaken only by personnel authorized and qualified to do so. All such personnel shall be thoroughly familiar with the equipment, the associated system and controls, and the procedures set forth in this manual. Proper care, personal protective equipment, procedures, and tools must be used in handling, lifting, installing, operating, maintaining, and repairing this equipment to prevent personal injury and/or property damage.

- **CAUTION:** This equipment should never be operated without all fan screens, access panels, and access doors in place.
- **CAUTION:** Openings and/or submerged obstructions may exist in the bottom of the cold water basin. Use caution when walking inside the equipment.
- **CAUTION**: Follow exposure control and personal protective equipment requirements as outlined in the MSDS for all recommended lubricant and maintenance materials.
- **CAUTION**: BAC does not recommend field application of aftermarket coatings in the cold water basins of products equipped with electric immersion heaters. The coating material may create an increased risk of fire if the heaters remain energized for any reason without sufficient water in the cold water basin.

Equipment Precautions

NOTICE

- The basin heater is not designed to prevent icing during unit operation.
- BAC units are typically installed immediately after shipment and many operate year round. However, if the unit is to be stored for a prolonged period of time either before or after installation, certain precautions should be observed, as outlined in "Prolonged Outdoor Storage" on **page 9**.
- Ensure controls for the fan and pump motors are set to allow a maximum of six on-off cycles per hour to prevent motor overheating.
- Do not use steam or high pressure water to clean dry coils, PVC eliminators, combined inlet shields, fill, hail guards, or any other, nonmetallic materials.
- Never use chloride or chlorine based solvents such as bleach or muriatic (hydrochloric) acid to clean stainless steel. It is important to rinse the surface with warm water and wipe with a dry cloth after cleaning.

General Maintenance Information

The services required to maintain a piece of evaporative cooling equipment are primarily a function of the quality of the air and water in the locality of the installation:

- **AIR:** The unit should be located such that unusual quantities of industrial smoke, chemical fumes, salt, or heavy dust do not enter the equipment. Such airborne impurities entering into the equipment and absorbed by the recirculating water can form a corrosive solution.
- **WATER:** As water evaporates from the equipment, dissolved solids are left behind, which were originally contained in the make-up water. These dissolved solids may be either alkaline or acidic and as they are concentrated in the circulating water, they can cause scaling or accelerated corrosion.

The extent of impurities in the air and water determines the frequency of most maintenance services and also governs the extent of water treatment which can vary from a simple continuous bleed and biological control to a sophisticated treatment system. Refer to "Water Treatment" on **page 22** and "Biological Control" on **page 24** for more details.

Warranties

Please refer to the Limitation of Warranties in the submittal package applicable to and in effect at the time of the sale/purchase of these products. Described in this manual are the recommended services for start-up, operation, and shutdown, and the approximate frequency of each.

HXV HYBRID COOLER

Unit Operation and Storage

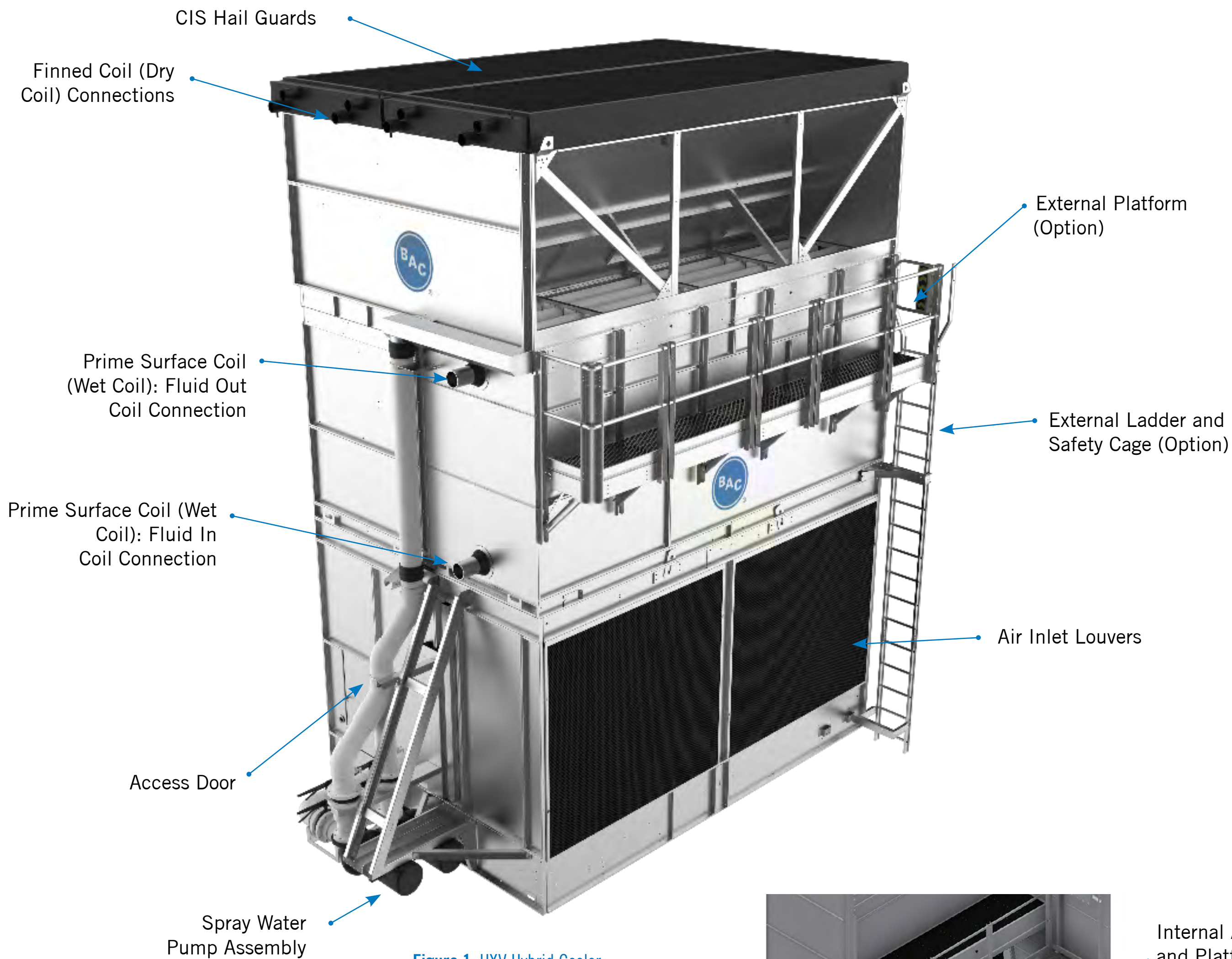
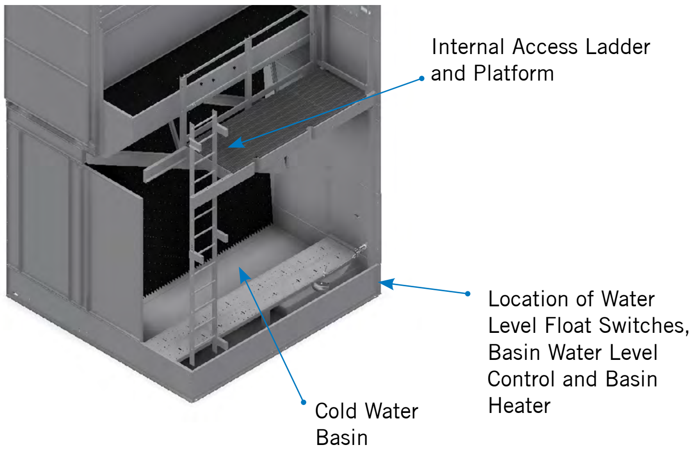


Figure 1. HXV Hybrid Cooler



Operation

To optimize water and energy savings, the HXV Hybrid Cooler operates in two modes. In each mode, capacity is controlled by fan motor modulation, and all of the process fluid flows through the finned coil (dry coil) and then through the prime surface coil (wet coil).

Operating Modes (Con't next page)

- **Energy Saver Mode (Wet Mode)**: The spray water circulating pump distributes water over the outside of the prime surface coil (wet coil). The spray water falls from the prime surface coil over the fill surface, where the spray water temperature is further reduced through evaporation. The cooled spray water collects in the cold water basin, passes through the suction strainer and is pumped through the distribution system. The fans draw air through the prime surface coil and through the fill surface (sensible and latent heat transfer), which saturates the air before it enters the plenum and flows into the fans. The saturated discharge air from the fans passes over the finned coil (dry coil) to cool the process fluid (sensible heat transfer). This mode take full advantage of evaporative cooling, and therefore reduces the fan energy necessary for cooling.
- **Water Saver Mode (Dry Mode):** The process fluid flows through the finned coil (dry coil) and the prime surface coil. However, the spray water circulating pump is turned off, which saves pump energy. There is only sensible heat transfer across both coils, as the air passes over them. This mode is typically used during periods of lower ambient temperatures or lower heat loads. During prolonged periods of dry mode operation, draining the cold water basin is recommended, minimizing the need for freeze protection and water treatment.

NOTE: Schematic drawings are not representations of actual units. Refer to submittal for your specific configuration.

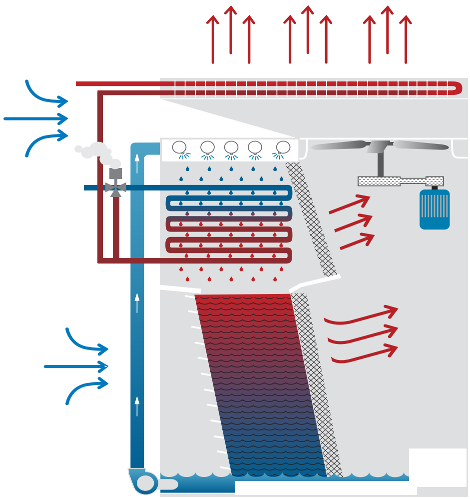


Figure 2a. Energy Saver Mode

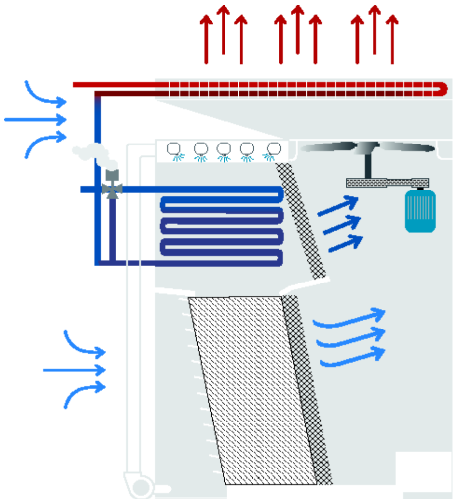


Figure 2b: Water Saver Mode

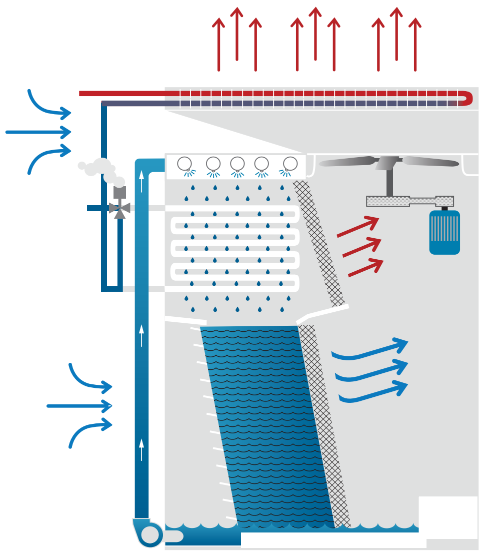


Figure 2c: Adiabatic Mode

Operating Modes

- **Adiabatic Mode (Balanced Water and Energy Savings):** The spray water circulating pump distributes water over the fill surface. The fans draw air over the wetted fill where it is adiabatically pre-cooled resulting is a significantly lower air temperature and greatly increasing the rate of sensible heat transfer. The process fluid is only circulated through the dry finned coil. To enable this mode, a customer-supplied three-way valve is needed.

Sequence of Operation

The following is applicable to all sequences of operation:

- All fan speed control operation is based on leaving fluid temperatures.
- Basin heaters are interlocked with the spray pump, and only operate when the spray pump is off and the basin temperature is less than 40°F.
- For extra coil freeze protection, spray pump can be locked out if ambient temperature is less than 32°F

NOTE: LWT= Fluid Cooler Leaving Water Temperature

Sequence of Operation with a 3-way Valve	
Conditions	**Operation**
No Heat Load	Spray pump OFF; Fans OFF
Peak (design) operating conditions - Ambient wet bulb ≥ Design wet bulb	**Energy Saver Mode:** Spray pump ON; Fan motors ON with VFD - fan motors ramp up and down together. 3-way valve fully closed to allow full flow through evaporative coil.
Fan speed is reduced based on load and reaches customer-defined fan speed switchpoint **OR** Ambient dry bulb ≤ Design adiabatic operation switchpoint temp	**Adiabatic Mode:** Spray pump ON; Fan motors ON with VFD - fan motors ramp up and down together. 3-way valve opens to bypass evaporative coil, thereby saving water.
Fan speed is reduced based on load and reaches customer-defined fan speed switchpoint **OR**	**Water Saver Mode:** Spray pump OFF; Fan motors ON with VFD - fan motors ramp up and down together. 3-way valve fully closed to allow full flow through evaporative coil to maximize dry performance.

Table 1a: Sequence of Operation with a 3-way Valve

Sequence of Operation without a 3-way Valve	
Conditions	**Operation**
No Heat Load	Spray pump OFF; Fans OFF
Peak (design) operating conditions - Process fluid leaving temperature ≥ Customer setpoint	**Energy Saver Mode:** Spray pump ON; Fan motors ON with VFD - fan motors ramp up and down together. Process fluid flows through dry coil and evaporative coil in series.
Fan speed is reduced based on load and reaches customer-defined fan speed switchpoint **OR** Ambient dry bulb ≤ Design dry operation switch-point temp	**Water Saver Mode:** Spray pump OFF; Fan motors ON with VFD - fan motors ramp up and down together. Process fluid flows through dry coil and evaporative coil in series to maximize dry performance.

Table 1b: Sequence of Operation without a 3-way Valve

Start-Up Procedure

Considerations for initial start-up:
For units with independent fan control, see Page 36. For units with VFDs, see Page 36. For units with vibration cutout switches, see Page 34.

General

- Verify the fan and unit pump motors are disconnected and locked out whenever performing inspection or maintenance.
- If the unit is mounted on vibration isolators or isolation rails (by others), refer to the vibration isolation manufacturer's guidelines before loading/unloading weight from the unit.

Cleaning

- Inspect all spray nozzles and clean any which are dirty or clogged (unlikely at initial start-up, but may be required for seasonal start-up).
- Clean all mechanical components, such as the fans and motors (unlikely to be required at initial start-up).
- Flush the cold water basin interior to remove any accumulated dirt and debris.
- Remove, clean, and replace the strainer.
- Remove all dirt and debris from the fan guards.
- If necessary or required by local code, disinfect the HXV towers in accordance with the most current versions of ASHRAE Standard 188: Legionellosis: Risk Management for Building Water Systems, and ASHRAE Guideline 12: Minimizing the Risk of Legionellosis Associated with Building Water Systems. This is not required on initial startup unless water has been allowed to stagnate in the tower prior to startup. Drain the cold water basin with the strainer in place.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

Inspection

- Conduct external inspection of the equipment. Check for leaks, corrosion, and any structural damage, including any damage to the hail guards.
- Conduct internal inspection of the equipment. Check for anything unusual such as structural or mechanical component looseness or damage.
- Inspect piping and connections to verify they are secure.
- Inspect the visible coil surfaces. Any corrosion, damage, or obstructions should be corrected.
- At seasonal start-up or after prolonged shutdown, check the motor insulation with an insulation tester prior to the energizing the motor.
- Thoroughly inspect the fans for any mechanical or physical damage, and verify proper fan tip clearance. Refer to Fan "Inspection & Maintenance" on **page 13** for more details.
- Inspect the fill, eliminators, combined inlet shields and hail guards before start-up, and clean them if necessary. Inspect the CIS hail guards annually or after a hail event. See **page 18** for more details.

Start-up

- Prior to seasonal start-up, check and adjust the belt tension.
- At initial start-up, the belt tension may not require adjustment as the drive will be properly tensioned at the factory prior to shipment.

NOTICE: Ensure the controls for the fan and pump motors are set to allow a maximum of six on-off cycles per hour to prevent motor overheating.

- Lubricate the fan shaft bearings. At initial start-up, no bearing lubrication is required unless the unit has been idle for more than three months. Refer to **page 17** for more details.
- Apply a good quality, corrosion inhibiting grease, such as one of those recommended for lubricating the fan shaft bearings, to the adjustable motor base and threaded rod. See **Figure 3**.

Figure 3. Adjustable Motor Base

- Apply RUST VETO® to steel shafts and bushings.
- Check the belt tension, and adjust if necessary. See **page 14** for more details.
- Set the make-up valve float so the water shuts off at the operating level. See **Table 2** on **page 12**.
- Start the unit pump and check for the proper rotation indicated by the arrow on the pump cover. Perform one of the following biocide treatment programs while operating only the pump. Do not operate fans until after the biocide treatment has been completed, and the biocide or chlorine levels have been reduced to normal operational levels.
  - If this is a startup after the tower has already operated with biocide treatment, then resume treatment with the biocide that was used prior to shutdown. Operate only the pump while maintaining the maximum recommended biocide residual for a sufficient duration (residual and time will vary with the biocide) as recommended by the water treatment supplier.
  - Check the pH of the circulating water and, if necessary, adjust it to 7.0 - 7.6 pH. Then, running the pump only, treat the system with sodium hypochlorite to maintain a level of 4 to 5 mg/l (ppm) free chlorine (as Cl_2) over a six hour period. Test kits for measuring the free residual of chlorine are commercially available.

After 24 hours of operation under thermal load, perform the following services:

- ✓ Check the unit for any unusual noises or vibrations.
- ✓ Check the operating water level in the cold water basins. Adjust the make-up valve if necessary. Thereafter, closely monitor the cold water basin operating level when the tower is under thermal load near design conditions, and adjust as necessary to maintain an operating level of 8 1/4”.
- ✓ Check the belt tension and readjust if necessary.
- ✓ Re-inspect the spray nozzles and visible heat transfer section.

- After the biocide treatment period is completed, bring the biocide and/or chlorine levels to normal operational levels.
- Resume operation with the standard water treatment program (including biocidal treatment) as recommended by the water treatment supplier.
- Check that the float operated make-up valve is operating freely. Closely monitor water level and adjust as necessary during the first 24 hours of operation. Refer to **Table 2** for more details.
- Inspect the heat transfer section as described on **page 18** and inspect the water distribution system as described on **page 19**.
- Passivation is required for galvanized coils. See **page 24** for more details.
- On initial start-up, or if the fan motor has been rewired, briefly energize the fan motors and note the direction of rotation. Fans should rotate in the direction indicated by the arrow on the fan cowl.
- Run the fan in the manual position for several minutes and check for any unusual noises or vibration. Correct as necessary.
- Test the vibration cutout switch (VCOS). See **page 34** for more details.
- While the unit is operating at full speed under heat load and during near design ambient conditions, check the current and voltage of all three phases (legs) of the fan motor. The current should not exceed the nameplate full load amp (FLA) value.
- To identify resonances within the operating speed range, see **page 37**.
- For units with the optional Electric Water Level Control, see **page 20.**

Extended Shutdown

Perform the following services whenever the unit is shutdown in excess of three days:

- If the unit is mounted on vibration isolators or isolation rails (by others), refer to the manufacturer's guidelines before loading/unloading weight from the unit.
- Disconnect, lock-out, and tag-out all fans and pump motors.
- Close the shut-off valve in the make-up water line (supplied by others) and drain all exposed make-up water piping. Heat trace and insulate all exposed make-up piping that will be exposed to freezing temperatures.
- Drain the cold water basin and all the piping (excluding the coils) that will be exposed to freezing temperatures. Heat trace and insulate all exposed piping.
- To minimize the risk of biological contamination during shutdown, it is recommended the entire system be drained, excluding the coils.
- Clean all debris, such as leaves and dirt, from the interior and exterior of the unit.
- Clean and flush the water distribution system and cold water basin with the basin strainer in place.
- Leave the cold water basin drain open so rain and melting snow will drain from the unit.
- Clean the basin strainer and re-install.
- Lubricate the fan shaft bearings.
- Apply a good quality, corrosion inhibiting grease, such as one of those recommended for lubricating the fan shaft bearings, to the adjustable motor base and threaded rod.
- Inspect steel shafts and bushings, and if necessary, apply RUST VETO® to protect the exposed surfaces of the steel shafts and bushings from corrosion.
- Inspect the protective finish on the unit. Clean and refinish as required. Refer to "Corrosion Protection" on **page 22** for more details.
- Lockout the fan motor starting device in the "OFF" position to ensure personal safety in case of future inspection or service.

Prolonged Outdoor Storage

- Conduct the "Extended Shutdown" procedure above if the unit is installed.
- Ensure the cold water basin is fully drained and the drain is open.
- For storage prior to installation, all components (ladders and platforms) and accessories, which sometimes ship inside the unit and are not a permanent fixture in the basin, should be removed and stored indoors.
- Remove the bottom drain plug from the spray pump(s). Store the plug(s) in a marked plastic bag and attach it to the spray pump(s) for future use.
- Remove and store fan belts (if supplied) indoors, keeping matched belts together. Tag belts appropriately for future identification.
- For storage prior to installation, coils should be charged with nitrogen at 15 psi in the factory. Dry coils are shipped from BAC charged with nitrogen.
- Installed units that have been piped but not filled do not require additional precautions.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

NOTICE: Covering the unit with a clear plastic tarpaulin during storage can trap heat inside the unit and cause damage to the PVC components. If units must be covered during storage, an opaque, reflective tarp should be used.

NOTICE: Draining the coil will not completely protect the coil from corrosion; some corrosion will still occur.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

- Units (with coils) that have been installed and operated should remain filled. If the unit is stored in a freezing climate, the coil must be protected from freezing. For protection against coil freeze-up, BAC recommends the use of an inhibited glycol solution. If protecting the coils with glycol is not possible, the galvanized steel coils should be drained completely and capped once as much water and moisture is removed from the coil as possible.
- For extended shutdown periods after start-up, coils should be charged with nitrogen at 15 psi in the field and capped by adding a threaded connection or a welded cap. Prior to start-up, bleed off the nitrogen, then cut off the caps so the coil connections can be piped.
- Apply a good quality, corrosion inhibiting grease, such as one of those recommended for lubricating the fan shaft bearings, to the adjustable motor base and threaded rod.
- Spray coat electrical component housings (if supplied) with a suitable protective coating, such as Cosmoline® Weathershed, and individually cover them with plastic, taking care to leave openings for free air circulation.
- Inspect the protective finish on the unit. Clean and refinish as required. Refer to "Corrosion Protection" on **page 22** for more details.

Motor Recommendations

BAC standard motors are designed for storage at ambient temperatures of -20ºF to 104ºF (-28.9ºC to 40ºC). Prolonged periods of exposure above or below these specified conditions could degrade components of the motor and cause malfunction or premature failure.

- Motors should be removed and stored inside whenever possible. When indoor storage is not possible the motors must be covered with a loose fitting tarpaulin. Do not use plastic/plastic film. This cover should extend below the motor and be secured; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation.
- Care must also be taken to protect the motor from flooding or from harmful chemical vapors.
- The storage area should be free from ambient vibration. Excessive vibration can cause bearing damage.
- Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must also be taken to prevent insects from gaining access to the interior of the motor.
- If motors are not stored indoors in a controlled environment, some form of heating must be utilized to prevent condensation from accumulating in the motor. This heating should maintain the winding temperature at a minimum of 9ºF (5ºC) above the ambient temperature of the room, keeping it from dropping below the dew point where condensation could form inside the motor. If space heaters are supplied, they should be energized. If none are available, single phase or "trickle" heating may be utilized by energizing one phase of the motor's winding with a low voltage. Request the required voltage and transformer capacity from BAC. A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing warm air into the motor.
- Rotate the motor shaft monthly to redistribute bearing grease.

Maintenance Requirements

- Rotate all fans and motors shafts monthly by hand. Hand-turning will ensure that the shafts and bearings rotate freely and will redistribute grease within the bearings.
- Inspect the cold water basin monthly to ensure that the drain is open and remove any leaves or debris that may have accumulated in the cold water basin.
- Inspect axial fans prior to start-up and at least once annually to ensure that the blades are tight and that there is no corrosion or damage. Do not energize the fans if there is damage or significant corrosion of fan components. Loose fan blades could result in fan failure and possible injury or equipment damage.
- At least quarterly, inspect the rust preventative coating on external machined surfaces of the drive system, including motor shafts, fan shafts, and bushings. If necessary re-coat the surfaces with RUST VETO®. Do not let the coating contact the sheave grooves, belts or fan blades

Start-Up Preparation After Prolonged Storage

Start-up procedures after long periods of storage are just as important as pre-shutdown procedures.

- Fan and pump motors should be thoroughly inspected and cleaned to restore them to pre-storage condition.
- Inspect axial fan(s) prior to start-up to ensure that the blades are tight and that there is no corrosion or damage. Do not energize the fan(s) if there is damage or significant corrosion of fan components. Loose fan blades could result in fan failure and possible injury or equipment damage.
- Reinstall all fan belts, motors, and drain plugs (as applicable), and remove all protective coverings.
- For units stored prior to installation, conduct rigging procedures as directed in the unit's *Rigging and Assembly Instructions*.
- Perform an insulation test of motor windings to ensure satisfactory insulation resistance.
- Conduct full start-up procedure as stated in the "Start-Up Procedure" on **page 7**. Be especially thorough for cleaning and inspection prior to start-up.

2

Detailed Component Maintenance Procedures

Cold Water Basin

The process fluid to be cooled is circulated inside the tubes of the unit's heat exchanger. Heat flows from the process fluid through the coil to the spray water outside which is cascading over the tubes. The spray water collects in the cold water basin, passes through the suction strainer and is pumped back to the distribution system.The cold water basin is constructed from one of the following materials of construction:
• Galvanized steel
• TriArmor® Corrosion Protection System
• Welded stainless steel (Type 304 or 316)

CAUTION: Openings and/or submerged obstructions may exist in the bottom of the cold water basin. Use caution when walking inside this equipment.

Water Levels

- The operating water level in the cold water basin will vary with system thermal load (evaporation rate), the bleed rate employed, and the make-up water supply pressure.
- The make-up valve controls the operating level, which is maintained at the levels shown in **Table 2.**
- Check the operating water level monthly, and readjust the float when necessary to maintain the recommended operating level.
- Consult "Water Level Control" on **page 19** for information on how to set and maintain basin operating level.

Model Number	At Overflow Level (in.)	At Operating Level (in.)
HXV-1212 and HXV-1218	14.5"	8"

Table 2. Water Levels

Inspection & Maintenance

- At least quarterly inspect the cold water basin, and remove any trash or debris accumulated in basin or on the strainer. If sediment has accumulated in the cold water basin, drain, clean and flush the cold water basin with fresh water. This will remove sediment which can collect in the basin during operation. If not removed, sediment can become corrosive and cause deterioration of the protective finish of metallic basins.
  - When flushing the basin, leave the strainer in place to prevent the debris from re-entering the system.
  - Remove the strainer after the basin has been flushed.
  - Clean and replace the strainer before refilling the basin with fresh water.
- Adjust the float to maintain the design operating level. See **Table 2.**

Inspection & Maintenance

- At least quarterly inspect the cold water basin, and remove any trash or debris accumulated in basin or on the strainer. If sediment has accumulated in the cold water basin, drain, clean and flush the cold water basin with fresh water. This will remove sediment which can collect in the basin during operation. If not removed, sediment can become corrosive and cause deterioration of the protective finish of metallic basins.
  - When flushing the basin, leave the strainer in place to prevent the debris from re-entering the system.
  - Remove the strainer after the basin has been flushed.
  - Clean and replace the strainer before refilling the basin with fresh water.
- Adjust the float to maintain the design operating level. See **Table 2.**

Fan

HXV units use axial fan(s). Thoroughly inspect the fan(s) for damaged or deteriorated fan blades and replace the fan(s) if necessary.

Inspection & Maintenance

- If the unit is already in operation, while the fan is running, check for any unusual noises or vibrations.
- With the fan off and the motor disconnected, locked out, and tagged out, check the general condition of the fan:
  - Inspect for any loose or missing bolts in the fan shaft bushing, the fan hub, and the fan shaft bearing(s).
  - Check the fan blades for looseness, first by twisting the blade by hand, and then by moving the blade tip up and down. There should be no play or slippage.
  - Inspect each blade for excessive scale build-up that could cause vibration.
  - Check each blade in the area of the shank for cracks. If cracks are found, the fan motor should be locked out of service until the fan is replaced. Contact BAC for assistance.
- **Tip Clearance:** Check the clearance between the tip of the blade and the fan cowl. The clearance should be within 5/16” to 1/2”.
- **Blade Pitch:** Check to ensure that the blades are all at the same pitch. If uncertain, measure the pitch with an inclinometer. All blades should be within 1/2° of each other.
- **Rotation:** Turn the fan by hand to ensure that it moves freely with no rough spots, binding or other malfunctions that could cause vibration or fan motor overload. While rotating the fan, check the blade tracking. All blades should track within a 1” band at any single point around the cowl.
- **Direction of Rotation:** On initial start-up, or if the fan motor has been rewired, briefly energize the fan motor and note the direction of rotation. It should rotate in the direction indicated by the arrow on the fan cowl. On units with independent fan motors, check the rotation of each fan.
- **Operation:** On initial start-up, run the fan in the manual position for several minutes and check for any unusual noises or vibration.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

NOTICE: Ensure the controls for the fan and pump motors are set to allow a maximum of six on-off cycles per hour to prevent motor overheating.

Fan Drive System

BALTIDRIVE® Power Train and Independent Fan

The BALTIDRIVE® Power Train consists of a solid-backed, multi-groove, neoprene/polyester belt rated for cooling tower service, and corrosion resistant sheaves. These components provide high reliability with low maintenance requirements.

The independent fan option consists of one fan motor and drive assembly for each fan to allow independent operation, adding redundancy to models with more than one fan.

Figure 4. BALTIGUARD™ Fan System

The BALTIGUARD™ Fan System consists of two standard single-speed fan motors and drive assemblies. One drive assembly is sized for full speed and load, and the other is sized for approximately 2/3 speed and consumes only 1/3 the design horsepower. This provides motor redundancy and the greatest level of reliability.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

Inspection & Maintenance

These drives require a periodic check of the belt condition and, when necessary, tension adjustment. The recommended service intervals are as follows:

- **Initial Start-up:** Servicing is not required prior to initial unit start-up. The drive has been tensioned and aligned at the factory.
- **Seasonal Start-up:** Readjust the belt tension (if required).
- **Operation:** After the first 24 hours of operation, readjust the belt tension on a new unit start-up or installation of a new belt. Thereafter, check the belt condition monthly, and adjust tension as necessary. Readjust tension at least once every three months.

NOTE: There should be no “chirp” or “squeal” when the fan motor is started.

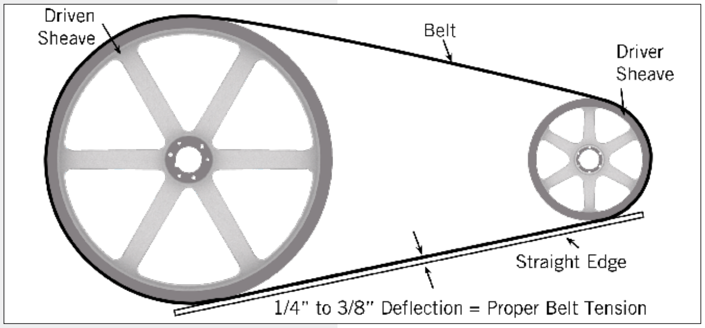


Figure 5a. Belt Tension with a Straight Edge

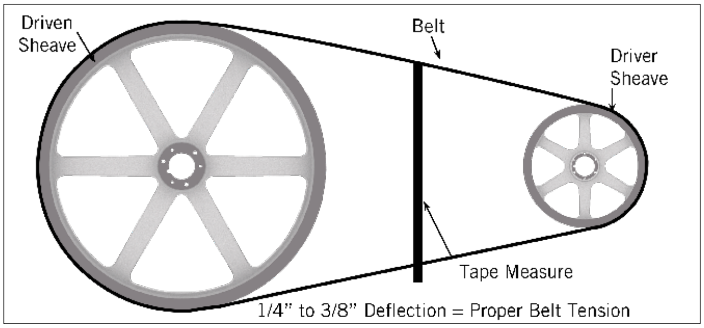


Figure 5b. Belt Tension with a Tape Measure

- **Belt tension check:**
  - Place a straight edge along the belt from sheave to sheave as shown in **Figure 5a**, or use a tape measure as shown in **Figure 5b**, to measure belt deflection.
  - Apply a moderate force by hand (approximately 40 lbs/275 kPa) evenly across the width of the belt in the center of the span between the sheaves.
  - There is adequate belt tension if the belt deflects between 1/4" and 3/8" as shown in **Figures 5a** and **5b**.
- **Belt tension adjustment (if required):**
  - Loosen the lock nut on the motor base adjusting screw.
  - Turn the motor base adjusting screw counterclockwise to tension the belt, or clockwise to relieve belt tension. During adjustment of belt tension, rotate the drives several times by hand to evenly distribute the tension throughout the belt.
  - When the belt is properly tensioned, retighten the locking nut on the motor base adjusting screw.
- **Drive alignment check and adjustment:**
  - Check the drive alignment annually to ensure maximum belt life.
  - Place a straight edge across the driver and the driven sheaves as shown in **Figure 6a** for standard drives and in **Figure 6b** for the BALTIGUARD™ Fan System.
  - There should be no more than 1/16" deviation from four points of contact.
  - If realignment is required, loosen the motor sheave and align it with the fan sheave. Allow 1/4" for draw-up as the bushing screws are retightened.

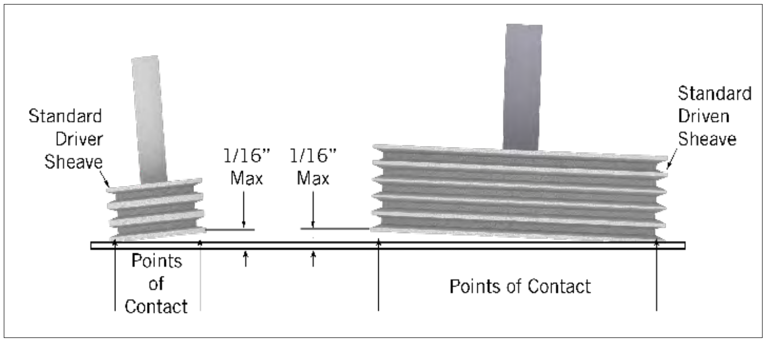


Figure 6a. Standard Drive Alignment

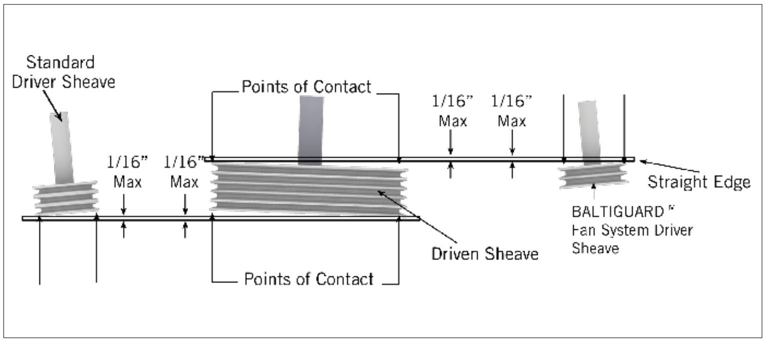


Figure 6b. BALTIGUARD™ Fan System Drive Alignment

NOTICE: Ensure the controls for the fan and pump motors are set to allow a maximum of six on-off cycles per hour to prevent motor overheating.

Fan Motors

HXV Hybrid Coolers use cooling tower inverter duty, premium efficient, totally enclosed, single-speed, single-winding, reversible ball bearing type motor(s).

Inspection & Maintenance

- Clean the outside of the motor at least quarterly to ensure proper motor cooling.
- After prolonged shutdowns, check the motor insulation with an insulation tester prior to restarting the motor.
- Check motor voltage and current following start-up and every three months while in operation.

NOTICE: Ensure the controls for the fan and pump motors are set to allow a maximum of six on-off cycles per hour to prevent motor overheating.

Adjustable Motor Base (BALTIDRIVE® Power Train Only)

Coat the motor base slides and adjusting screws (refer to **Figure 3** on **page 8**) prior to start-up, every three months while in operation, and following shutdown. Use good quality, corrosion inhibiting grease such as one of those recommended for lubricating the fan shaft bearings.

Fan Motor Removal Instructions (For Units with the Motor Removal System Option)

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

If the motor has to be removed, follow the instructions below:

- Lockout and tag out fan and pump motors before entering the unit.
- Disconnect wiring from fan motor.
- Using the motor base adjusting screw, relieve tension from the drive belt and remove belt
- Rotate the davit arm over the motor using 3/4" socket or wrench on the hex head on the bottom of the davit.
- Attach a suitable lifting device of sufficient load capacity to the eye hook on the davit arm.
- Attach the other end of the lifting device to the factory supplied lifting points which are mounted on the motor. Verify that the lifting device is secure at all attachment points.
- Position the lifting device to take up any slack, and to support the weight of the motor with minimal movement when the motor mounting hardware is removed.
- Carefully loosen and remove motor mounting hardware.
- Remove the hardware and clips which fasten the removable grating section directly below motor.
- Remove the grating section directly below the motor.
- Lower motor down to the internal walkway and remove the motor through unit access door.

Fan Motor Installation Instructions (For Units with the Motor Removal System Option)

- Lock out and tag out fan motor, fan motor power supply, and pump motors before entering the unit.
- Attach a suitable lifting device of sufficient load capacity to the eye hook on the davit arm.

- Remove the hardware and clips which fasten the removable grating section directly below motor base.
- Remove grating section directly below the motor base.
- Attach the other end of the lifting device to the factory supplied lifting points which are mounted on the motor. Verify that the lifting device is secure at all attachment points.
- Lift the motor into place.
- Reinstall grating section directly below the motor using factory supplied hardware.
- Fasten the motor to the motor base using factory supplied hardware.
- Remove lifting device from motor and from davit arm.
- Rotate the davit arm so that it is out of the area immediately above the fan discharge.
- Install the driver sheave and bushing, and align the drives per the drive alignment instructions.
- Apply RUST VETO® to the exposed motor shaft and bushing.
- Install the drive belt and tension it per the instructions on **page 15**.
- Rewire the motor.
- Verify that area is clear of tools and personnel.
- From a safe location,re-energize the motor and check for proper rotation per the start-up instructions.

Fan Shaft Bearings

Two pillow block ball bearings support each fan shaft. Each bearing is equipped with a lubrication fitting and a slinger/locking collar to keep out moisture. Extended lubrication lines are provided for convenience.

Inspection & Maintenance

- Lubricate the bearings with a manual grease gun or BAC's optional Automatic Bearing Greaser. Do not use high-pressure grease guns because they may rupture the bearing seals.
- For units equipped with extended lubrication lines, if re-greasing in colder ambient temperatures, apply the grease more slowly to allow it to flow through the extended lube lines without over-pressurizing them.
- Lubricate the bearings with one of the following compatible water resistant greases which are suitable for ambient temperatures ranging from - 65ºF (-53.9ºC) to +250ºF (121.1ºC).
  - Amoco - Rycon Premium #3
  - Chevron - SRI
  - Citgo - Polyurea MP2™
  - Conoco - Polyurea 2™
  - Exxon - Polyrex® EM
  - Exxon - Unirex N™
  - MobilGrease® - AW2
  - Shell - Gadus S2 V100 3
  - Shell - Gadus S3 T100 2
  - SKF - LGHP2™
  - Unocal 76 - Unilife Grease™

NOTE: List of brand names is for identification only and are not exclusive recommendations.

- Lubricate the bearings as follows:
  - **Initial Start-up:** Normally, no lubrication is required since the bearings have been lubricated at the factory prior to shipment. However, if the unit has been stored at the job site for more than three months, all fan bearings should be lubricated with new grease before initial operation. **When lubricating, purge the old grease from the bearing by gradually adding grease until a bead of new grease appears at the seal on the underside of the bearing. It is necessary to visually observe the bearing as new grease is pumped through the extended grease lines.**
  - **Seasonal Start-up:** Purge both bearings with new grease prior to start-up.
  - **Operation**: Purge bearings with new grease every three months or 2,000 hours of operation, whichever comes first.
  - **Extended Shutdown:** Purge bearings with new grease prior to any prolonged storage or downtime, then again just before startup.

Heat Transfer Section

Inspect the coil surface. Any corrosion, damage, or obstructions must be corrected.

Fill & Drift Eliminators, Combined Inlet Shields, and CIS Hail Guards

HXV Hybrid Coolers contain polyvinyl chloride (PVC) fill with integral drift eliminators, PVC combined inlet shields, and PVC drift eliminators located in the air path leaving the prime surface coil. CIS hail guards are located on top of the unit, above the dry finned coil, to protect the coil from hail damage. PVC material is impervious to rot, decay, rust, and biological attack.

Inspection & Maintenance

Inspect the fill, eliminators, and combined inlet shields at least quarterly, and clean them as described below. Inspect the CIS hail guards annually or after a hail event. The inspection procedure is as follows:

- De-energize, lockout and tagout the fan motor(s) and the unit pump(s).
- Inspect the fill, eliminators, combined inlet shields and CIS hail guards for obstructions, damage and fouling. Hail guard inspection requires safe access to the top of the unit, which is provided by others.
- Remove any obstructions from the fill, eliminators, combined inlet shields, and CIS hail guards.
- Remove any minor fouling chemically. Contact your local water treatment consultant for advice. CIS Hail guards must be removed before cleaning, to avoid contaminating the dry finned coil surfaces.
- Extensive fouling may require mechanical cleaning and flushing. Exercise care when cleaning to avoid damage to the PVC components. Hail guards must be removed before cleaning, to avoid contaminating the dry finned coil surfaces. See **page 30** for removal instructions.

Water Distribution System

The spray water is distributed through a corrosion resistant polyvinyl chloride (PVC) distribution system. Inspect the spray nozzles at least quarterly and clean as necessary. The design of the HXV allows for the inspection of the water distribution system while the unit is fully operational. The fan motors may continue to operate while external inspection of distribution system is underway.

Figure 7. Nozzle Spray Pattern

The inspection procedure is as follows:

- Ensure the spray pump is running.
- Check to see if the nozzles are producing the spray pattern shown in **Figure 7**.
- Clean any nozzles which are clogged. If necessary, the nozzle and rubber grommet may be removed for cleaning.
- Inspect the coil surface. Any corrosion, damage, or obstructions must be corrected.

Water Level Control

There are two types of water level controls used on BAC cooling units:
• Mechanical make-up valve assembly
• Optional electric water level control package

Mechanical Make-up Valve Assembly

A float-operated mechanical water make-up assembly is furnished as standard equipment on the unit. The standard make-up assembly consists of a corrosion resistant make-up valve connected to a float arm assembly actuated by a polystyrene-filled plastic float. The float is mounted on an all-thread rod held in place by wing nuts. The cold water basin operating water level can be adjusted by repositioning the float and all-thread rod using the wing nuts provided.

- Inspect the make-up valve assembly monthly and adjust if necessary.
- Inspect the valve annually for leakage. Replace the valve seat if necessary.
- Maintain the make-up water supply pressure between 15 psig and 50 psig for proper operation. BAC recommends a surge protector (provided by others) for pressures over 50 psig.
- Set the initial basin water level by adjusting the wing nuts, so that the make-up valve is completely closed when the water level in the cold water basin is at the overflow connection.
- With the design thermal load and the average water pressure (15 to 50 psig) at the valve, the above setting procedure will result in an operating water level near design, although some adjustment may still be required.
- If the thermal load is less than the design load at the time of unit start-up, the procedure may produce operating levels greater than design. If operating levels are higher than design, readjust the float in order to attain the recommended operating level as stated in **Table 2.**
- During the first 24 hours of operation, closely monitor the water level in the cold water basin and adjust the level if necessary.

NOTICE: Do not use steam or high pressure water to clean PVC eliminators or materials other than steel.

Optional Electric Water Level Control Package

As an option, an electric water level control package is available in lieu of the mechanical make-up assembly. The package consists of a probe-type liquid level control assembly and a slow-closing solenoid valve. Stainless steel electrodes, factory-set at predetermined lengths, extend from an electrode holder into the cold water basin. For more information, refer to the *Universal Electric Water Level Control Installation, Operation & Maintenance Manual For Part number 313555* available at BaltimoreAircoil.com.

- Clean the stainless steel electrodes periodically to prevent accumulations of scale, corrosion, sludge, or biological growth, which could interfere with the electrical circuit.
- The water level is maintained at the recommended operating level regardless of the system thermal load. Therefore, it is not recommended that the operating level be adjusted.
- During the start-up of units equipped with the electric water level control package, bypass the control unit in order to fill the unit to the overflow connection.

3

HXV HYBRID COOLER

Corrosion Protection

BAC products are constructed of corrosion-resistant materials. The fill, eliminators, hail guards, and distribution piping are made of polyvinyl chloride (PVC), which is impervious to rot, decay, rust or biological attack. Other corrosion-resistant materials listed below are used in the equipment construction

- **Galvanized Steel Components:** Inspect the galvanized steel components for blemishes or corrosion. Wire brush and recoat the affected areas with a cold galvanizing compound such as zinc rich compound (ZRC).
- **Thermosetting Hybrid Polymer Components:** Inspect the galvanized steel components protected with the thermosetting hybrid polymer for scratches, scrapes, or blemishes. To cosmetically touch up these areas with color matched paint use BAC Part #160133 available from your local BAC Representative.
- **Stainless Steel Components:** Inspect stainless steel components for signs of blemishes or corrosion. See "Long Term Care of Stainless Steel" **page 25** for cleaning and care instructions.
- **TriArmor® Corrosion Protection System:** Inspect components protected with the TriArmor® Corrosion Protection System for signs of deep scratches or blemishes, especially in areas with field penetrations. Touch these up with 3M™ Windo-Weld™ Super Fast Urethane which is available through your local BAC Representative (BAC Part # RK1015).

Water Treatment

A proper water treatment program, administered under the supervision of a competent water treatment specialist, is an essential part of routine maintenance to ensure the safe operation, efficiency and longevity of evaporative cooling equipment, as well as other system components. In evaporative cooling products, cooling is accomplished by evaporating a small portion of the recirculating water as it flows through the unit. As the water evaporates, the dissolved solids originally present in the water remain behind and if not controlled, the concentration of dissolved solids will increase rapidly. This can lead to corrosion, scale or biological fouling which may negatively affect heat transfer as well as the longevity of system components.

- **Corrosion** – Red rust on steel components and white rust on galvanized surfaces may affect the longevity of system components.
- **Scale Formation** – Scale, typically a calcium or magnesium based build-up, not only reduces heat transfer and system efficiency, but also may lead to under deposit corrosion. If scale is not controlled, it may continue building on critical components such as the fill and evaporative coil surfaces, severely impacting thermal performance.
- **Biological Fouling** – Slime and algae formations may reduce heat transfer, promote corrosion, and harbor pathogens such as *Legionella.*

NOTES:

1. Galvanized steel units require passivation in order to prevent white rust (refer to "Passivation").
2. Hardness and alkalinity limits may be exceeded under certain circumstances. Consult your water treatment specialist for recommendations.
3. The conversion factor used to determine conductivity is 0.625 (TDS = 0.625 x Conductivity).
4. The guidelines above refer to the materials used in construction. Different combinations of materials may be used on the same unit.
5. Water chemistry will change with operating temperatures. The recommended guidelines listed in **Table 1** refers to water temperature at 95°F.

NOTE: Since the quality of the ambient air and make-up water varies significantly from job site to job site, BAC strongly recommends obtaining the services of a qualified water treatment specialist prior to the initial start-up of the evaporative cooling equipment. Additionally, to protect against the risk of Legionella contamination, never operate the cooling equipment without adequate biological control, or without drift eliminators properly installed.

Corrosion and Scale Control

- To control corrosion and scale, maintain the water chemistry of the recirculating water within the parameters listed in **Table 3**. The specific measures required vary from system to system and are dependent on the chemistry of the make-up water, the metallurgy of the piping and heat transfer devices exposed to the recirculating water, and the temperatures at which the system will be operating.
- Bleed/blowdown, the continuous flow of a small portion of the recirculating water to a drain, is used to control the concentration of dissolved solids. On rare occasions, this may be adequate to control scale and corrosion. More often, chemical scale and corrosion inhibitors are necessary, which can raise the allowable level of dissolved solids without the risk of scale and corrosion.
- Keep the chemically treated water within the guidelines given in **Table 3**. In cases where bleed/blowdown alone is being employed for corrosion and scale control without chemical treatment your water treatment specialist may recommend more conservative limits than those shown in **Table 3.**

Property of Water	Recommended Levels for Various Materials of Construction			
	Galvanized Steel	Thermosetting Hybrid Polymer	Type 304 Stainless Steel	TriArmor® Corrosion Protection System or Type 316 Stainless Steel
pH	6.5 to 9.0[1]	6.5 to 9.2[1]	6.5 to 9.2[1]	6.5 to 9.5[1]
Total Suspended Solids	25 ppm	25 ppm	25 ppm	25 ppm
Total Dissolved Solids (TDS)	1,500 ppm	2,050 ppm	2,050 ppm	2,500 ppm
Conductivity	2,400 (micromhos/cm)	3,300 (micromhos/cm)	3,300 (micromhos/cm)	4,000 (micromhos/cm)
Alkalinity as $CaCO_3$	500 ppm[2]	600 ppm[2]	600 ppm[2]	600 ppm[2]
Calcium Hardness as $CaCO_3$	50 to 600 ppm[3]	50 to 750 ppm[3]	50 to 750 ppm[3]	50 to 750 ppm[3]
Chlorides (CL)	250 ppm	300 ppm	300 ppm	750 ppm
Sulfates	250 ppm	350 ppm	350 ppm	750 ppm
Silica	150 ppm	150 ppm	150 ppm	150 ppm

Table 3. Recommended Levels for Various Materials of Construction

Chemical Treatment Requirements

Chemical treatment programs must meet the following requirements:

- The chemicals must be compatible with the unit materials of construction as well as other materials used in the system (pipe, heat exchanger, etc.).
- BAC discourages acid dosing as means of scale control except for open circuit cooling towers with remote sump applications or towers constructed from stainless steel. This should be done at a point in the system where total mixing and dilution occur before reaching the evaporative cooling equipment. The preferred injection point for chemical scale and corrosion inhibitors is on the discharge side of the system circulating pump(s). These chemicals should not be batch fed directly into the unit's cold water basin or water distribution system, as this can severely damage areas directly contacted.
- When chlorine is added to the system, free residual chlorine should not exceed 1 ppm, except as noted in start-up, disinfection, and shutdown procedures. Exceeding this limit on a routine basis may accelerate corrosion.

Passivation

NOTE: Stainless steel cold water basins and basins protected by the TriArmor® Corrosion Protection System or thermosetting hybrid polymer do not require passivation. However, if the upper structure is galvanized steel, passivation is required on the galvanized area including any Hot Dip Galvanized After Fabrication (HDGAF) coil(s).

When new systems are first commissioned, special measures should be taken to ensure that galvanized steel surfaces are properly passivated to provide maximum protection from corrosion. Passivation is the formation of a protective, passive, oxide layer on galvanized steel surfaces. To ensure the galvanized steel surfaces are passivated, the pH of circulating water should be kept between 6.5 and 8.2 and calcium hardness between 50 and 600 ppm (as $CaCO_3$) for four to eight weeks after start-up, or until new zinc surfaces turn dull gray in color. If white rust forms on galvanized steel surfaces after the pH is returned to normal service levels, it may be necessary to repeat the passivation process. In case the pH can't be kept below 8.2, a secondary approach is to conduct a chemical passivation using inorganic phosphate or film-forming passivation agents. Consult your water treatment specialist for specific recommendation.

Biological Control

NOTE: ASHRAE Guideline 12: Minimizing the Risk of Legionellosis Associated with Building Water Systems is available for free from www.BaltimoreAircoil.com.

- The warm, oxygen and nutrient rich environment inside evaporative cooling equipment provides an ideal environment for the growth of algae, slime, and other micro-organisms. Uncontrolled, this can reduce heat transfer, promote corrosion, and promote the growth of potentially harmful organisms such as Legionella.
- **To avoid biological contamination and minimize the risk of *Legionella,* initiate the biocide treatment program at start-up and continue on a regular basis thereafter in accordance with the treatment supplier's instructions.**
- Bleed/blowdown or chemical treatment used for corrosion and scale control alone is not adequate for control of biological contamination.
- Introduce solid or granular biocides through a chemical "pot" feeder installed in parallel with the unit recirculating pump.

Long Term Care of Stainless Steel

When the percentage of chromium in steel exceeds 10.5%, it is called stainless steel. The chromium in the steel reacts with the oxygen in the air to form a chromium-oxide surface layer, also called the passivation layer that provides the corrosion resistance in stainless steel.

BAC's Manufacturing Process

BAC takes precautions to prevent cross-contamination, processing galvanized and stainless steel parts separately. Also, stainless steel brushes are used to clean welds on stainless parts and care is taken to avoid scratching parts during processing. Organic cleaners are used to clean the finished product prior to shipping.

Jobsite Considerations

While stainless steel itself does not rust so long as the chromium-oxide surface layer is intact, it is not immune to contamination from its surroundings. Some common sources of surface contamination are:

- Dirt and soil
- Shop oil or grease that may carry other contaminants such as metal chips
- Machining or welding galvanized steel at the jobsite may cause debris to impinge itself into the stainless steel

These contaminants can deposit on the surface and scratch the passivation layer or prevent it from re-forming. They can also get trapped underneath the passivation layer and reduce corrosion resistance.

Recommended Cleaning Procedure

Stainless steel needs to be cleaned regularly to maintain the corrosion resistance as well as to maintain the overall aesthetics of the stainless steel.

It is fairly simple to clean most contaminants off the surface of stainless steel. Most dirt and soil can be cleaned with a clean cloth, warm water, and mild detergent. For persistent dirt, a little vinegar can be added in the cleaning water. It is important to always rinse the surface with warm water and wipe with a dry cloth after any cleaning, whether mild or aggressive.

- Fingerprints, mild stains or grease spots can be cleaned using organic solvents such as acetone, methyl or ethyl alcohol, or mineral spirits. Stainless steel wipes or glass cleaners commonly available in stores may also be used.
- Occasionally the surface of stainless steel can get iron chips or shavings embedded in it from having galvanized steel machined or welded in the vicinity. The iron chips can start to rust, reducing the corrosion resistance of the stainless steel, and stain the surface giving the impression that the stainless steel is rusting. These types of contaminants require more aggressive cleaning. Mild abrasives such as Scotch-Brite™ products may be used where aesthetic considerations are not important followed by solvent cleaning with organic solvents as described above. It is important to rinse the surface with warm water and wipe with a dry cloth after cleaning.

NOTICE: Never use chloride or chlorine based solvents such as bleach or muriatic (hydrochloric) acid to clean stainless steel. It is important to rinse the surface with warm water and wipe with a dry cloth after cleaning.

NOTE: Long term care of stainless steel information reprinted with permission from "The Care and Cleaning of Stainless Steel"; Specialty Steel Industry of North America; http://www.ssina.com.

- If the iron chips are not removed with the Scotch-Brite™ Products, electro-chemical cleaning may be required. BAC uses commercially available equipment for electro-chemical cleaning in the field.

System Cleaning

System Cleaning

NOTE: Contact your local water treatment specialist for assistance.

With proper precautions, prior to start-up circulate an alkaline solution which can be used to clean condenser or process water systems through a closed circuit cooling tower.

The necessary precautions include:

- Limit the duration of the cleaning to one day or at the most two days.
- The temperature of the solution should never exceed 100ºF (37.8ºC).
- The maximum concentration of chemicals in the circulation solution should not exceed any of the following:
  - — 5% Sodium Hydroxide
  - — 5% Sodium Metasilicate
  - — 2% Sodium Carbonate
  - — 2% Tetra Sodium Pyrophosphate
  - — 0.5% Trisodium Phosphate
  - — 0.5% Sodium Nitrate
  - — 5-10% Butyl Cellosolve

Coil Cleaning for HXV Hybrid Coolers

The outside of the coils may require occasional cleaning. The chemicals used must be compatible with the materials being cleaned. For example, the prime surface coil is galvanized steel on the outside. The inside of the coil is black carbon steel. The dry finned coil is copper with aluminum fins. The coil cleaning process and chemicals must be selected to prevent damaging and corroding the coils. Damaged dry coil fins may be straightened using a fin comb. Follow safe access procedures. For specific recommendations on coil cleaning, contact a qualified consultant.

Bleed Rate

In evaporative cooling, evaporation of a small portion of the recirculating spray water as it flows through the equipment causes the cooling effect. As this water evaporates, the impurities originally present remain in the recirculating water. The concentration of the dissolved solids increases over time and can reach unacceptable levels. In addition, airborne impurities are often introduced into the recirculating water. If these impurities and contaminants are not effectively controlled, they can cause scaling, corrosion, and sludge accumulations that reduce heat transfer efficiency and increase system-operating costs, potentially shortening the useful life of the equipment. The degree to which dissolved solids and other impurities build up in the recirculating water may be defined as the cycles of concentration. Specifically, cycles of concentration equal the ratio of the concentration of dissolved solids (for example - chlorides, sulfates, etc.) in the recirculating water to the concentration of the same material in the make-up water.

- In order to optimize heat transfer efficiency and maximize equipment life, bleed or blowdown a small amount of recirculating water from the system. This controls the cycles of concentration to maintain the quality of the recirculating water within the guidelines given in **Table 3**, on **page 23**.
- Replenish the "bleed" water with fresh make-up water, thereby limiting the build-up of impurities.
- Bleed/blowdown:
  - Accomplish the bleed automatically through a solenoid valve controlled by a conductivity meter. The set point is the water conductivity at the desired cycles of concentration and should be determined by a competent water treatment expert.

NOTE: A proper water treatment program, administered under the supervision of a competent water treatment specialist, is an essential part of routine maintenance to ensure the safe operation and longevity of evaporative cooling equipment, as well as other system components.

NOTE: The solenoid valve and conductivity meter must be supplied by others. Evaporation is proportional to the load and will vary seasonally. BAC recommends the use of a conductivity meter to maximize water conservation.

NOTE: The peak evaporation rate (E) can be estimated by any one of the following methods:

- The evaporation rate is approximately 2 USGPM per 1 million BTUH of heat rejection.
- The evaporation rate is approximately 3 USGPM per 100 tons of refrigeration.
- Evaporation Rate = Q (USGPM) * R * 0.001.

NOTE: Evaporation is proportional to the load and will vary seasonally. BAC recommends the use of a conductivity meter to maximize water conservation.

Bleed Line Calculations: Bleed rate is determined by the following formula:

$$B = \frac{E}{(n-1)}$$

Where: B = Bleed Rate (USGPM)

E = Evaporation Rate (USGPM) = Q (USGPM) x R (°F) x 0.001

Q = Process Fluid Flow Rate (USGPM)

R = Range

n = Number of Cycles of Concentration = CR/CM

CR = Concentration in Recirculating Water

CM = Concentration in Make-up Water

Given:

- Closed Circuit Cooling Tower
- Process Fluid Flow Rate = 800 USGPM
- Maximum Allowable Chloride Concentration = 250 ppm
- Concentration of Chlorides in Make-up Water = 45 ppm
- Range = 10°F

Find: Bleed Rate

Solution: So in this case,

$$E = Q * R * 0.001 = 800 * 10 * 0.001 = 8 \text{ USGPM}$$

$$n = \frac{CR}{CM} = \frac{250 \text{ ppm}}{45 \text{ ppm}} = 5.55$$

$$B = \frac{E}{(n-1)} = \frac{8 \text{ USGPM}}{(5.55-1)} = 1.75 \text{ USGPM}$$

Therefore, in this case we must bleed approximately 1.75 USGPM to limit the concentration of impurities to an acceptable level.

This example focuses on a single parameter (chloride concentration) of water only. The bleed rate required for a system (when evaluating more than one parameter) is the highest bleed rate required to keep all parameters within recommended limits.

Cold Weather Operation

5

Inspection & Maintenance

BAC products can be operated at subfreezing ambient temperatures provided proper operating methods are established and diligently followed.

- Carry out frequent visual inspections and routine maintenance services during operation in subfreezing weather.
- Ensure all controls for capacity and freeze protection are set properly and functioning normally.
- Prevent excessively high water levels and possible overflow of the cold water basin due to clogged strainers or make-up valve malfunction.
- Some unit icing can be expected in very cold weather. Usually this will not effect the operation of the unit. Resolve any icing conditions that may damage the unit or the supports, impair the system performance, or create a safety hazard.

Fan Section Icing Protection

There are three basic operational methods which can be used to provide the system's required cooling: temperature setting, fan control, and dry operation. The method of control employed on a given application depends upon the climatic extremes which are expected, the variations in heat load that will be encountered, and the compatibility of the control system with other portions of the installation.

In subfreezing ambient temperatures, effective icing control may require a combination of these three methods. Operate each unit with the highest thermal load it can handle, rather than evenly dividing the total heat load across all cells. During prolonged cold weather periods, bypass the idle units and drain the basins.

Temperature Setting

Low leaving fluid temperatures promote ice formation. During operation in subfreezing ambient temperatures, maintain the leaving fluid temperature as high as possible. Ensure the unit operates with the maximum possible heat load. The minimum recommended leaving fluid temperature is 50°F (10°C) for HXV units with water (non-glycol) as the heat transfer liquid and 45°F (7.2°C) for HXV units with glycol as the heat transfer liquid. Coils will freeze in ambient temperatures of 32°F or lower without a heat load. Use of glycol is strongly recommended in applications where low ambient temperatures are possible.

NOTE: Modulating the spray water flow rate to the unit is NOT a recommended method of controlling cooling capacity.

Fan Control

Reduce the unit capacity with the load by cycling the fans, thus modulating the airflow through the unit. Rapid on-off cycles can cause the fan motor to overheat. Set the controls to allow a maximum of six on-off cycles per hour. Periodically, cycle the fans off to prevent ice formation and/or to melt ice that accumulates on the combined inlet shields.

The following are fan control methods:

- **Variable Frequency Drives**: VFDs offer the most precise method of capacity control by modulating fan motor speed. When using VFDs, avoid operating at or near resonant speeds. Units with VFDs require premium efficient/inverter duty motors.
- **Fan Cycling**: Cycle the fan off for five minutes every 15 to 20 minutes for each cell. If ice continues to build on the air intake, decrease the on-time. Observe the air intake of the unit at least every four to eight hours.
- **Multi-Speed Motors:** If the unit is equipped with 2-speed motors or BALTIGUARD™ Fan System, operation at a lower speed may be sufficient to prevent icing. The motor starter should include a minimum 15 second time delay when switching from high to low speed.
- **Fan Reversal:** This procedure should be used only after the other methods of fan control fail. If utilized, the fans should be run in reverse for no longer than 20 minutes and the unit should be observed during this time. Operate the fans in reverse at 20-30% fan speed. If water is observed exiting the air inlets, reduce the speed until no water is observed. Before returning to normal operation, visually inspect the fan blades for ice formation.

Dry Operation

The HXV Hybrid Cooler provides high switch points for dry operation. One method to prevent icing is dry operation. Dry operation of the HXV unit protects fans from ice formation due to mist and splash from the cold water basin. The water in the cold water basin must be drained for dry operation in freezing ambient conditions. For dry operation switch points and recommendations, contact your local BAC Representative.

Basin Water and Internal Piping Freeze Protection

Cold Water Basin Protection

It is important to protect the basin and internal piping. The basin water could freeze when the unit is shutdown and exposed to subfreezing ambient temperatures.

- **Basin Heaters**: On applications without a remote sump, heat must be provided to the cold water basin to prevent freezing. Electrical immersion heaters will provide the required protection. Contact BAC for more details.
- **Heat Tracing**: Heat trace and insulate all exposed water piping including pump piping below the overflow level (see **Table 3, page 12**) and make-up water lines with electrical heater tape.
- **Remote Sump:** The ideal method of protection is a remote sump located in a heated indoor space. When the circulating pump stops, the water in the connecting piping will drain by gravity to this indoor sump.
- **Electric Water Level Control:** An electric water level control will maintain the proper water level regardless of the thermal load or variations in make-up water supply pressure. The two-position, slow closing solenoid valve provided with the BAC electric water level control package also minimizes valve freezing problems (see **page 20**).

Coil Freeze Protection

For protection against coil freeze-up, recommended coil fluid solutions are an industrial grade inhibited ethylene glycol or propylene glycol solution. When the use of glycol is not practical, the system must be designed to meet both minimum flow and minimum temperature requirements.

Minimum Operation

When a glycol solution is not utilized, operate the system to meet the following conditions.

- Maintain the minimum recommended flow through the unit coils at all times.
- Maintain a minimum heat load on the circulating fluid so that the temperature of the fluid leaving the prime surface coil (wet coil) is not less than 50°F (10°C). To maintain the leaving fluid temperature at 50°F (10°C) when the process load is extremely light or shut off, apply an auxiliary heat load to the circulating fluid and adjust the flow to ensure that fluid leaving the prime surface coil (wet coil) maintains the minimum required temperature.

Model Number	Minimum Coil Flow (USGPM)
HXV-1212x-xxxxTx-x, HXV-1218x-xxxxTx-x	175
HXV-1212x-xxxxQx-x, HXV-1218x-xxxxQx-x	220
HXV-1212x-xxxxHx-x, HXV-1218x-xxxxHx-x	350

Table 4. Minimum Coil Flow

Emergency Coil Drain

Do not drain the coils as a normal method of freeze protection. Frequent draining promotes corrosion inside the coil tubes. However, draining is acceptable as an emergency method of freeze protection if the coils are not protected by a glycol solution. If the coils are not protected, automatic drain valves and vacuum breakers are recommended to drain both the prime surface coil (wet coil) and the finned coils (dry coils) if flow stops or the fluid temperature drops below 50°F (10°C) when the ambient temperature is below freezing. Further protection against coil freeze-up is possible with the installation of an alarm to alert personnel when the temperature of the fluid leaving the prime surface coil (wet coil) falls below 50°F (10°C). Contact your local BAC Representative for guidelines on the installation of an emergency coil drain system.

6

HXV HYBRID COOLER

Operation Considerations for Accessories

Basin Heater (Optional)

Figure 8. Basin Heater

NOTICE: The basin heater is not designed to prevent icing during unit operation.

One or more electric immersion heaters, properly sized, will prevent the cold water basin from freezing and damaging the unit during shutdown or standby. The heaters are sized to maintain 40 degrees Fahrenheit basin water temperature for the specific unit at specified ambient conditions. The heating element has an enclosure that is suitable for outdoor use. At least quarterly and prior to the risk of freezing ambient conditions, inspect the basin heater and controls for proper function.

Operation

Ensure that the heating element is completely submerged before energizing the basin heater(s). De-energize, lockout, and tag out power to the basin heater(s) prior to draining the cold water basin. The heater circuit must never be energized when the water level in the cold water basin is not sufficient to completely submerge the heating element. For installations that have a BAC Controls Enclosure, please consult the submittal packet provided with the unit and contact BAC for support.

Stand Alone BAC Heater Control Panel (Optional)

NOTICE: The heater control panel temperature/low level control can only be used with the supplied combination temperature/water level sensor probe. Please contact your local BAC Representative for replacement parts.

The heater control system consists of a heater control panel and a combination temperature/water level sensor. The stainless steel sensor probe with 1/2" NPT mounting fitting has an on/off relay output that de-energizes the heaters whenever the basin water temperature is above 45°F (7.2°C), or whenever the sensor probe is not fully submersed. The control panel enclosure is suitable for outdoor use.

The control system utilizes a combination temperature/low water level control sensor, which is powered by a transformer in the control panel. When the sensor provides a signal to the control panel, the panel sends a control voltage to the magnetic contactors. When energized, the magnetic contactors supply line voltage to the heaters. Annually inspect the heater control system prior to the risk of reaching freezing operating conditions.

Operation

Ensure that the element is completely submerged before energizing the main disconnect.The combination temperature/low level control is preset to energize the heater at 40°F (4.5°C), but will not energize if the water level is too low or if the water temperature is above 45°F (7.2°C).

Testing the heater when water temperatures are above 45°F (7.2°C):

- Disconnect the heater control panel and tag out the circuit.
- Remove the heater control panel cover.
- Remove the sensor wires connected to terminals T1 and T2 on the combination temperature/low level control and isolate them.
- Install the 1.5K ohm test resistor supplied with the heater control panel (in bag on outside of cover) across terminals T1 and T2.
- Install the heater control panel cover.
- Energize the system and listen for the contactor closing.
- After operation, de-energize the circuit, disconnect the heater control panel, and tag out the circuit.
- Remove the resistor and place it back in the storage bag. Check all connections, reconnect sensor wires per the wiring diagram to terminals T1 and T2, replace the cover, and place the system back in service.lades for ice formation.

Operation when the sensor probe is encased in ice:

- Disconnect the heater control panel and tag out the circuit.
- Remove the heater control panel cover.
- Install a jumper wire across terminals G1 and G2 on the combination temperature/low level control circuit board.
- Install the heater control panel cover.
- Energize the system and listen for the contactor closing.
- Operate the system until the ice is melted around the probe.
- After operation, de-energize the circuit, disconnect the heater control panel, and tag out the circuit.
- Remove the jumper, check all connections, replace the cover, and place the system back in service.

WARNING: Dangerous voltages are present in this equipment. Disconnect the electrical service of the source and tag the circuit out before servicing or replacing components.

NOTICE: Do not operate the system unattended or for extended periods of time during test mode (resistor across terminals T1 and T2). Operation in water temperatures above 45°F (7.2°C) could damage the unit.

NOTICE: Do not operate the system unattended or for extended periods of time with terminals G1-G2 jumpered. A low liquid level condition could occur, and the system will not shut off which could result in damage to the heater and unit.

NOTE: Figure 8 is superseded by anydrawing supplied with the panel by the manufacturer.

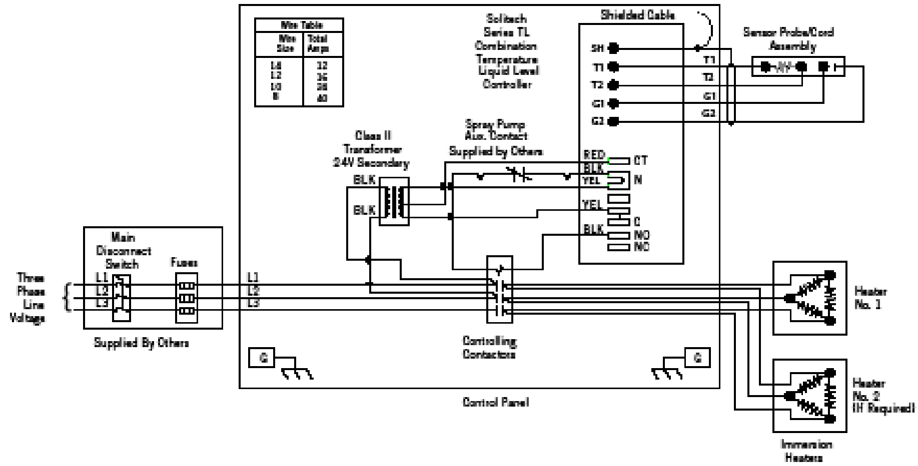


Figure 9. Example Wiring Diagram for Stand Alone BAC Heater Control Panel (Refer to Submittal Drawing for Specific Wiring Diagram)

CIS Hail Guards

CIS hail guards are provided to protect the dry coil from hail damage. The CIS hail guards must be removed before cleaning, to avoid contaminating the dry finned coil surfaces. Below are the instructions for removal. To re-install the CIS hail guards, reverse the instructions.

- Lock out and tag out fan and pump motors before performing maintenance on the unit.
- Use appropriate means, complying with applicable safety standards related to working on elevated surfaces, to access the top of the unit.
- Loosen and remove hardware from hail guard end covers on the air inlet side of the unit, and remove covers.
- Slide hail guard bundles out of frame.

NOTICE: Do not allow CIS sections to drag across coil fins, damage to fins may occur.

Figure 10. CIS Hail Guards - Loosen and Remove Hardware from End Covers

Vibration Cutout Switch (VCOS)

Testing:

- De-energize, lock out and tag out power to the fan motors before entering the HXV unit to reset, test, or calibrate the VCOS.
- Carefully remove the cover from the VCOS housing.
- Rotate the 'Shut Down' setpoint adjustment knob counterclockwise to the 'Test' position. This will increase the switch sensitivity to trip at the slightest vibration level. When tripped, the LED light adjacent to the set point control will come on immediately, and the circuit trip will occur after the duration of the time delay, proving the switch is operational.
- When finished testing, rotate the 'Shut Down' setpoint adjustment knob to 0.45 ips factory setting, and reset the switch.
- Carefully install the VCOS housing cover to protect the inside of the switch housing from moisture ingress. Ensure the cover gasket is intact.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. De-energize, lock out and tag out power to the fan motor(s) before entering the HXV unit to reset, test, or calibrate the VCOS, or prior to performing any service, maintenance or inspection on or near the fans, motors, and drives, or inside the unit

If desired, the VCOS can be periodically calibrated as follows:

- De-energize, lock out and tag out power to the fan motors before entering the HXV unit to reset, test, or calibrate the VCOS.
- Carefully remove the cover from the VCOS housing.
- Mount an accelerometer connected to a vibration meter (provided by others) near the VCOS.
- While applying a vibration near the VCOS and the accelerometer, slowly turn the 'Shut Down' setpoint adjustment knob counterclockwise until the light comes on, indicating that the trip level has been exceeded.
- This setting is then compared with the vibration measured with the vibration meter (provided by others), thus providing a calibration check of the VCOS.
- When calibration is completed, rotate the 'Shut Down' setpoint adjustment knob to 0.45 ips factory setting, and reset the switch.
- Carefully install the VCOS housing cover to protect the inside of the switch housing from moisture ingress. Ensure the cover gasket is intact.
- Remove the accelerometer and vibration meter (provided by others).

NOTE: Remote reset is disabled if the push button option is selected.

Remote Reset: When wired in this mode, the shutdown switch latch is a "trip", but can be reset to the "non-shutdown" mode by momentarily interrupting the connection from terminal Reset to Common. This can be accomplished with a normally closed momentary switch. The switch contacts should be isolated from other circuits, potentials or grounds.

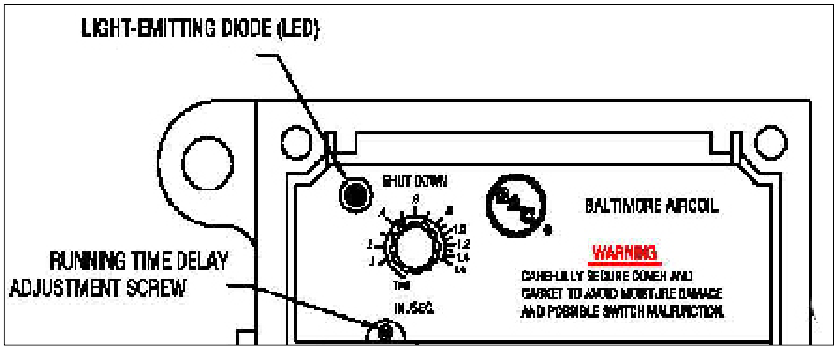


Figure 11. Electronic VCOS

Mechanical Vibration Cutout Switch

The Mechanical Vibration Cutout Switch and the Optional Electronic Vibration Cutout Switch should be tested and field adjusted at start-up and yearly thereafter.

Mechanical Vibration Cutout Switch (Standard)

Set Point Adjustment When Installed:

1. For safety, turn off, then lock and tag-out the electrical supply to the fan motor(s).
2. Turn adjustment screw counterclockwise 1/8 turn at a time until you hear the control trip.
3. Once tripped, rotate adjustment screw ¼ turn clockwise. Push in the manual reset button.
4. Start up the fan(s) to determine if the start-up will cause the cut-out switch to trip.
5. If the VCOS does not trip, start and stop the fan two more times. If the VCOS still does not trip, then calibration is complete.
6. If the VCOS trips, follow the steps in the note to the right.

Electrical Reset and Start-up Lockout (Optional):

1. If rated voltage is continuously applied to the reset circuit at unit start-up, the reset solenoid energizes for a fixed time interval (approximately 30 sec), after which time the solenoid is automatically de-energized by the thermistor. This provides a trip lockout during machine start-up roughness.
2. The voltage must be removed from the reset circuit when the machine is stopped to allow the thermistor to cool off.
3. The switch mechanism can be reset electrically by a momentary application of the reset voltage or it can be reset manually.

NOTE: If the VCOS trips, turn off, then lock and tag out the electrical supply to the fan motor(s). Adjust the set point screw an additional 1/4 turn clockwise, and push in the manual reset button. Start up the fan motor(s) to determine if the start-up will cause the VCOS to trip. Repeat this adjustment process until the VCOS no longer trips when the unit is operated. Make sure to lock out and tag out the electrical supply to the fan motor(s) before entering the unit or re-setting the switch, each time an adjustment to the VCOS is made. After the final adjustment has been made, start and stop the fan motor(s) two more times to ensure that the VCOS is properly set.

Electrionic Vibration Cutout Switch (Optional)

The single set point, electronic hybrid vibration cutout switch (VCOS) contains one trip limit for shutdown. The shutdown set-point is factory set at 0.45 in/sec. Additional details can be found in the submittal packet.

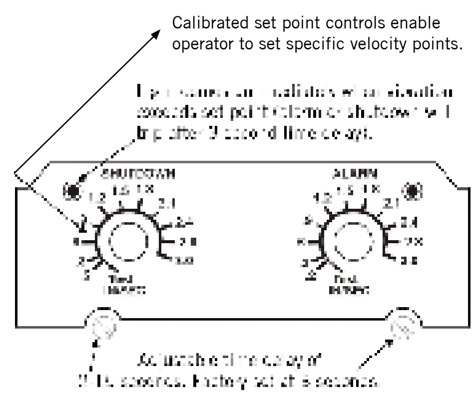


Figure 12. Electronic VCOS with Alarm Contact

Fan Control

Independent Fan Control

BAC recommends controlling all fans together. However, follow the instructions below if independent fan control is performed.

In an operating induced draft unit with independent fan capabilities and no partitions, idle fans tend to windmill in the reverse direction. A windmilling fan poses no threat to the system while turning freely, but can create a large shock load when the fan motor is suddenly powered up. Proper staging of fans when starting from a windmilling condition will prevent excessive stresses on the drive system.

- **VFD:** The recommended control option is to use a variable frequency drive to control all of the motors. VFDs regulate motor speed electronically and start motors with reduced voltage and frequency. The result is a gentle motor start, and therefore reduced stress.
- No VFD
  — Staging Up: Turn all motors off for 15 seconds. Following the 15 second delay, bring all required fans online. Allow for a 1 second time delay between fan stages to reduce staging current.
  — Staging Down: Turn off the fan motor. No need for delays.

NOTE: With evaporative cooling, a 15 second fan motor delay will not be noticed when staging up.

NOTICE: For a unit with a VFD, with a switching frequency of 2.5 kHz, the line lead length cannot exceed 100 feet. If the switching frequency is higher that 2.5 kHz and/or the line lead length exceeds 100 feet, a dV/dT output filter is recommended to protect the motor. Since the switching frequency and maximum line length requirements vary between VFD and motor suppliers, contact your local BAC Representative to determine if a dV/dT filter is required.

Variable Frequency Drive Operation

- Applications utilizing variable frequency drives (VFDs) for fan motor control must use inverter duty motors built in compliance with NEMA standard MG-1, Part 31.
- Operation of the unit at a speed which resonates with components of the drive system or support structure may result in vibrations which could damage the components or structure, and/or create objectionable noise. Therefore, these resonant speed ranges should be identified at start-up and locked out to prevent operation of the motor at these resonant speeds. The “Resonant Speed Identification Procedure” must be conducted on **page 37**.
- Please refer to the manufacturer’s variable frequency drive recommended start-up procedure for further information or consult with BAC for any VFD applications.

NOTE: The minimum turndown ratio for units with a belt drive is 10:1 (or 6 hz).

Resonant Speed Identification Procedure

There are several characteristic frequencies at which vibration levels may resonate with unit structural components. These include fan speed, motor speed, bearing frequency, and blade pass frequency. Within the overall operating speed range of a unit, it is not unusual for one or more of these characteristic frequencies to excite the structural components over relatively small speed ranges and create an increase in vibration levels. If the vibration levels are excessive at these resonant speeds, they need to be locked out to prevent the VFD from operating the motor at these speeds. The following procedure describes how to identify the lockout speed ranges:

- Ensure the VFD that controls the fan motor is off, and the power to the motor circuit is locked out.
- Attach the accelerometer (provided by others) onto the bearing support or mechanical support as shown in **Figure 11a** and **11b**.

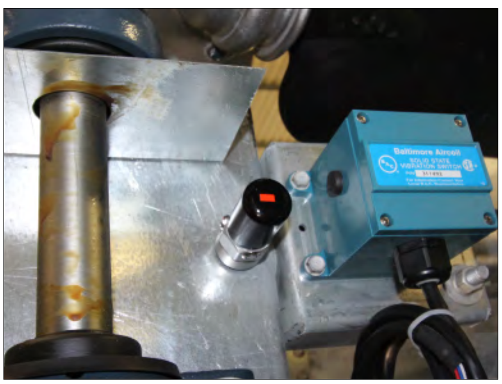


Figure 11a. Preferred Accelerometer Location

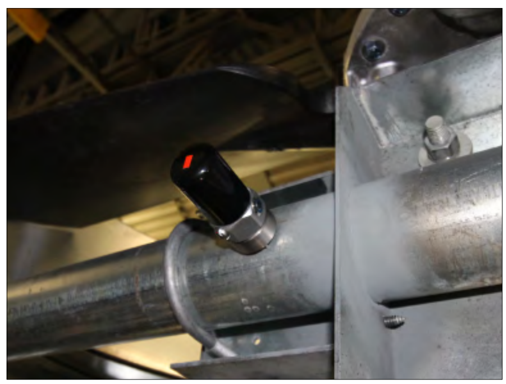


Figure 11b. Alternate Accelerometer Location

- Connect the signal wire from the accelerometer (provided by others) to the vibration analyzer (provided by others). Be sure to route and fasten the wire so that it will not contact any rotating parts inside the unit when the drive system is operational.
- Get out of the unit, and ensure that the drive system is "all clear." Remove the lockout from the motor circuit.
- With the VFD off, record the vibration level indicated on the vibration analyzer, and confirm that it is very low (only picking up ambient vibration). Record this overall vibration level (0-peak) in inches per second (ips). If the ambient vibration level is greater than 0.35 ips, identify and correct the cause of the vibration. It could be vibration transmitted from another source, instrumentation malfunction, radio frequency interference, etc. If the cause is vibration transmitted from another source, and that source cannot be isolated or turned off for the duration of the measurements, note the source and magnitude of the vibration before continuing.
- After it is confirmed that the drive system is "all clear" and the unit access doors are closed, turn the VFD on, and verify that the fan is turning in the correct direction.
- Using the VFD, slowly (about 1 RPM increase every five to ten second(s) adjust the motor speed from the lowest limit to full speed while monitoring the vibration levels. Record the overall vibration levels at regular intervals if desired.

NOTE: The resonant speed identification procedure must be performed at start-up for units with VFDs.

DANGER: Rotating equipment will cause severe personal injury or death to persons who come in contact. Do not perform any service, maintenance, or inspection on or near the fans, motors, and drives, or inside the unit without first ensuring that the fans and pump motors are disconnected, locked out, and tagged out.

- As stated previously, when adjusting the VFD speed, proceed slowly while monitoring the vibration levels. If the vibration value approaches 0.35 ips (0-peak), slowly "zero in" on the speed where the value equals 0.35 ips, and record the speed at which this occurs as the lower end of the lockout range. Also record the vibration level at this speed.
- Continue to slowly increase the speed while monitoring the vibration level. If this is a resonance, then the value should peak and eventually decrease to a level that is below 0.35 ips as the speed is increased. After the vibration level has peaked and continues to fall, record the speed where the value equals 0.35 ips as the upper end of the lockout range.
- Using this data, a baseline for vibration history can be developed. The vibration levels can be monitored yearly and the trend used to indicate potential wear or the need to replace components in the drive system.
- After the entire speed range has been checked and any resonances identified, ensure the VFD that controls the fan motor is then turned off, and the power to the motor circuit is locked out.
- Enter the unit, and carefully remove the accelerometer, along with any associated wiring from the unit.
- Work with the VFD contractor to enter the lockout speed ranges, if any have been identified, into the VFD, so the unit will not operate at a resonant speed.
- Once it has been verified that the drive system is all clear, return the unit to its normal operating condition.
- Keep a record of any lockout speed ranges for future reference.

Installation Instructions for Field Connections

8

The following are installation instructions for adding new field connections (Equalizer/ Bypass/Outlet) on a cold water basin with the TriArmor® Corrosion Protection System.

Supplies Provided by BAC	Recommended Supplies Provided bu Others
Template for the connection with bolt holes	Stainless steel threaded shoulder bolts
Type 304 stainless steel backing ring with gasket	150 lb flange, weld any piping to the flange prior to installation
Vulkem® Caulk	Gasket for the outside of the cold water basin

Table 7. Supplies for Installing Field Connections

1. Use the BAC template provided with the accessory to layout and mark the hole pattern on the exterior of the cold water basin.
2. Drill a pilot hole from the outside of the cold water basin to the inside of the cold water basin.
3. On the inside of the cold water basin:
   a. For connections 3" or less, score the TriArmor® Corrosion Protection System with a hole saw as shown in **Figure 12**.
   b. For connections 3" or greater, proceed to step 4.
4. Cut the hole from the outside of the cold water basin.
   a. Use a hole saw or a step drill bit for smaller connections 3" or less as shown in **Figure 13**.
   b. Use a reciprocating saw or a Sawzall® for larger connections 3" or greater.
5. Position the BAC supplied stainless steel backing ring gasket to the inside of the cold water basin.
6. Position the flange to the outside of the cold water basin.
7. Bolt the flange and the stainless steel backing plate together using stainless steel bolts.
8. Seal any exposed galvanized steel of the connection inside the cold water basin with Vulkem® Caulk as shown in **Figure 14**.

Figure 12. Scored TriArmor® Corrosion Protection System

Figure 13. Removal Material

NOTE: BAC recommends adding a flange connection for field installed equalizers, bypass and outlet connections. Please order the recommended supplies listed in **Table 5** prior to unit shutdown.

Figure 14. Caulk Exposed Galvanized Steel

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