



**BALTIMORE
AIRCOIL COMPANY**

Common

OPERATION & MAINTENANCE MANUAL





Maintenance Checklist for:

Cooling Towers, Closed Circuit Cooling Towers, and Evaporative Condensers^[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/Spray nozzles	✓		✓		
Drain basin and piping			✓		✓
Inspect air inlet louvers/Combined inlet shields	✓	✓			
Check and adjust water level in basins	✓	✓			
Check operation of make-up valve	✓	✓			
Check and adjust bleed rate	✓	✓			
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 adjusting screw	✓		✓		✓
Check and lubricate optional gear drive	See product specific O&M Manual for detailed instructions and schedule				
Check drive alignment				✓	
Check motor voltage and current	✓		✓		✓
Clean fan motor exterior	✓		✓		
Check fan motor for proper rotation	✓				
Check general condition of the fan			✓		
Check and unplug fan drain holes (hollow blade fans)			✓		
Check fan for uniform pitch			✓		
Check fan for rotation without obstruction	✓		✓		
Check and recoat steel shafts with RUST VETO®	✓		✓		✓



WARNING: Do not perform any service on or near the fans, motors, or drives, or inside the unit without first ensuring that the fans and pumps are disconnected and locked 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 8** for more details.
3. Tension on new belts must be readjusted after the first 24 hours of operation and quarterly, thereafter.



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Warnings

- **WARNING:** Do not perform any service on or near the fans, motors, or drives or inside the unit without first ensuring that the fans and pumps are disconnected, locked out, and tagged out.
- **WARNING:** Check to ensure the controls for the fan motor are set to allow a maximum of six on-off cycles per hour to prevent motor overload.
- **WARNING:** Openings and/or submerged obstructions may exist in the bottom of the cold water basin. Use caution when walking inside this equipment.
- **WARNING:** The top horizontal surface of the unit is not intended for use 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 of governmental authorities.
- **WARNING:** Drift eliminators on PT2, PC2, VT0, VT1, VTL, VC1, VCL, VF1, VFL, and VCA units 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 as walking, working or storage surfaces may result in injury to personnel or damage to equipment. Units with drift eliminators 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 resonant speed which could result in fan failure and possible personal injury or damage. Contact your local BAC Representative regarding any such applications. Additionally, inverter duty motors are required on installations that are to be controlled by VFDs. See "Variable Frequency Drive Operation" on **Page 5** for more details.
- **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:** The basin heater is not designed to prevent icing during unit operation.
- **WARNING:** Disconnect the heater control panel and tag the circuit out before performing the steps on **Page 30**.
- **WARNING:** Do not operate the system unattended or for extended periods of time during test mode of the stand alone BAC heater control panel (resistor across terminals T1 and T2). Operation in water temperatures above 45°F (7.2°C) could damage the unit.
- **WARNING:** Do not operate the stand alone BAC heater control panel 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.

Warranties

Please refer to the Limitation of Warranties in the submittal packet 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.



Cautions

- **CAUTION:** 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. See “Prolonged Outdoor Storage” on **Page 36** for more details. For instance, covering the unit with a clear plastic tarpaulin during storage can trap heat inside the unit, potentially causing damage to the fill and other plastic components. If the unit must be covered during storage, an opaque, reflective tarp should be used. For normal seasonal shutdowns, refer to the applicable section of the product specific Operation & Maintenance Manual available at www.BaltimoreAircoil.com.
- **CAUTION:** All electrical, mechanical, and rotating machinery are potential hazards, particularly for those not familiar with their design, construction, and operation. Therefore, 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.
- **CAUTION:** When reversing the direction of fan rotation, allow the fan to come to a complete stop before restarting the motor.
- **CAUTION:** Do not use oils containing detergents for bearing lubrication. Detergent oils will remove the graphite in the bearing sleeve and cause bearing failure. Also, do not disturb bearing alignment by tightening the bearing cap adjustment on a new unit as it is torque-adjusted at the factory.
- **CAUTION:** This equipment should never be operated without all fan screens, access panels, and access doors in place. For the protection of authorized service and maintenance personnel, install a lockable disconnect switch located within sight of the unit on each fan and pump motor associated with this equipment.
- **CAUTION:** Mechanical and operational methods must be employed to protect these products against damage and/or reduced effectiveness due to possible freeze-up. Please refer to www.BaltimoreAircoil.com or contact your local BAC Representative for recommended protection alternatives.
- **CAUTION:** 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 most harmful atmospheric conditions are those with unusual quantities of industrial smoke, chemical fumes, salt or heavy dust. Such airborne impurities are carried into the equipment and absorbed by the recirculating water to form a corrosive solution.
- **WATER:** The most harmful conditions develop as water evaporates from the equipment, leaving behind the dissolved solids 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, can produce scaling or accelerate 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 25** and “Biological Control” on **Page 22** for more details.



COMMON

Controls

CONTROL MULTIPLE FAN MOTORS

VARIABLE FREQUENCY DRIVE OPERATION

RESONANT SPEED IDENTIFICATION PROCEDURE

Control Multiple Fan Motors



BAC has over ten years of successful experience with motors starting from a backwards condition on Cooling Towers, Closed Circuit Cooling Towers and Evaporative Condensers when there are no partitions. When starting the motors when the fans may be windmilling backwards, there are two control strategy options:

- **VFD:** The best control option is to use a variable frequency drive to control all of the motors. See VFD operation guidelines below.
- **No VFD:** When staging up (for example going from one to two motors, or from two to three motors) turn all motors off for 10 seconds, then bring on the next required stage set of fans.

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 the VFD to operate the motor at these resonant speeds.
- At start-up, slowly increase the output of the variable frequency drive to control the fan motor from 0 to increase the maximum motor speed, while monitoring the vibration level and listening for unusual noise. A resonant speed is characterized by a sharp increase in vibration or noise as the speed is slowly increased then peaks and drops back down to acceptable levels as the speed is further increased. The speed range with the elevated vibration and/or noise level should be locked out to prevent operation at these resonant speeds. There may be more than one resonance and therefore more than one lockout speed range within the operating speed range of the unit.
- Please refer to the manufacturer's variable frequency drive recommended start-up procedure for further information or consult with your local BAC Representative for any VFD applications. For projects with BAC controls, visit www.BaltimoreAircoil.com.

Controls

Control Multiple Fan Motors

Variable Frequency Drive Operation



NOTES:

1. With evaporative cooling, a 10 second fan motor start-up delay will not be noticed when staging up.
2. An optional one second time delay between fan on staging can be used to reduce staging current.
3. When staging down, turn off the fan motor needed, no need for any delays.



NOTE: The minimum turndown ratio for units with a belt drive is 10:1 (or 6 hz). The minimum turndown ratio for units with gear drive is 4:1 (or 15 hz), unless supplied with an oil pump or a no minimum speed gear. Units with the oil pump do not have a minimum speed.

Gear Drive Units with VFDs

- Do not operate the standard gear drives below 450 RPM motor speed (gear input speed). For speeds less than 450 RPM, a low speed option gear drive must be supplied.
- Continued operation at a speed which resonates with the gear drive system may result in torsional vibrations which can damage system components. The most common indicator of torsional vibration is an unusual rumbling or grinding noise from the gear drive at a narrow speed range. The noise will decrease to normal levels when the speed is increased or decreased away from the resonant speed range. This noise is not indicative of a defect, but results when the vibratory torque exceeds the drive torque, causing the gear teeth to separate and clash together very rapidly. On variable frequency drive applications, avoid operation near this resonant speed by locking out the resonant speed range.

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



Resonant Speed Identification Procedure

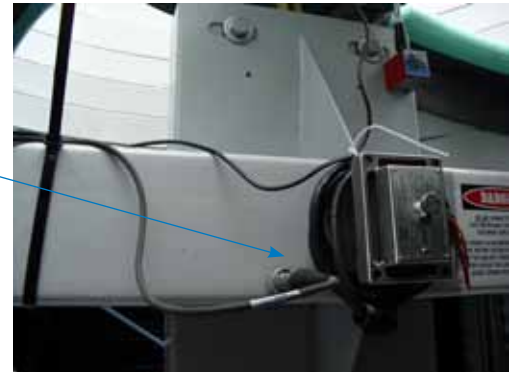
There are several characteristic frequencies at which vibration levels may resonate with unit structural components. These include fan speed, motor speed, gear mesh frequency, bearing frequency, and blade pass frequency. Within the overall operating speed range of a unit, it is not unusual for one or 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:

Figure 1a. Accelerometer Location - Gear Drive



• Correct accelerometer location, 1" from the edge of the box beam

Figure 1b. Accelerometer Location - Belt Drive



- Ensure the VFD that controls the fan motor is off, and the power to the motor circuit is locked out.
- Depending on the type of drive system (gear or belt), attach the accelerometer onto the box beam as shown in **Figure 1a** or **1b**. The accelerometer should be located away from the center of the web of the box beam, such that the center line of the accelerometer is about 1 inch from the upper or lower edge, as shown.



Controls

Variable Frequency Drive Operation

Gear Drive Units with VFDs

Resonant Speed Identification Procedure

- Connect the signal wire from the accelerometer to the vibration analyzer. Be sure to route and fasten the wire so that it will not contact any rotating parts inside the cooling tower 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 0.05 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 tower 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 seconds) 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.
- 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 periodically 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 tower.
- Work with the VFD contractor to enter the lockout speed ranges into the VFD, so the tower will not operate at a resonant speed.
- Once it has been verified that the drive system is all clear, return the tower to its normal operating condition.
- Keep a record of any lockout speed ranges for future reference.



COMMON

Cold Weather Operation

INSPECTION AND MAINTENANCE

FAN SECTION ICING PROTECTION

COIL FREEZE PROTECTION

BASIN WATER AND INTERNAL PIPING FREEZE PROTECTION

Inspection and 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 over pumping, 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. Effective icing control in subfreezing ambient conditions may require a combination of these three methods.

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 recommended minimum process fluid temperature is:

- 43°F (6.1°C) for crossflow cooling towers
- 42°F (5.5°C) for counterflow cooling towers
- 50°F (10°C) for closed circuit cooling towers with water (non-glycol) as the heat transfer liquid
- 45°F (7.2°C) for closed circuit cooling towers with glycol as the heat transfer liquid

Cold Weather Operation

Inspection and Maintenance

Fan Section Icing Protection

Temperature Setting



NOTE: Dry operation applies only to closed circuit cooling towers and evaporative condensers.

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



Fan Control

Reduce the unit capacity by cycling 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 intake louvers or combined inlet shields and face of the fill. 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:** 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.
- **Multi-Speed Motors:** If the unit is equipped with 2-speed motors or BALTIGUARD™/BALTIGUARD PLUS™ 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.

In subfreezing ambient temperatures, cycle the fan off for five minutes every 15 to 20 minutes for each cell. If ice continues to build on the louvers, decrease the on-time. Observe the inlet louvers of the towers at least every four to eight hours.

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 cooling tower should be observed during this time. Before returning to normal operation, visually inspect the fan blades for ice formation.

Dry Operation for Models

FXV, CXVB, PC2, VF1, VFL, VCA, VC1, VCL, and HXV

One method to prevent icing is dry operation. Dry operation of the closed circuit cooling tower or evaporative condenser protects fans from ice formation due to mist and splash from the cold water basin.

Coil Freeze Protection



For protection against coil freeze-up, recommended 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.

Coil volumes for models FXV, HXV, VF1, and VFL can be found in the corresponding Engineering Data section at www.BaltimoreAircoil.com. Coil volume for CXVB, PC2, VCA, VC1, and VCL condenser models using liquid cooling circuits is job specific.

Minimum Operation

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

- Maintain the minimum recommended flow through the coil at all times (see **Table 1**).
- Maintain a minimum heat load on so that the temperature of the fluid leaving the 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.

Model Number	Minimum Coil Flow (GPM)	Model Number	Minimum Coil Flow (GPM)
FXV-0806X-XXD, FXV-0809X-XXD, FXV-0812X-XXD, FXV-0818X-XXD	75	HXV-6XX	110
FXV-0806X-XXT, FXV-0809X-XXT, FXV-0812X-XXT, FXV-0818X-XXT	100	HXV-Q6XX	220
FXV-0806X-XXQ, FXV-0809X-XXQ, FXV-0812X-XXQ, FXV-0818X-XXQ	150	VF1-009, VF1-018, VF1-027, VF1-036	50
FXV-0806X-XXH, FXV-0809X-XXH, FXV-0812X-XXH, FXV-0818X-XXH	200	VF1-048	75
FXV-1212X-XXD, FXV-1218X-XXD	110	VF1-072	100
FXV-1212X-XXT, FXV-1218X-XXT	175	VF1-096, VF1-144N	125
FXV-1212X-XXQ, FXV-1218X-XXQ	220	VF1-144, VF1-216N	200
FXV-1212X-XXH, FXV-1218X-XXH	350	VF1-192, VF1-288N	250
FXV-288-X1X, FXV-288-2TX, FXV-364-X1X	275	VF1-288, VF1-432	400
FXV-288-XQX, FXV-364-XQX, FXV-364-2TX	550	VFL-012 thru VFL-048	65
		VFL-072 thru VFL-096	125

Table 1. Minimum Coil Flow

Cold Weather Operation

Fan Section Icing Protection

Fan Control

Fan Reversal

Dry Operation for Models FXV, CXVB, PC2, VF1, VFL, VCA, VC1, VCL, and HXV

Coil Freeze Protection

Minimum Operation

Positive Closure Damper Hood and Insulation

The amount of auxiliary heat required can be substantially reduced by the use of a positive closure damper hood and insulation on the hood and casing. The heat loss data can be found in **Tables 2, 3, 4, and 5.**

Model Number	Standard Unit	Unit with PCD Hood	Unit with PCD Hood & Insulation ^[1]
FXV-0806X-12D	82,000	46,200	34,700
FXV-0806X-16D	97,100	45,900	34,500
FXV-0806x-20D	111,400	45,600	34,200
FXV-0806X-24D	140,200	61,300	44,600
FXV-0806X-28D	153,000	60,900	44,400
FXV-0806x-32D	165,100	60,600	44,100
FXV-0806x-36D	176,700	60,200	43,900
FXV-0806X-24T	141,200	61,900	45,100
FXV-0806x-30T	160,500	61,500	44,800
FXV-0806x-36T	178,400	61,100	44,500
FXV-0806x-16Q	98,100	46,600	35,000
FXV-0806x-24Q	142,200	62,600	45,600
FXV-0806x-32Q	168,000	62,200	45,300
FXV-0809X-12D	118,700	60,400	47,400
FXV-0809x-16D	141,500	59,800	46,900
FXV-0809x-20D	163,000	59,200	46,400
FXV-0809x-24D	203,100	79,300	60,200
FXV-0809x-28D	222,000	78,600	59,600
FXV-0809X-32D	239,900	77,900	59,100
FXV-0809X-36D	256,800	77,300	58,600
FXV-0809x-24T	205,300	80,700	61,200
FXV-0809X-30T	233,900	79,800	60,500
FXV-0809X-36T	260,400	79,100	60,000
FXV-0809x-16Q	143,600	61,200	48,000
FXV-0809x-24Q	207,500	82,000	62,200
FXV-0809X-32Q	246,200	81,300	61,600
FXV-0812x-12D	154,900	74,300	59,800
FXV-0812x-16D	185,000	73,200	58,900
FXV-0812x-20D	213,400	72,200	58,100
FXV-0812x-24D	264,100	96,500	75,000
FXV-0812X-28D	288,800	95,300	74,100
FXV-0812X-32D	312,200	94,200	73,200
FXV-0812X-36D	334,000	93,200	72,400
FXV-0812X-24T	267,900	98,700	76,700
FXV-0812X-30T	305,600	97,400	75,600
FXV-0812X-36T	340,300	96,100	74,600
FXV-0812x-16Q	188,700	75,500	60,800
FXV-0812X-24Q	271,700	101,000	78,400
FXV-0812X-32Q	323,100	99,700	77,500
FXV-0818X-12D	225,500	100,900	83,600
FXV-0818X-16D	269,600	98,700	81,800
FXV-0818X-20D	310,600	96,700	80,100
FXV-0818X-24D	381,100	128,500	102,500
FXV-0818X-28D	416,200	126,100	100,600
FXV-0818X-32D	449,100	123,800	98,800
FXV-0818X-36D	479,800	121,700	97,100
FXV-0818X-24T	389,200	132,900	106,000
FXV-0818X-30T	443,600	130,200	103,800
FXV-0818X-36T	493,200	127,600	101,800
FXV-0818X-16Q	277,700	103,500	85,700
FXV-0818X-24Q	397,500	137,500	109,700
FXV-0818X-32Q	472,700	135,000	107,700
FXV-0818X-36H	514,300	137,100	109,300

NOTES:

- One inch thick PVC nitrite rubber blend thermal insulation on both the PCD hood and the casing panels surround the coil.
- Heat loss is based on 50°F (10°C) coil water and -10°F (-23.3°C) ambient air with a 45 MPH wind. The fan(s) and pump(s) are turned off.



Table 2. FXV-0806X thru FXV-0818X Heat Loss Data (BTU/hour)^[2]



Cold Weather Operation

Coil Freeze Protection

Positive Closure Damper Hood and Insulation

Model Number	Standard Unit	Unit with PCD Hood	Unit with PCD Hood & Insulation ⁽¹⁾
FXV-1212X-12D	228,300	83,100	70,700
FXV-1212X-16D	277,800	81,700	69,500
FXV-1212X-20D	324,000	80,500	68,500
FXV-1212X-24D	394,300	107,500	86,500
FXV-1212X-28D	434,600	106,000	85,300
FXV-1212X-32D	472,400	104,600	84,200
FXV-1212X-36D	507,900	103,300	83,100
FXV-1212X-24T	403,100	111,600	89,800
FXV-1212X-30T	465,700	110,100	88,600
FXV-1212X-36T	523,100	108,800	87,600
FXV-1212X-16Q	283,600	84,600	72,000
FXV-1212X-24Q	406,200	113,000	91,000
FXV-1212X-32Q	489,900	111,500	89,700
FXV-1212X-36H	536,300	113,700	91,500
FXV-1218X-12D	331,900	109,000	97,000
FXV-1218X-16D	404,200	106,400	94,600
FXV-1218X-20D	471,100	103,900	92,500
FXV-1218X-24D	567,700	137,800	115,600
FXV-1218X-28D	625,000	134,900	113,200
FXV-1218X-32D	678,200	132,300	110,900
FXV-1218X-36D	728,000	129,800	108,800
FXV-1218X-24T	586,700	145,800	122,300
FXV-1218X-30T	677,600	143,000	119,900
FXV-1218X-36T	760,500	140,400	117,700
FXV-1218X-16Q	416,900	112,200	99,800
FXV-1218X-24Q	593,400	148,700	124,700
FXV-1218X-32Q	716,100	145,700	122,200
FXV-1218X-36H	789,300	150,100	125,900
FXV-288-31X	760,200	280,700	202,000
FXV-288-41X	881,100	294,500	211,000
FXV-288-2TX	881,100	294,500	211,000
FXV-288-1QX	881,100	294,500	211,000
FXV-364-31X	894,000	330,100	237,600
FXV-364-41X	1,036,200	346,400	248,100
FXV-364-2TX	1,036,200	346,400	248,100
FXV-364-1QX	1,036,200	346,400	248,100

Table 3. FXV-1212X thru FXV-1218X and FXV-288 thru FXV-364 Heat Loss Data (BTU/hour)⁽²⁾

Model Number	Standard Unit	Unit with PCD Hood	Unit with PCD Hood & Insulation ⁽¹⁾
VFL-012-02	19,200	16,500	11,000
VFL-012-12	25,000	17,800	11,900
VFL-012-22	29,900	19,200	12,800
VFL-012-32	33,800	20,500	13,700
VFL-024-12	48,200	28,500	19,000
VFL-024-22	57,700	30,400	20,300
VFL-024-32	65,400	32,300	21,500
VFL-036-22	87,000	47,100	30,700
VFL-036-33	98,400	49,800	32,500
VFL-048-22	126,400	66,000	42,600
VFL-048-31	138,800	69,300	44,800
VFL-048-41	151,200	72,600	47,000
VFL-072-22	210,900	84,400	56,200
VFL-072-31	234,100	87,900	58,600
VFL-072-41	252,900	91,400	60,900
VFL-096-41	311,700	103,600	69,000

Table 4. VFL Heat Loss Data (BTU/hour)⁽²⁾



NOTES:

1. One inch thick PVC nitrile rubber blend thermal insulation on both the PCD hood and the casing panels surround the coil.
2. Heat loss is based on 50°F (10°C) coil water and -10°F (-23.3°C) ambient air with a 45 MPH wind. The fan(s) and pump(s) are turned off.

Model Number	Standard Unit	Unit with PCD Hood	Unit with PCD Hood & Insulation ⁽¹⁾
VF1-009-12	24,300	17,100	10,300
VF1-009-22	29,400	18,800	12,000
VF1-009-32	32,900	20,500	12,000
VF1-009-42	34,800	22,200	13,700
VF1-018-02	34,700	25,600	15,400
VF1-018-12	46,200	27,300	15,400
VF1-018-22	56,000	29,100	17,100
VF1-018-32	64,300	30,800	17,100
VF1-018-42	70,950	32,550	18,800
VF1-027-22	86,100	46,100	27,300
VF1-027-32	97,700	49,500	29,100
VF1-027-42	106,300	52,900	29,100
VF1-036-21	112,600	63,200	39,300
VF1-036-31	128,900	66,600	39,300
VF1-036-41	145,000	70,000	43,600
VF1-036-51	161,500	73,400	43,600
VF1-048-21	154,900	80,200	52,900
VF1-048-31	177,200	83,700	52,900
VF1-048-41	197,000	85,600	54,600
VF1-072-21	212,400	83,700	51,200
VF1-072-31	241,100	87,100	51,200
VF1-072-41	269,800	90,500	56,800
VF1-096-31	286,700	97,600	60,000
VF1-096-41	312,100	102,600	60,900
VF1-096-51	329,800	107,900	61,700
VF1-144N-21	381,400	128,300	81,300
VF1-144N-31	429,900	134,700	82,800
VF1-144N-41	464,800	141,400	84,400
VF1-144-21	385,000	139,900	88,600
VF1-144-31	435,500	146,900	90,200
VF1-144-41	474,600	154,200	91,900
VF1-192-31	576,300	228,400	153,600
VF1-192-41	627,300	240,100	156,700
VF1-192-51	662,800	252,500	160,100
VF1-216-21	579,900	194,000	122,900
VF1-216-31	653,500	203,700	125,100
VF1-216-41	707,300	213,800	127,300
VF1-288N-21	762,800	256,600	162,600
VF1-288N-31	859,800	269,400	165,600
VF1-288N-41	929,600	282,800	168,800
VF1-288-21	750,800	260,300	171,900
VF1-288-31	849,300	273,300	175,000
VF1-288-41	925,600	286,800	178,300
VF1-432-21	1,142,500	390,000	259,400
VF1-432-31	1,287,400	409,500	264,000
VF1-432-41	1,393,500	429,800	268,500

Table 5. VF1 Heat Loss Data (BTU/hour)⁽²⁾

NOTES:

- One inch thick PVC nitrile rubber blend thermal insulation on both the PCD hood and the casing panels surround the coil.
- Heat loss is based on 50°F (10°C) coil water and -10°F (-23.3°C) ambient air with a 45 MPH wind. The fan(s) and pump(s) are turned off.



Emergency Coil Drain

Do not drain the coil as a normal method of freeze protection. Frequent draining promotes corrosion inside the coil tube. However, draining is acceptable as an emergency method of freeze protection if the coil is not protected by a glycol solution. If the coil is not protected, an automatic drain valve and vacuum breaker are recommended to drain the coil 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 coil falls below 50°F (10°C). Contact your local BAC Representative for guidelines on the installation of an emergency coil drain system.



Cold Weather Operation

Coil Freeze Protection

Positive Closure Damper Hood and Insulation

Emergency Coil Drain

Basin Water and Internal Piping Freeze Protection

Cold Water Basin Protection

Basin Water and Internal Piping Freeze Protection

Cold Water Basin Protection

The basin water could freeze when the unit is shut-down and exposed to subfreezing ambient temperatures.

- **Remote Sump:** The ideal method of protection is a remote sump located in a heated indoor area. When the circulating pump stops, the water in the connecting piping will drain by gravity to this indoor sump.
- **Basin Heaters:** On applications without a remote sump, heat must be provided to the cold water basin. Electrical immersion heaters, steam coils or hot water coils can provide the required function. Contact your local BAC Representative for details.
- **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.
- **Heat Tracing:** Heat trace and insulate all exposed water piping including pump piping below the overflow level, external header cleanout (PT2 only) and make-up water lines with electrical heater tape.



NOTE: For remote sump applications, the water level in the basin of the equipment is a function of the design flow rate, the quantity, size and location of the remote sump connection and the pipe design between the cooling tower and remote sump. Units installed on remote sump applications are supplied without a make-up connection.

EASY CONNECT® Piping Arrangement Freeze Protection

- Eliminate all water in the optional EASY CONNECT® Piping Arrangement (Series 3000) and in all internal piping when the tower is idle.
- It is essential to drain water from the EASY CONNECT® Piping Arrangement and internal piping whenever the potential for freezing temperatures exists. Drain the water by using 1/2" NPT drain port located on the inboard side of the EASY CONNECT® Piping Arrangement.



Figure 2. EASY CONNECT® Piping Arrangement

- There are three recommended methods for draining the piping:
 - **Preferred:** Install a normally open 1/2" solenoid valve on the 1/2" drain connection of the EASY CONNECT® Piping Arrangement. Wire the valve in the pump circuit so the valve closes when the pump is energized. Select the solenoid valve to operate with a minimum pressure differential of 0 psi, which is required to limit the static head imposed on the valve from the water column.
 - Install a 1/2" manual valve on the 1/2" drain connection of the EASY CONNECT® Piping Arrangement. Open the valve during the cold weather operation. Keep the valve closed during the warm weather to achieve full thermal performance.
 - Remove the 1/2" plug from the 1/2" drain connection of EASY CONNECT® Piping Arrangement during the cold weather operation. Reinstall the plug during the warm weather to obtain full thermal performance.

COMMON

Corrosion Protection



WATER TREATMENT

CORROSION AND SCALE CONTROL

CHEMICAL TREATMENT REQUIREMENTS

PASSIVATION

LONG TERM CARE OF STAINLESS STEEL

BIOLOGICAL CONTROL

SYSTEM CLEANING

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 competent 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.

BAC products are constructed of corrosion-resistant materials. The fill is made of a polyvinyl chloride (PVC), which requires no protection against rot, decay, rust or biological attack. Other 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:** Galvanized steel components protected with the thermosetting hybrid polymer can be scratched, scraped or blemished. To touch up these use a repair kit (BAC Part # 16-133P) 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” on **Page 21** for cleaning and care instructions.
- **Fiberglass Reinforced Polyester (FRP) Components:** Series 3000, dual air inlet FXV, and CXV-T products are provided with FRP casing panels as standard. Inspect the casing panels for accumulation of dirt and clean them with soap and water as necessary.
- **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).
- **Pultruded Fiberglass Reinforced Polyester (PFRP) Components:** Series 3000 Cooling Towers are optionally provided with PFRP hot water basins. Inspect the basin panels for accumulation of dirt and clean them with soap and water as necessary.

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 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 Protection

Water Treatment

Corrosion and Scale Control

- **Corrosion** – Red rust on steel components and white rust on galvanized surfaces may affect the longevity of system components.
- **Scale Formation** – Scale 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 severely impact thermal performance.
- **Biological Fouling** – Slime and algae formations may reduce heat transfer, promote corrosion, and harbor pathogens such as Legionella.

Corrosion and Scale Control

- To control corrosion and scale, maintain the water chemistry of the recirculating water within the parameters listed in **Table 6**. 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 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 6**. 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 6**.



NOTES:

1. Galvanized steel units require passivation in order to prevent white rust (refer to “Passivation” on **Page 20**).
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).

Property of Water	Recommended Level
pH	6.5 to 9.0 ^[1]
Hardness as CaCO ₃	30 to 750 ppm ^[2]
Alkalinity as CaCO ₃	500 ppm maximum ^[2]
Total Dissolved Solids (TDS)	1500 ppm maximum
Conductivity	2400 micromhos ^[3]
Chlorides	250 ppm maximum Cl (410 ppm maximum as NaCl)
Sulfates	250 ppm maximum
Silica	150 ppm maximum

Table 6. Quality Guidelines for Chemically Treated Circulating Water

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.).
- Chemical scale and corrosion inhibitors, particularly acid (if used), should be introduced into the circulating water through automatic feeders. 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 and shutdown section. Exceeding this limit 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.

- Passivation is the formation of a protective, passive, carbonate layer on galvanized steel surfaces.
- To provide maximum protection from corrosion on newly installed units take special measures to passivate galvanized steel surfaces.
- To ensure proper passivation of the galvanized steel, keep the pH of the circulating water between 7.0 to 8.2 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.

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. Galvanized steel also has a passivation layer, but it is of less rugged zinc-oxide. It is stainless steel's chromium-oxide 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.

Corrosion Protection

Chemical Treatment Requirements

Passivation

Long Term Care of Stainless Steel

BAC's Manufacturing Process

Recommended Cleaning Procedure

CAUTION: 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>.



- 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.
- 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. Contact your local BAC Representative for more information or to arrange a service call.

Biological Control

- The warm, oxygen and nutrient rich environment inside evaporative cooling equipment provides an ideal environment conducive to 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 system circulating pump. Diluted liquid biocides may be added directly to the cold water basin.
- If ozone water treatment is used, at no point should concentrations exceed 0.5 ppm.



Corrosion Protection

Long Term Care of Stainless Steel

Recommended Cleaning Procedure

Biological Control

Initial Start-up and Start-up Following a Shutdown Period:

- To minimize the risk of biological contamination during a shut-down period of three days or more, it is recommended that the entire system (evaporative cooling equipment, system piping, heat exchangers, etc.) be drained.
- To resume operation of a drained system and at initial start-up, clean all debris from the cold water basin and fill the system with fresh water. Then execute one of the following biocide treatment programs while operating the circulating pump and prior to operating the unit fans:
 - Resume treatment with the biocide that was used prior to shut-down. Operate the pump only 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. Start the fan only after this treatment period is completed.
 - 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. Start the fan only after this treatment period is completed.
- When it is not practical to drain the system during shut-down periods, install a by-pass line with shut-off valves to permit the recirculating water to circulate throughout the system, including the unit basin, while bypassing the fill section of the evaporative cooling equipment (fans should remain off).
- Treat the system as per one of the above-described methods prior to restarting the unit.

System Cleaning

System Cleaning for Models FXV, VF1, VFL, and HXV

With proper precautions, prior to start-up circulate an alkaline solution which can be used to clean condenser 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 100°F (37.8°C).
- 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 Models FXV, VF1, VFL, and HXV

The outside of the heat exchange coil may require occasional cleaning. The chemicals used must be compatible with the materials being treated. For example, the standard coil outside is galvanized steel. The inside of the coil is black carbon steel. For finned coils, the coil cleaning must be careful not to damage the fins (outside of the coils) and the coils themselves. For specific recommendations on coil cleaning, contact a qualified consultant.

Weld Byproduct Cleaning for Models CXVB, CXV-T, PC2, VCA, VCL and VC1

The installation and manufacturing processes commonly used for field assembly of steel-piped systems may leave weld byproducts inside coils and connecting piping (especially in refrigeration systems). It is common practice to install filters and/or strainers that remove contaminants during initial system operation. Shortly after system startup, the filters and/or strainers should be cleaned or replaced.

COMMON

Bleed Rate

BLEED RATE



Bleed Rate

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.



- 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 equals 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 6**, on **Page 19**.
- 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.
 - Alternatively, use a bleed line with a valve to continuously bleed from the system. In this arrangement, adjust the rate of bleed using the valve in the bleed line. Measure the rate of bleed by filling a container of known volume while noting the duration. Check the bleed rate and water quality periodically to ensure that adequate control of the water quality is being maintained.

NOTE: The solenoid valve and conductivity meter must be supplied by others.





Bleed Rate

Bleed Rate

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

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

Where: B = Bleed Rate (GPM)

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

Q = Process Fluid Flow Rate (GPM)

R = Range

n = Number of Cycles of Concentration = CR/CM

CR = Concentration in Recirculating Water

CM = Concentration in Make-up Water

The following example illustrates a bleed rate calculation:

Given:

- Closed Circuit Cooling Tower
- Process Fluid Flow Rate = 800 GPM
- 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,

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

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

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

Therefore, in this case we must bleed approximately 1.75 GPM to limit the concentration of impurities.

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.



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

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



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



COMMON

Basin Heater and Stand Alone Heater Control Panel

BASIN HEATER

STAND ALONE BAC HEATER CONTROL PANEL

Basin Heater



Basin Heater and Stand Alone Heater Control Panel

The cold water basin heater consists of one or more electric immersion heaters. It is designed to prevent the cold water basin from freezing during shutdown or standby. The heaters are sized for the specific application. The heating element has an enclosure that is suitable for outdoor use.

Operation

Ensure that the heating element is completely submerged before energizing the main disconnect. For installations that have a BAC Controls Enclosure, please contact your local BAC Representative. For installations that use a stand alone BAC heater control panel, see below.



Figure 3. Basin Heater

Basin Heater

Operation

Stand Alone BAC Heater Control Panel



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



NOTE: Basin heater information reprinted with permission from INDEECO, O&M #76-2000-83-5.

Stand Alone BAC Heater Control Panel

The heater control system consists of a heater control panel and a combination temperature/liquid level sensor. The stainless steel 1/4" NPT sensor has an on/off relay output that de-energizes the heaters whenever the basin liquid temperature is above 45°F (7.2°C), or whenever the sensor probe is not fully submerged. The control panel enclosure is suitable for outdoor use.

The control system utilizes a 24V combination temperature/low liquid level control sensor, which is powered by a transformer in the control panel. When the sensor provides a 24V signal back to the control panel, the panel sends a 24V control voltage to the magnetic contactors. When energized, the magnetic contactors supply line voltage to the heaters.



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

WARNING: Disconnect the heater control panel and tag the circuit out before performing the following steps.

WARNING: 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.

WARNING: 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.



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

- Disconnect the heater control panel and tag out 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, 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.

Operation when sensor probe is encased in ice:

- Disconnect the heater control panel and tag out 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, remove the jumper, check all connections, replace the cover and place the system back in service.

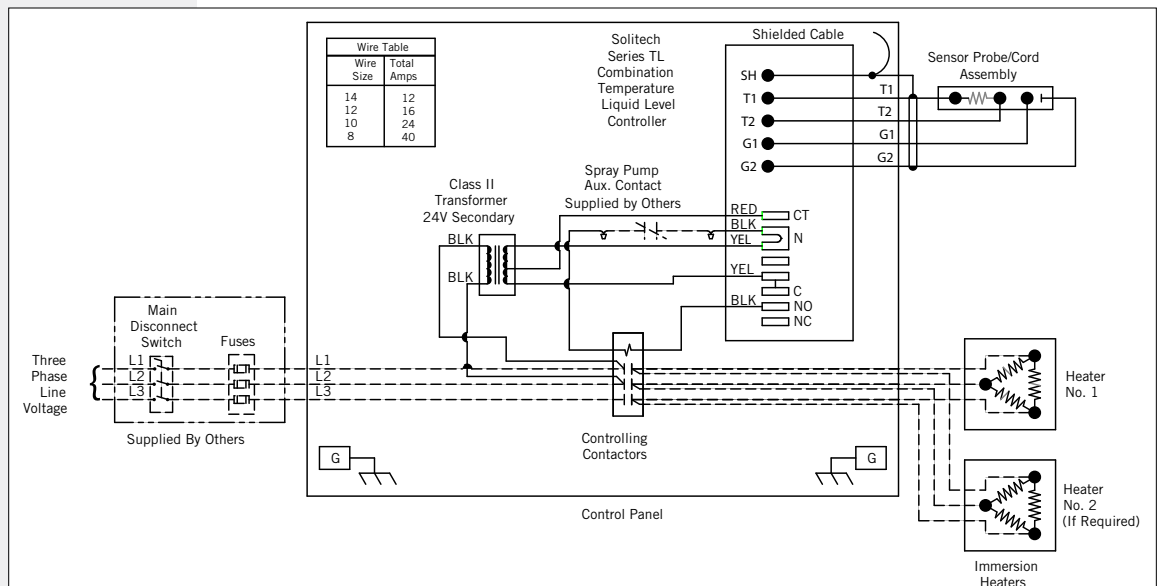


Figure 4. Wiring Diagram for Stand Alone BAC Heater Control Panel

COMMON

Electronic Vibration Cutout Switch



ELECTRONIC VIBRATION CUTOUT SWITCH

Electronic Vibration Cutout Switch

NOTE: Electronic vibration cutout section reprinted with permission from METRIX Instrument Company documentation for “Model 440 and 450 Electronic Vibration Switch”.



The BAC electronic switches utilize a solid state crystal accelerometer which provides an electrical output when it is deformed by the vibration forces. The output is electronically converted to a signal proportional to velocity. This signal is compared with a preset limit and triggers a solid state relay if the limit is exceeded.

An important feature of the vibration cutout switch is the built in time delay. This prevents triggering of the alarm or shutdown functions from transient increases in vibration levels. It also avoids shutdown due to transitory vibrations occurring during start-up. Three second alarm trip delay is standard, however time delays are independently adjustable in the field over a range of 2 to 15 seconds.



Figure 5. Electronic Vibration Cutout Switch

Operation

Testing

“Test” position on the shutdown dial sets a minimum set point so that any vibration will cause trip condition. The light will come on immediately, and the trip will occur after duration of the time delay, providing that the complete system is operational. If test position is maintained for less than the duration of the time delay, trip will not occur, thus permitting system test without shutdown.

Remote Reset

Connection between terminals 5 and 6 latches triac output in the alarm state after setpoint is exceeded. Operating the connection will reset the output to non-alarm state.

COMMON

Installation Instructions for Field Connections



INSTALLATION INSTRUCTIONS

Installation Instructions

NOTE: BAC recommends adding a flange connection for field installed equalizers, bypass and outlet connections. Please order the recommended supplies listed in **Table 7** prior to unit shutdown.



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



Figure 6. Scored TriArmor® Corrosion Protection System



Figure 7. Removal Material

Supplies Provided by BAC	Recommended Supplies Provided by Others
Template for the connection with bolt holes	Stainless steel threaded shoulder bolts
Type 304 stainless steel backing ring with gasket	150 lb flange – please 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 6**.
 - b. For connections 3" or greater, proceed to step 4 and 4b.
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 7**.
 - 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 8**.



Figure 8. Caulk Exposed Galvanized Steel

COMMON

Storage

PROLONGED OUTDOOR STORAGE



Prolonged Outdoor Storage

Should the unit(s) be stored outside prior to installation and/or start-up for approximately one month or longer, or stored in severe climates, it is imperative that certain actions be performed by the installing contractor in order to maintain the unit in “as shipped” condition. These actions include but are not limited to:

- Rotate the fan(s) once per month, at least 10 revolutions.
- Rotate the motor shaft once per month, at least 10 revolutions.
- Add desiccants to control panel interiors.
- Wrap motor in non-plastic protective material.
- Ensure hot water basins are covered.
- Keep drains open on the EASY CONNECT® Piping Arrangement and cold water basins.
- Remove and store fan belts and access door gaskets.
- Ensure unit(s) is stored on level ground.

For complete instructions, please contact your local BAC Representative.

Parts available for purchase
at www.CoolingTowerWorld.com



Recommended Spare Parts

BAC's Factory Authorized Parts are manufactured to meet rigorous cooling tower duty specifications and are guaranteed to fit your unit and perform as original equipment.

BAC is proud to introduce Cooling Tower World, the only place to purchase BAC Factory Authorized Parts online. All Cooling Tower Parts are shipped second day and carry a full 1-year warranty backed by BAC. To purchase parts online, visit www.CoolingTowerWorld.com today.

BAC Factory Authorized Parts can also be ordered through your local BAC Representative. In addition, most BAC Representatives maintain a local inventory of commonly used parts. For a free unit inspection, call your local BAC Representative today.

Even with this fast delivery capability, it is still recommended that certain essential, emergency repair parts be maintained in your local inventory to minimize any potential downtime.

Basic Recommended Spare Parts

- Bearing set
- Float valve or repair kit
- Float ball
- Solenoid valve (if unit is equipped with electric water level control)
- Powerband or set of belts
- Spray nozzle kit with grommets
- Basin heater and low water cut out
- Door gasket
- Strainer (inlet and suction)
- Fan and sheave bushings
- Pump seal and gasket kit for coil products
- Automatic bearing greaser refill kit

Parts to Consider if Extended Downtime is a Concern

- Spray pump for coil products
- Axial or centrifugal fan
- Fan shaft
- Sheave set
- Fan motor

COOLING TOWERS

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