BALTIMORE
AIRCOIL COMPANY

HFL Hybrid Closed Circuit Cooling Tower

OPERATING AND MAINTENANCE INSTRUCTIONS

Recommended maintenance and monitoring programme

Baltimore Aircoil Company equipment needs to be properly installed, operated and maintained. Documentation of the equipment used, including a drawing, technical data sheet and this manual should be kept on record. To achieve long, trouble-free and safe operation, it is necessary to establish an operating plan including a programme of regular inspection, monitoring and maintenance. All inspections, maintenance and monitoring actions should be recorded in a cooling system logbook. The operating and maintenance instructions published here can be used as a guide to achieve these goals.

In addition to establishing the operating plan and the cooling system logbook it is recommended to conduct a cooling system risk analysis, preferably by an independent third party.

For the cooling system, scale, corrosion and biological control must be established and initiated when the system is first filled with water and administered on a regular basis thereafter in accordance with recognized Codes of Practice, (such as EUROVENT 9 - 5/6, ACOP HSC L8, Guide des bonnes pratiques, Legionella et tours aéroréfrigérantes, etc.). Water sampling, test results and corrective actions should be recorded in the cooling system logbook.

For more specific recommendations on keeping your cooling system efficient and safe, contact your local BAC Balticare service provider or representative. Name, e-mail and phone number can be found on the website www.BACService.eu.

Checks and adjustments	Start-Up	Weekly	Monthly	Quarterly	Every 6 months	Annually	Shutdown
Cold water basin & strainer	X			X			
Operating level and make-up	X		X				
Blow down	X		X				
Sump heater package	X				X		
Belt tension	X		X				
Drive alignment	X					X	
Locking collar	X				X		
Rotation of fan(s) and pump(s)	X						
Motor voltage and current	X					X	
Unusual noise and/or vibration	X		X				

Inspections and monitoring	Start-Up	Weekly	Monthly	Quarterly	Every 6 months	Annually	Shutdown
General condition	X		X				
Heat transfer section	X				X		
Finned discharge coil (optional)	X					X	
Drift eliminators	X				X		
Water distribution	X				X		
Fan shaft	X			X			
Fan motor	X			X			
Spray water pump	X			X			
Electric water level control package	X				X		
TAB test (dip slides)	X	X					
Circulating water quality	X		X				

Inspections and monitoring	Start-Up	Weekly	Monthly	Quarterly	Every 6 months	Annually	Shutdown
System overview	X					X	
Record keeping	as per event						

Lubrication	Start-Up	Weekly	Monthly	Quarterly	Every 6 months	Annually	Shutdown
Fan shaft bearings	X				X		X
Motor bearings*	X				X		
Adjustable motor base	X				X		X

* only for motors with grease fittings with typical frame size > 200L (>30 KW)

Cleaning procedures	Start-Up	Weekly	Monthly	Quarterly	Every 6 months	Annually	Shutdown
Mechanical cleaning	X					X	X
Disinfection**	(X)					(X)	(X)
Drain basin and pump							X

** depends on applied code of practice

Notes

1. Water treatment and auxiliary equipment integrated in the cooling system may require additions to the table above. Contact suppliers for recommended actions and their required frequency.
2. Recommended service intervals are for typical installations. Different environmental conditions may dictate more frequent servicing.
3. When operating in ambient temperatures below freezing, the unit should be inspected more frequently (see Cold weather operations in the appropriate Operating and Maintenance Instructions).
4. For units with belt drive, tension on new belts must be readjusted after the first 24 hours of operation and monthly thereafter.

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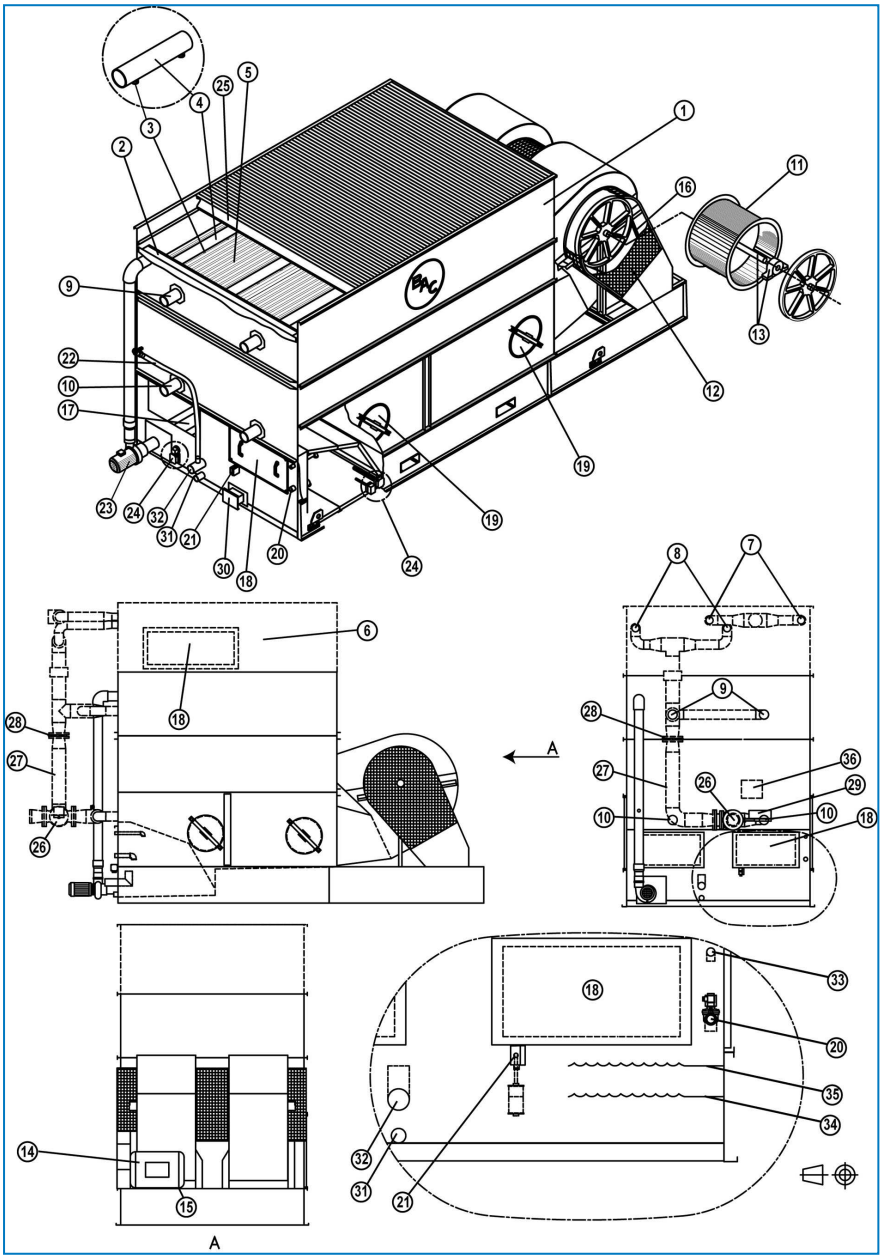
CONSTRUCTION DETAILS



1. Casing
2. Water distribution system
3. Spray nozzles
4. Spray branches
5. Evaporative heat transfer coil
6. Finned discharge coil
7. Finned discharge coil inlet connection
8. Finned discharge coil outlet connection
9. Evaporative heat transfer coil inlet connection
10. Evaporative heat transfer coil outlet connection
11. Forward curved centrifugal fan
12. Fan screen
13. Fan shaft & Bearings
14. Fan motor
15. Fan motor adjustment screw
16. V-belt drive system
17. Strainer
18. Access door (rectangular)
19. Access door (circular)
20. Make-up
21. Electrical water level control
22. Water bleed line
23. Spray water pump
24. Heater package (optional)
25. Drift eliminators
26. Three-way flow control valve (optional)
27. By-pass connection (optional)
28. Orifice plate (optional)
29. Three-way valve actuator (optional)
30. Clean out port (optional)
31. Drain
32. Overflow
33. Water treatment connection
34. Operating level
35. Overflow level
36. Terminal box (optional)

2 HFL GENERAL INFORMATION

Operating conditions

BAC cooling equipment is designed for the operating conditions specified below, which must not be exceeded during operation.

- **Wind Load**: For safe operation of unshielded equipment exposed to wind speeds above 120 km/h installed at a height above 30 m from the ground, contact your local BAC-Balticare representative.
- **Seismic Risk**: For safe operation of equipment installed in moderate and high hazard area's contact your local BAC-Balticare representative.

Standard electrical motors are suitable for an ambient temperature range from -25°C to +40°C.

- Design pressure: max. 10 bar
- Fluid inlet temperature: max. 82°C
- Fluid outlet temperature: min. 10°C

Fluids circulated through the inside of the coils must be compatible with the coil construction material, ie.

- black steel, for hot dip galvanized coils
- stainless steel AISI 304L or 316L (options)
- copper tubes when units are fitted with the optional finned discharge coil.

Maximum spray pressure: 14 kPa (If pump(s) are installed by others, it is recommended to install a pressure gauge at the inlet of the water distribution system.)

Stand-by pump arrangements for evaporative fluid coolers require alternating operation of each pump at least twice per week to avoid stagnant water conditions and bacteriological growth.

PURGE REQUIREMENTS

The installer of BAC closed circuit cooling towers must ensure a proper air purging of the system prior to operation. Entrained air can restrict the capacity of the cooler, resulting in higher process temperatures.
All connections (installed by others) must be leak free and tested accordingly.

CIRCULATING WATER QUALITY

The standard heat exchanger coils are made of black steel and are galvanized on the outside only. They are intended for application on closed, pressurized systems which are not open to the atmosphere in order to prevent internal corrosion of the coil and possible leaks.
The circulating water quality needs to remain within the following limits:

pH	7 - 10.5
Hardness (as CaCO3)	100 - 500 mg/l
Alkalinity (as CaCO3)	100 - 500 mg/l
Conductivity	< 3000 µS/cm
Chlorides	< 200 mg/l
Total suspended solids	< 10 mg/l
COD	< 50 ppm

Above values are general guidelines for pressurized closed systems closed systems with a leak rate lower than 15% of system volume per year. If the annual make-up of the closed system is greater than 15% yearly or if highly corrosive water such as water with very low hardness or alkalinity is used, it is recommended to consider alternative stainless steel material or implement a proper water treatment program to prevent steel corrosion.

Stainless steel coil are available to cool corrosive fluids or water and ethylene/propylene glycol solutions in systems open to the atmosphere. In case of stainless steel heat exchanger coils the circulating water quality needs to remain within the following limits:

	SST304L	SST316L
pH	6.5 - 10.5	6.5 - 10.5
Hardness (as CaCO3)	0 - 500 mg/l	0 - 500 mg/l
Alkalinity (as CaCO3)	0 - 500 mg/l	0 - 500 mg/l
Conductivity	< 3300 µS/cm	< 4000 µS/cm
Chlorides	< 250 mg/l	< 750 mg/l
Total suspended solids	< 10 mg/l	< 10 mg/l
COD	< 50 ppm	< 50 ppm

In all cases, regardless of the material of construction of the coil a competent water treatment company should be consulted for the specific water treatment to be applied, suitable for all the materials of construction used in the entire system.

OPERATING MODES

The hybrid closed Circuit Fluid Cooler operates under three different operating modes:

1. **Combined Dry-Wet Mode:** During this mode, the process fluid flows through the finned coil bundle (sensible heat transfer) and then through the wetted prime surface coil bundle (sensible and latent heat transfer). With lower heat loads and/or ambient temperatures, the evaporative cooling portion (and hence the water usage) is reduced by keeping the flow fed through the wetted prime surface coil bundle to a minimum. This is accomplished by a modulating flow control valve, which controls the design outlet temperature.
2. **Adiabatic Mode:** During this mode, the process fluid flows through the finned coil bundle and by-passes the wetted prime surface coil bundle completely. This entering ambient air is pre-humidified (cooled) by the spray water before flowing over the high density finned coil bundle.
3. **Dry Mode:** The full process fluid flows through the finned coil bundle and the prime surface coil bundle. Since the spray pump is turned off, only sensible heat transfer is used.

SEASONAL PERIODS

The optimal operation of the Hybrid Closed Circuit Cooling Tower is obtained by a combination of the above mentioned operating modes, depending on the thermal load of the process fluid and the ambient conditions. Typically two different seasonal periods are distinguished from each other:

1. Summer period: During this period all three operating modes are applied and as such the spray pump is activated during the dry/wet and the adiabatic operating mode. Therefore the cold water basin is filled with water at all time.
2. Winter period: during this period only the dry operating mode is applied and as such the cold water basin is drained.

The following table summarises the use of the different operating modes during the seasonal periods.

	Summer period			Winter period
	Dry mode	Adiabatic mode	Dry/Wet mode	Dry mode
Fan motors	Full / Half / Variable speed	Full speed	Full speed	Full / Half / Variable speed
Spray pump motor	Off	On	On	Off
Process fluid through finned foil bundle	100% Design flow	100% Design flow	100% Design flow	100% Design flow
Process fluid through bare coil bundle	100% Design flow (2)	0%	Variable flow (1)	100% Design flow (2)

Use of different operating modes during the seasonal periods

(1) Process fluid flow through bare coil bundle is controlled by the three way valve and is in function of the process fluid return temperature.
(2) The three way valve is locked and closes the bypass line completely.

When working dry during winter, the sump can be drained in which case power to the pump and heaters must be switched off. If the sump is not drained during freezing conditions, heat tracing must be foreseen for pump/piping.
Frequent on/off cycling of the spray pump should be limited to a minimum operating period of 5 hours.
Rapid on/off cycling of the fan motors can cause the fan motors to overheat. This should be limited to a maximum of six on/off cycles/h. If the limit is equipped with 2-speed fan motors, a 15 seconds delay should be observed when switching from high to low speed.

Connecting pipework

All piping external to BAC cooling equipment must be supported separately.
In case the equipment is installed on vibration rails or springs, the piping must contain compensators to eliminate vibrations carried through the external pipework.
The equipment outlet piping must be installed under the operating level of the equipment to prevent air suction and pump cavitation.
Suction pipe sizing should be done according to good practice, which may for larger flows require larger pipe diameters than the outlet connection. In such cases adapter pieces need to be installed.

Safety precautions

All electrical, mechanical and rotating machinery constitutes a potential hazard, particularly for those not familiar with its design, construction and operation. Accordingly, adequate safeguards (including use of protective enclosures where necessary) should be taken with this equipment both to safeguard the public (including minors) from injury and to prevent damage to the equipment, its associated system and the premises.
If there is doubt about safe and proper rigging, installation, operation or maintenance procedures, contact the equipment manufacturer or his representative for advice.
When working on operating equipment, be aware that some parts may have an elevated temperature. Any operations on elevated level have to be executed with extra care to prevent accidents.

CAUTION

Do not cover units with PVC eliminators with a plastic tarpaulin. Temperature increase due to sun radiation could deform the eliminators.

AUTHORIZED PERSONNEL

The operation, maintenance and repair of this equipment should be undertaken only by personnel authorized and qualified to do so. All such personnel should be thoroughly familiar with the equipment, the associated systems and controls and the procedures set forth in this and other relevant manuals. 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. Personnel must use personal protective equipment where necessary (gloves, ear plugs, etc...)

MECHANICAL SAFETY

Mechanical safety of the equipment is in accordance with the requirements of the EU machinery directive.
Depending upon site conditions it also may be necessary to install items such as bottom screens, ladders, safety cages, stairways, access platforms, handrails and toe boards for the safety and convenience of the authorized service and maintenance personnel.
At no time this equipment should be operated without all fan screens, access panels and access doors in place.
When the equipment is operated with a variable fan speed control device, steps must be taken to avoid operating at or near to the fan's «critical speed».
For more information consult your local BAC Balticare representative.

ELECTRICAL SAFETY

All electrical components associated with this equipment should be installed with a lockable disconnect switch located within sight of the equipment.
In the event of multiple components, these can be installed after a single disconnect switch but multiple switches or a combination thereof are also allowed.
No service work should be performed on or near electrical components unless adequate safety measures are taken. These include, but are not limited to the following:

- Isolate the component electrically
- Lock the isolation switch in order to prevent unintentional restart
- Measure that no electrical voltage is present anymore
- If parts of the installation remain energized, make sure to properly demarcate these in order to avoid confusion

Fan motor terminals and connections may have residual voltage after unit shut-down. Wait five minutes after disconnecting the voltage at all poles before opening the fan motor terminal box.

LOCATION

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

LOCAL REGULATIONS

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

Disposal requirements

Dismantling of the unit and treatment of refrigerants (if applicable), oil and other parts must be done with respect to the environment whilst protecting workers from potential risks related to exposure to harmful substances.
National and regional legislation for material disposal and protection of workers should be taken into account with regard to:

- Appropriate handling of construction and maintenance materials when dismantling the unit. In particular when dealing with materials that contain harmful substances, such as asbestos or carcinogenic substances.
- Appropriate disposal of the construction and maintenance materials and components such as steel, plastics, refrigerants and waste water according to local and national requirements for waste management, recycling and disposal.

Non-walking surfaces

Access to and maintenance of any component needs to be performed in accordance with all local applicable laws and regulations. If the proper and required access means are not present, temporary structures need to be foreseen. Under no circumstance can one use parts of the unit, that are not designed as an access mean, unless measures can be taken to mitigate any risks that might occur from doing so.

Modifications by others

Whenever modifications or changes are made by others to the BAC equipment without written permission of BAC, the party who has done the modification becomes responsible for all consequences of this change and BAC declines all liability for the product.

Warranty

BAC will guarantee all products to be free from manufactured defects in materials and workmanship for a period of 24 months from the date of shipment. In the event of any such defect, BAC will repair or provide a replacement. For more details, please refer to the Limitation of Warranties applicable to and in effect at the time of the sale/purchase of these products. You can find these terms and conditions on the reverse side of your order acknowledgement form and your invoice.

3 HFL WATER CARE

About water care

In all cooling equipment, operating in evaporative mode, the cooling is accomplished by evaporating a small portion of the re-circulating water as it flows through the equipment. When this water evaporates, the impurities originally present in the water remain. Unless a small amount of water is drained from the system, known as blow down, the concentration of dissolved solids will increase rapidly and lead to scale formation or corrosion or both. Also, since water is being lost from the system through evaporation and blow down, this water needs to be replenished.
The total amount of replenishment, known as make-up, is defined as:

Make-up = evaporation loss + blow down

In addition to the impurities present in the make-up water, any airborne impurities or biological matter are carried into the equipment and drawn into the re-circulating water. Over and above the necessity to blow down a small quantity of water, a water treatment programme specifically designed to address scale, corrosion and biological control should be initiated when the system is first installed and maintained on a continuous base thereafter. Moreover there must be an ongoing programme of monitoring in place to ensure the water treatment system is maintaining the water quality within the control guidelines.
Check and adjustments of blow down depends on the blow down device actual in use.
To prevent excessive build-up of impurities in the circulating water, a small amount of water must be « bled » from the system at a rate to be determined by the water treatment regime. The amount of blow down is determined by the design cycles of concentration for the system. These cycles of concentration depend on the quality of the make-up water and the design guidelines for the quality of the recirculating water given below.
Make-up water to the evaporative unit should have minimum 30 ppm hardness as $CaCO_3$.
Where use of a softener is necessary to achieve this, the supply to the evaporative unit should not be totally softened, but blended with the incoming unsoftened water to achieve the minimum hardness between 30 and 70 ppm as $CaCO_3$.
Maintaining a minimum hardness in the make-up water offsets the corrosive properties of totally softened water and reduces the reliance on corrosion inhibitors to protect the system.
To control corrosion and scale, the water chemistry of the circulated water has to be kept within the water quality guidelines of the specific materials of construction used, as listed in the following table(s).

	Baltibond®Hybrid Coating and SST304L
pH	6.5 to 9.2
pH during initial passivation	Below 8.2 (for units with HDG coil only)
Total hardness (as $CaCO_3$)	50 to 750 mg/l
Total alkalinity (as $CaCO_3$)	600 mg/l max.
Total dissolved solids	2050 mg/l max.
Conductivity	3300 µS/cm
Chlorides	300 mg/l max.
Sulfates*	350 mg/l max.*
Total suspended solids	25 mg/l max.
Chlorination (as free chlorine / halogen): continuous	1.5 mg/l max.
Chlorination (as free chlorine / halogen): batch dosing for cleaning & disinfection	5-15 mg/l max. for 6 hours max. 25 mg/l max. for 2 hours max. 50 mg/l max. for 1 hour max.

Circulated water quality guidelines for Baltibond® Hybrid Coating

***Note**: Higher concentration of sulfates is allowed, provided the sum of chlorides + sulfates parameters does not exceed 650 mg/l for Baltibond/SST304L.

	Baltiplus protection
pH	6.5 to 9.0
pH during initial passivation	Below 8.2
Total hardness (as $CaCO_3$)	50 to 600 mg/l
Total alkalinity (as $CaCO_3$)	500 mg/l max.
Total dissolved solids	1500 mg/l max.
Conductivity	2400 µS/cm
Chlorides	250 mg/l max.
Sulfates*	250 mg/l max.*
Total suspended solids	25 mg/l max.
Chlorination (as free chlorine / halogen): continuous	1 mg/l max.
Chlorination (as free chlorine / halogan): batch dosing for cleaning & disinfection	5-15 mg/l max. for 6 hours max. 25 mg/l max. for 2 hours max. 50 mg/l max. for 1 hour max.

Circulated water quality guidelines for Baltiplus protection

***Note:** Higher concentration of sulfates is allowed provided the sum of chlorides + sulfates parameters does not exceed 500 mg/l for Baltiplus protection.

	SST304L SST316L with HDG coil	SST316L (with SST316L coil)
pH	6.5 to 9.2	6.5 to 9.5
pH during initial passivation	Below 8.2 (for units with HDG coil only)	Not applicable
Total hardness (as $CaCO_3$)	50 to 750 mg/l	50 to 750 mg/l
Total alkalinity (as $CaCO_3$)	600 mg/l max.	600 mg/l max.
Total dissolved solids	2050 mg/l max.	2500 mg/l max.
Conductivity	3300 µS/cm	4000 µS/cm
Chlorides	300 mg/l max.	750 mg/l max.
Sulfates*	350 mg/l max.*	750 mg/l max.*
Total suspended solids	25 mg/l max.	25 mg/l max.
Chlorination (as free chlorine/halogen): continuous	1,5 mg/l max.	2 mg/l max.
Chlorination (as free chlorine/halogen): batch dosing for cleaning & disinfection	5-15 mg/l max. for 6 hours max. 25 mg/l max. for 2 hours max. 50 mg/l max. for 1 hour max.	5-15 mg/l max. for 6 hours max. 25 mg/l max. for 2 hours max. 50 mg/l max. for 1 hour max.

Circulated water quality guidelines for Stainless Steel

***Note:** Higher concentration of sulphates is allowed provided the sum of chlorides + sulphates parameters does not exceed 650 mg/l for SST304L and 1500 mg/l for SST316L.

For Ozone water treatment application:

- Stainless steel 316L execution is required.
- Ozone levels are to be maintained to 0.2 ppm ± 0.1 ppm for at least 90% of the time, with absolute maximum peaks of 0.5 ppm

Cycles of concentration are the ratio of the dissolved solids concentration in the circulating water compared to the dissolved solids concentration in the make-up water. The blow down rate can be calculated as follows:

Blow down = Evaporation loss / (Cycles of concentration – 1)

The evaporation loss is not only function of the heat load but also depends on climatic conditions, the type of equipment used and the method of capacity control, which is applied. The evaporation loss at summer conditions is approximately 0.431 l/ 1000 kJ heat rejection. This number should be used for blow down valve sizing only and not for the calculation of annual water consumption.

Biological control

The growth of algae, slimes and other micro-organisms, if uncontrolled, will reduce system efficiency and may contribute to the growth of potentially harmful micro-organisms, such as Legionella, in the recirculating water system.
Accordingly a treatment programme specifically designed to address biological control should be initiated when the system is first filled with water and administered on a regular base thereafter in accordance with any regulations (national, regional) that may exist or in accordance with accepted codes of good practice, such as EUROVENT 9-5/6, VDMA Detailsheet 24649 etc.
Also during shutdown periods it is recommended to continue the water treatment programme. Alternatively, the basin and pump should be drained.
It is strongly recommended to monitor the bacteriological contamination of the recirculating water on a regular base (for example, TAB test with dip slides on a weekly base) and record all results.
Certain products used for water treatment, particular some dispersant and bio-dispersant additives, might change the properties of the water (such as the surface tension), which can cause excessive drift loss (water passing through the eliminators). In such case we recommend to review the water treatment (product type, dosage) with your water treatment expert.
In case of doubt, a short test can be performed, after cleaning & disinfection, using fresh water without addition of the concerned chemical (within the limits of the local legislation).

Chemical treatment

1. Water treatment chemicals or non-chemical systems need to be compatible with the materials of construction used in the cooling system including the evaporative cooling equipment itself.
2. In case of chemical water treatment, chemicals should be added to the recirculating water by an automatic feed system. This will prevent localised high concentrations of chemicals, which may cause corrosion. Preferably the water treatment chemicals should be fed into the cooling system at the discharge of the recirculation pump. The chemicals should not be fed in concentrated form, nor batch fed directly into the cold water sump of the evaporative cooling equipment.
3. BAC specifically discourages acid dosing as mean of scale control (unless under certain strict circumstances for open circuit cooling towers with very large system volume and remote sump, or constructed from stainless steel).
4. A competent water treatment company should be consulted for the specific water treatment programme to be applied. Next to the supply of dosing and control equipment and chemicals, the programme should include regular monthly monitoring of the circulating and make up water quality.
5. If it is proposed to operate a treatment programme outside the BAC Water Quality Control Guidelines, the BAC factory warranty may be invalidated if the water quality is persistently outside the Control Guidelines, unless specific prior written BAC approval. (Some parameters may be exceeded under certain strict circumstances.)

It is strongly recommended to check the key parameters of the circulating water quality on a monthly base. See table: "Circulated water quality guidelines". All test results need to be recorded.

Passivation

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 that galvanized steel surfaces are passivated, the pH of circulating water should be kept between 7.0 and 8.2 and calcium hardness between 100 and 300 ppm (as $CaCO_3$) for four to eight weeks after start-up, or until new zinc surfaces turn dull grey in colour. If white deposits form on galvanized steel surfaces after the pH is returned to normal service levels, it may be necessary to repeat the passivation process.

Full stainless steel units and units protected by the Baltibond® hybrid coating do not require passivation. An exception to this are units with a galvanized steel coil bundle which do still require the proper passivation procedure as described here in this section.

In case you can't keep the pH 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.

Overflow connection

A slight loss of water through the overflow on forced draft units is normal when the fans are in operation, since the unit is in overpressure and some saturated air will be blown out to the unit, carrying several droplets of water.

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COLD WEATHER OPERATIONS

About cold weather operation

BAC cooling equipment can be operated in sub freezing ambient conditions provided the proper measures are taken. Listed below are general guidelines which should be followed to minimize the possibility of coil freeze-up. As these guidelines may not include all aspects of the anticipated operation scheme, system designer and operator must thoroughly review the system, location of the equipment, controls and accessories to ensure reliable operation at all times.

Protection against sump water freezing

Units exposed to below freezing ambient temperatures, require protection to prevent freezing of the water in the wet sump. During dry operation all water will drain into the wet sump, that is shielded from the air stream. Heaters in the wet sump are sufficiently sized to prevent freezing at temperatures as low as -18°C at full speed of the fan system.

CAUTION

Switch off heaters when the sump is drained.

Capacity control

In addition to protecting the sump water, all exposed water piping, in particular make-up water lines should be heat traced and insulated.
Spray pumps also need to be heat traced and insulated from pump suction to the overflow level, if they can be exposed to sub-freezing ambient conditions.
It is necessary to prevent the recirculating water from approaching freezing conditions when the system is operating under load. The most « critical » situation occurs, if operation at subfreezing conditions coincides with light load conditions. The key to protecting the recirculating water is capacity control by adjustment of air flow to maintain the temperature of the recirculating water minimal above freezing point. As a rule of thumb this minimum temperature is 5°C, but there are applications, where even lower temperatures can be accepted. (Contact your local BAC Balticare representative for advice.)
The desired method to match the cooling capacity to load and weather conditions is to adjust the air flow by the use of modulating controls (variable speed drives).
Alternatively, multi speed fan motors or fan cycling can be applied, but fans operating on a common heat exchange section should always be operated simultaneously.
It is not recommended to cycle the spray pump as a means of controlling the unit capacity.

Whenever two speed motors are used for capacity control, a time delay of at least 15 seconds is required when switching form high to low speed. Sudden switch over might damage the drive system or the motor.

When operating with VFD drives above nominal frequency be aware of the potential risk for motor overload or mechanical damages.

It is recommended to provide sinus filters on the VFD to prevent bearing damage on fan motors.

CAUTION

Refer to fan motor nameplate data when programming a VFD.

Spray pumps should be switched off when the fan(s) are idle. Operation with pump but without fan(s) does not provide cooling capacity of any significance but could lead to occasional water splash out at the air intake. For this reason this operation mode should be avoided. Spray pump should be switched off with a time delay of **maximum** 30 seconds after switching off the fan(s) and should be activated **maximum** 30 seconds prior to the anticipated start of the fan(s).
The purpose of a low level cut out switch for pump protection is to protect the pump from running dry in case of make-up failure or extreme water loss. The status of the alarm can be checked prior to pump start-up, but should not be considered during the first minute after start-up, since activation of the pump can cause a water level drop, that might trigger the alarm. Normal make-up will stabilize the water level after a short period of time.
In case the low level alarm signals, that there is no longer enough water in the cold water sump to guarantee a proper operation, the pump should be stopped (after a time delay of 60 seconds) and only manually restarted after it has been verified that the water in the sump is at or near the overflow level.

In case the low level pump alarm is used to stop the pump, appropriate control logic should be incorporated to prevent hunting of the pump motor. Once the spray pump is stopped, the water in suspension will drain back to the tank and raise the water-level above the alarm level, which will reset the alarm immediately. A manual reset of the alarm after solving the root cause of the low level alarm is recommended. Frequent start/stop or hunting will damage the motor.

Protection against coil freezing

The best protection is the use of glycol or other anti freeze solutions in appropriate concentrations. The use of such solutions influences the thermal performance of the closed circuit cooling tower and this should be taken into account, when selecting the model(s). The table below indicates the freeze protection range for various ethylene glycol concentrations (% by volume).

% Ethylene	Freeze protection
20%	-10°C
30%	-16°C
40%	-25°C
50%	-39°C

Freeze protection of ethylene glycol solutions

Glycol systems require specific inhibitors compatible with the materials of construction they come into contact with. These inhibitors generally come pre-mixed with the glycol additive for the cooling circuit.

If the system must be operated with water, the following conditions must be met simultaneously:

1. Maintain a minimum flow through the unit at all times. (see table below)
2. Maintain a minimum heat load, so that the temperature of the water leaving the coil(s) will not fall below 10°C based on -14°C ambient temperature and 20 m/s wind velocity.
3. In order to prevent coil freezing, the 3-way valve must be positioned to let the full flow circulating through the prime surface coil.

If the process load is extremely light or shut off, it may be necessary to apply an auxiliary heat load during freezing conditions. Consult your local BAC Balticare representative for advice, if these conditions cannot be met.
Draining of the coil(s) is not recommended as a normal method of freeze protection unless the coil(s) are constructed from stainless steel or are of the cleanable type. For standard hot dip galvanized coils draining is ONLY acceptable as an emergency method of freeze protection, since draining will lead to internal corrosion of the coil. For this purpose an automatic drain valve and air vent needs to be installed to drain the coil(s) if flow stops or the fluid temperature drops below 10°C when the ambient temperature is below freezing.

Ensure that all coils and/or coil sections (split coils/multi-circuiting) can drain individually.

Model	Minimum flow (l/s)
HFL 36X - 48X	4,1
HFL 72X – 96X	7,9
HFL 108X – 144X	12
HFL 150X – 192X	15,8
HFL 180X – 240X	19,9
HFL 216X – 288X	24

Minimum requirements for water flow

Draining of the coil is not recommended as a normal method of freeze protection. Frequent draining promotes oxidation inside the coil tubes. Full draining of the heat exchanger coil is not guaranteed because of rising coil circuiting on the finned discharge coil (optional) and the risk for coil freeze-up remains. The local BAC Balticare representative should be consulted for guidelines on the installation of an emergency coil drain system.

5 HFL
MAINTENANCE PROCEDURE

Checks and adjustments

COLD WATER BASIN AND BASIN STRAINERS

The cold water basin should be inspected regularly. Any debris which may have accumulated in the basin or on the strainers should be removed.
Quarterly, or more often if necessary, the entire cold water basin should be drained, cleaned and flushed with fresh water to remove the silt and sediment which normally collects in the basin during operation.
When flushing the basin, the strainers should be left in place to prevent the sediment from re-entering the unit system. After the basin has been flushed, the strainers should be removed, cleaned, and replaced before refilling the basin with fresh water.

CAUTION
Do not use acid to clean the strainers.

OPERATING LEVEL

The electric water level control package maintains a constant water level in the cold water sump independent of cooling load changes and water supply pressure variations. Ensure every six months that all components (valve, float switches) are operational and clean.

CAUTION
Supply pressure for mechanical make-up valves should be between 1 and 10 bar.

Operating height is the water level above sump bottom during operation.

SUMP HEATER PACKAGE

Sump heaters must only operate in the winter to prevent the water in the wet sump from freezing, when the circulating water pump(s) are shut off.
Under no circumstances should sump heaters operate at other times as they could potentially heat the water to temperature levels, which are favourable to bacteriological growth. Ensure every six months the heater thermostat is properly set and clean. Also ensure that control and safety devices, such as low level cut out switches, are operational, clean and properly incorporated into the control circuit.

CAUTION

Sump heaters can be hot.

BELT TENSIONING

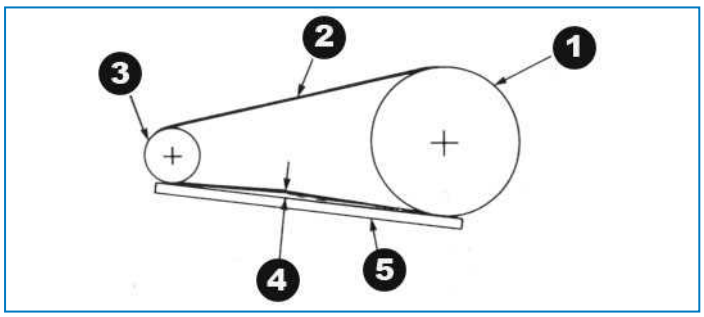
Belt tensioning can be adjusted by changing the position of the fan motor(s) by rotating the motor base adjustment screw, which extends through the bottom frame angle.

Check belt tension as follows:

1. Shut off fan(s).
2. Rotate the fan sheave half a turn to evenly distribute the tension in the belt before measuring.
3. Check belt tension by verifying both following conditions.
   - The deflection amounts 10 mm / m free belt length (see figure below).
   - The deflection force required is between the minimum and maximum values given in the table below.

CAUTION

Fan has to be blocked while replacing belts.



Fan belt check and adjustment

1. Fan sheave
2. Belt
3. Motor sheave
4. 10 mm/m deflection = proper belt tension
5. Straight edge

CAUTION

Over-tensioning of belts can lead to component damage.

Belt profile	Diameter (mm) motor sheave	Deflection force (kg)	
		Min.	Max.
XPA	80 through 125 135 through 200 >200	1.5 2.0 2.5	2.5 3.0 3.5
SPA	100 through 125 132 through 212 >212	1.5 2.0 2.0	2.0 2.5 3.0

Belt tension forces

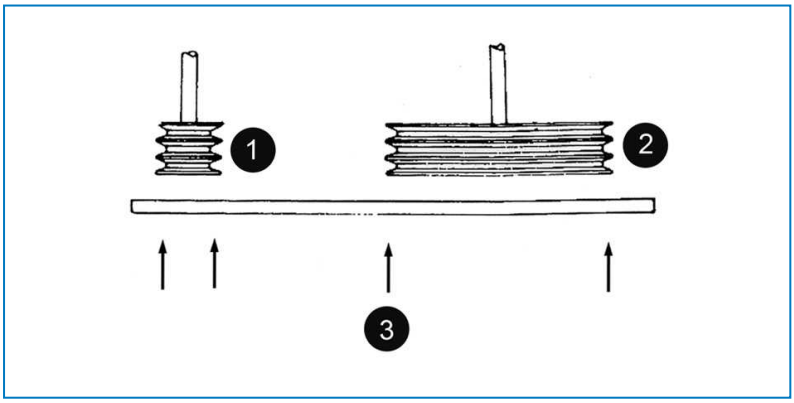
New belts have to be re-tensioned after 24 hours operation.
If belt tensioning is required, please proceed as follows:

1. Loosen the lock nuts on the motor base adjusting screws.
2. Turn the motor base adjusting screws clockwise to tension the belt, or counter-clockwise to relieve belt tension. During adjustment of belt tension the drives should be rotated several times by hand to evenly distribute the tension throughout the belt.
3. When the belt is properly tensioned, re-tighten the locking nuts on the motor base adjusting screws.

There should be no "chirp" or "squeal" when the fan motor is started.

DRIVE ALIGNMENT

Proper drive alignment ensures maximum belt life. Alignment is checked for standard drives **after correct belt tensioning** by placing a straight-edge across both sheaves as shown in the Figure below.
When the drives are properly aligned the gap measured between straight-edge and sheave does not exceed 0,5 mm per 100 mm of fan sheave diameter.



Checking sheave alignment

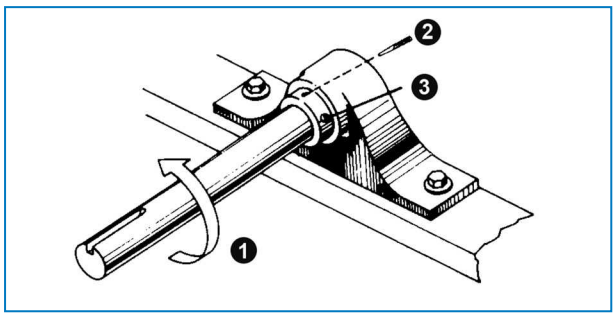
1. Motor sheave
2. Fan sheave
3. Points of contact

LOCKING COLLAR

The excentric locking collar of the bearing at the drive end ensures that the inner bearing race is secured to the fan shaft. Locking collars can be set using the following procedure. (See figure below)

1. Stop fan(s) and remove side access panel(s).

2. Loosen the set screw.
3. Using a drift pin centre-punch, tap the collar (in the hole provided) tangentially in the direction of rotation while holding the shaft.
4. Re-tighten the screw.
5. Close unit access door and start pump(s) and fan(s).



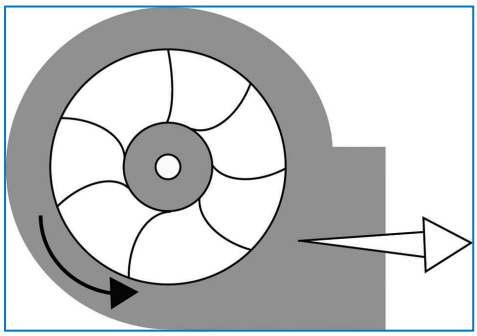
Locking collar assembly

1. Direction of rotation
2. Drift pin: Tap the locking collar in direction of fan rotation until cam is locked.
3. Tighten set screw.

ROTATION OF FAN(S) AND PUMP(S)

Fans must rotate without obstruction and both fans and pumps must rotate in the correct direction, which is indicated by arrows on the equipment. Check proper functioning as follows:

1. Stop fan(s) and pump(s).
2. Turn the fan by hand to ensure rotation without obstruction. Remove obstruction, if present.
3. Start the pump(s) and check for the proper rotation as indicated by the arrow on the pump cover. If rotation is wrong, stop pump and correct electrical wiring.
4. Start the fan(s) and check for proper rotation as indicated by the arrow on the fan housing. If rotation is wrong stop fan(s) and contact BAC.



Forward curved centrifugal fan

MOTOR VOLTAGE AND CURRENT

Check the voltage and the current of all three legs of the fan and pump motors. The current should not exceed the nameplate rating. After prolonged shut-down (or motor is stored with unit in kit form) the motor insulation should be checked with a Megger insulation tester prior to restarting.

1. Insulation resistance test – minimum value should be 1 Mega Ohm (1.000.000 Ohms).
2. Thermistors, if fitted, should be checked for continuity with a multi-meter but never Megger-tested.
3. Ensure supply voltage and frequency correspond to the motor nameplate rating.
4. Ensure shaft turns freely.
5. Wire the motor in accordance with the wiring diagram as shown on the motor nameplate and/or in the motor terminal box.
6. Turn on unit and check amp draw does not exceed nameplate rating.

If motor is stored, it should be in a clean, dry place & have the shaft rotated occasionally. Storage areas should not be subject to vibration.

CAUTION

Rapid on-off cycling can cause the fan motor to overheat.

It is recommended that controls be set to allow a maximum of 6 on/off cycles per hour.

UNUSUAL NOISE AND VIBRATIONS

Unusual noise and/or vibration are the result of malfunctioning of mechanical components or operational problems (e.g. unwanted ice formation). If this occurs, a thorough inspection of the entire unit followed by immediate corrective action is needed. If required, consult your local BAC Balticare representative for assistance.

Inspections and corrective actions

GENERAL CONDITION OF THE EQUIPMENT

The inspection should focus on following areas:

- damage of corrosion protection
- signs of scale formation or corrosion
- accumulation of dirt and debris
- presence of biofilms

Smaller damages of the corrosion protection MUST be repaired as soon as possible to prevent the damage from getting bigger. For Baltibond® hybrid coating use kit (part number RK1057). Larger damages should be reported to the local BAC Balticare representative.

If there is evidence of scale formation (more than 0,1 mm) or corrosion, water treatment regime must be checked and adjusted by the supplier.

Any dirt and debris need to be removed following the "Cleaning procedures" on page 29 .

If there is evidence of biofilms the system, including piping should be drained, flushed and cleaned of slimes and other organic contamination. Refill system with water and apply biocide shock treatment. Check pH value and functionality of ongoing biocide treatment.

HEAT TRANSFER SECTION

The inspection procedure is as follows:

1. Shut off fan(s) and pump(s).

2. Remove the eliminators and access doors.
3. Inspect the coil for
   - obstructions
   - damages
   - corrosion
   - fouling
4. After inspection, install eliminators and access doors and start pump(s) and fan(s).

Remove any obstructions from heat transfer section(s).
Any damages or corroded areas need to be repaired. Call your local BAC Balticare representative for assistance.
Minor fouling can usually be removed chemically or by temporary changes to the water treatment programme. Contact your water treatment supplier for advice. Major fouling requires cleaning and flushing according to the "Cleaning procedures" on page 29 .
Regular checking of the total aerobic bacteria count (TAB) and maintaining it within acceptable levels are the key to prevent fouling.

FINNED DISCHARGE COIL (OPTIONAL)

The dry finned coil is susceptible to corrosion and entrapment of airborne particulates (coil fouling).
The dry finned coil requires periodic cleaning to maintain the highest operating efficiency possible under the environmental conditions in which the unit operates. Regularly scheduled coil cleaning makes a significant contribution to extending equipment lifetime and is an excellent source of energy conservation.
Periodic cleaning of the heat exchanger coil can be accomplished by a vacuum cleaner and/or pressurised air stream. In polluted environments cleaning will require commercially available coil cleaning agents. Cleaning coils by spraying them with water may remove large deposits but do little to remove pollutants. Removing dirt and salts requires a detergent to break the bond between the soil and the surface of the heat exchanger. However, if water spray is applied, the water pressure must never exceed 2 bar and the water jet must never be applied at an angle to the surface of the fin, but only in parallel to it.
Selecting a coil cleaner is important since the cleaner must neutralise and remove deposits on the surface of the coil. BAC does not recommend the use of alkaline and acidic coil cleaners. These coil cleaners can cause foaming action (oxides or hydroxides of aluminium) resulting in the stripping away of minute layers of the base alloy and the attached soil. Most of these foaming cleaners are harsh and known as reactive cleaning products. One way to recognise this type of cleaner is that normally it will be labelled as corrosive. The base ingredient of a coil cleaner should not be so harsh that it attacks the metal, coil coating or the personnel applying the cleaner.
An important concern when applying coil cleaners is rinse-ability. Most hydroxides tend to cling the surface unless sufficient wetting agents have been added to the formula to reduce surface tension of the solution. If the solution does not have enough wetting agents and is not rinsed thoroughly from the surface, the residual material can settle at the fin/tube interface and continue to attack the fin.
BAC recommends the use of the more sophisticated cleaners, known as a "surfactant system". They reduce surface tension, penetrate, emulsify, and dissolve the soils without the base alloy. Surfactant systems are safe for the coil alloy, they are free rinsing, they lift and remove deposits better than alkaline cleaners, and they are environmentally safe, as well as safe and easy to apply and rinse. Surfactant systems are almost always non-corrosive.

DRIFT ELIMINATORS

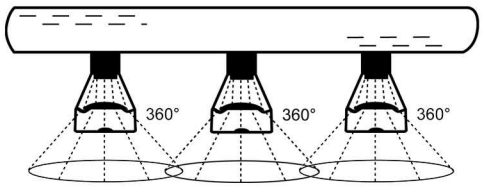
The inspection procedure is as follows:
1. With fan(s) and pump(s) running visually check for areas with excessive drift loss.
2. Shut off fan(s) and pump(s) and visually check eliminators for
   - obstructions
   - damages
   - cleanliness
   - proper fit
3. If any of the above problems have been observed, stop fan(s) and pump(s) and remove eliminators.

4. Clean eliminators from debris and foreign matter. Remove dirt and obstructions. Replace damaged or ineffective eliminators.
5. Install eliminators and ensure they fit tightly with no gaps.

CAUTION
Do not step on eliminators.

WATER DISTRIBUTION

The inspection procedure is as follows:
1. Shut off the fan(s), but leave the pump(s) running.
2. Check and adjust spray pressure, if required. (not applicable for coil models with standard pumps)
3. Remove the eliminators.
4. Check to see if the nozzles are producing the spray pattern shown in figure(s) below
5. Shut off pump(s) and clean water distribution from dirt and debris. Ensure spray branches and nozzles are in place and clean. Replace damaged or missing nozzles.
6. Install eliminators and ensure they fit tightly with no gaps.
7. Start fan(s) and pump(s).



Nozzle spray distribution type

FAN SHAFT

The exposed areas of the fan shaft are coated with a soft seal for added corrosion protection. It is recommended that the coating be inspected for continuity quarterly or at least every 6 months. Any signs of surface corrosion must be treated. This involves:
1. Removal of the protective coating with a suitable cleaning medium.
2. The removal of any surface corrosion with emery cloth.
3. The re-coating of the shaft with soft seal.

FAN MOTOR

During operation it is required to clean the outside surface of the motor at least every 6 months (or more often depending on site conditions) to ensure proper motor cooling. Do not wash down the motor unless it is IP 66 rated. On a quarterly or six monthly basis check:
- Electric connections
- Motor protection devices
- Check amp draw
- Motor bearings for noise/overheating
- Motor holding bolts
- External surface of motor for corrosion

SPRAY WATER PUMP

The BAC pump contains a mechanical seal between pump housing and pump motor. This seal needs to be checked quarterly for proper operation and replaced if necessary.

ELECTRIC WATER LEVEL CONTROL PACKAGE

During commissioning the tower should be filled manually till overflow level (push float ball under) to prevent air suction of the pump during first start-up.

CAUTION

When disassembling the float switch for cleaning, make sure to reassemble it in *exactly* the same position, otherwise it will not function correctly.

Lubrication

FAN SHAFT BEARINGS

The fan shaft is supported by ball bearings (see figure below).
Under normal operating conditions the bearings should be greased every 2000 operating hours or at least every six months. The bearings should be lubricated with one of the following water resistant inhibited greases (or an equivalent), which are good for ambient temperature ranging from -20°C to 120°C or an equivalent.

Ball bearing

1. Lube fitting
2. Locking collar

The bearings should be lubricated only with a hand grease gun. Do not use high-pressure grease guns, since they may rupture the bearing seals. When lubricating, purge the old grease from the bearing by gradually adding grease until a bead of new grease appears at the seal. In particular when extended lubrication lines are fitted ensure that ALL old grease is removed and that new grease is leaving the seal.

For grease products see table below.

MOTOR BEARINGS

Motors with frame size >200L (>30kW) have grease fittings

- grease intervals: twice a year unless otherwise shown on the nameplate of the motor
- grease products: see below

The bearings should be lubricated only with a hand grease gun. Do not use high pressure grease guns, since they may rupture the bearing seals. When lubricating, purge the old grease from the bearing by gradually adding grease until a bead of new grease appears at the seal.

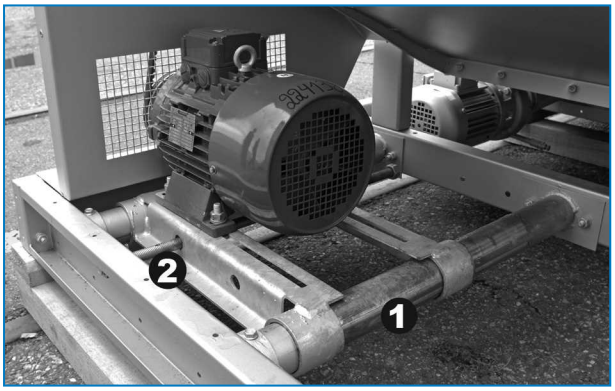
GREASE PRODUCTS

Shell	Alvania grease RL3	-20°C to +120°C
Texaco	Multifak Premium 3	-30°C to +140°C
Klüber	Isoflex LDS Special A	-50°C to +120°C
Mobil	Mobilith SHC 100	-40°C to +175°C
Total Fina Elf	Multis 3	-20°C to +120°C

Grease products

ADJUSTABLE MOTOR BASE

The motor base adjusting screw (see figure below) should be coated every six months using a good quality corrosion inhibiting grease, such as one of those recommended for lubricating the fan shaft bearings.



Adjustable motor base

1. Motor base slides
2. Adjusting screw

Cleaning procedures

MECHANICAL CLEANING

Keeping your evaporative cooling equipment (and the associated system) clean will maintain its efficiency and help to prevent uncontrolled bacteriological growth. The recommended cleaning procedures are described below:

1. Disconnect fan and pump motor(s) and shut off make-up supply.
2. Remove screens, eliminators, access panels, doors and drain system. Do not remove sump strainer.
3. Clean debris from exterior and fan(s) with soft brush, if necessary use water and soap.
4. Clean interior with (soap) water and soft brush, if necessary use high pressure water jet.
5. Remove any debris from water distribution system and clean any nozzles if clogged. If necessary nozzle and grommet may be removed for cleaning.
6. Remove debris from heat transfer section (coil).

7. Flush with clean water and drain to remove accumulated dirt.
8. Remove, clean and replace sump strainer(s).
9. Clean debris from screens and eliminators with water jet and install.
10. Remove debris from access doors and panels with soft brush and (soap) water and install.
11. Close drain and open make-up supply. Fill system up to overflow level with clean water.

DISINFECTION

Disinfection of your cooling system may be needed in case of high concentration of aerobic bacteria and/or Legionella. Disinfection is also recommended for evaporative cooling systems with known or suspected high bacteriological levels, prior to a cleaning procedure.
Some local or national guidance also recommends disinfection prior to initial start up, after a prolonged shut down, after routine cleaning operations or when significant alterations have been made to the cooling system.
Disinfection must be carried out in accordance with a proper procedure and take into account the safety of the cleaning and disinfection staff.
Typically disinfection is achieved using a sodium hyper chloride solution to maintain a residual value of 5 - 15 mg/l of free chlorine and circulate this around the system for up to 6 hours. Higher chlorine levels for a shorter period are possible, but require a higher level of corrosion protection than galvanized steel only. Consult your BAC Balticare representative for further information.
Excessive levels of chlorine must be avoided as this quickly can lead to corrosion and damage to your system.
Chlorinated water should be de-chlorinated before draining and after disinfection the system must be thoroughly flushed through with clean water.

A proper regularly monitored biocide programme reduces the need for cleaning and disinfection actions significantly.

6 HFL
COMPREHENSIVE MAINTENANCE

About comprehensive maintenance

In order to ensure maximum efficiency and minimum downtime of your evaporative cooling system, it is recommended to establish and execute a programme of preventive maintenance.
Your local BAC Balticare representative will assist you in establishing and implementing such programme. The preventive maintenance programme must not only avoid that excessive downtime occurs under unforeseen and unwanted conditions, it also ensures that factory authorized replacement parts are used, which are designed to fit and for their purpose carry the full factory warranty. To order factory authorized parts, contact your local BAC Balticare representative. Make sure you include the unit serial number when ordering any parts.
To facilitate servicing of the equipment, it is suggested that the following parts be carried on hand:

- Water make-up valve
- Fan shaft bearings
- Spray nozzles and grommets
- Spray distribution branch grommets
- Set of belts
- Baltiplus/Baltibond® repair (touch-up) kits

Insist on factory authorised parts to avoid loss of efficiency or an operational risk, which may occur when non authorised parts are used.

Prolonged outdoor stay

Should the unit(s) be stored outside prior to installation and/or start-up for approximately one month (shelf life) 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 of all motors installed on the unit(s) once per month, at least 10 revolutions. This includes the pump motor.
- Add desiccants to control panel interiors.
- Wrap motor in non-plastic protective material.
- Keep drains open on the cold water basins.
- Ensure unit(s) is stored on level ground surface.
- Remove and store fan belts and access door gaskets.
- Hot dip galvanized and stainless steel coils of BAC closed circuit cooling towers are filled with a low pressure inert gas at the factory before shipping, to ensure an optimal internal corrosion protection. It is recommended to check the overpressure every six months (connect a manometer to the valve).
- Purge old bearing grease by new grease at start of storage period and repeat before start-up.
- Protect all black steel components with RUST VETO or equivalent corrosion protective material.

For complete instructions, please contact your local BAC Balticare Representative.

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HFL
FURTHER ASSISTANCE & INFORMATION

Assistance

BAC has established a specialized total care company called Balticare. The BAC Balticare offering involves all elements required to ensure a safe and efficient operation of your evaporative cooling products.
For more details, contact your local BAC representative for further information and specific assistance at www.BaltimoreAircoil.eu

More information

REFERENCE LITERATURE

- Eurovent 9-5 (6) Recommended Code of Practice to keep your Cooling System efficient and safe. Eurovent/Cecomaf, 2002, 30p.
- Guide des Bonnes Pratiques, Legionella et Tours Aéroréfrigérantes. Ministères de l'Emploi et de la Solidarité, Ministère de l'Economie des Finances et de l'Industrie, Ministère de l'Environnement, Juin 2001, 54p.
- Voorkom Legionellose. Minsterie van de Vlaamse Gemeenschap. December 2002, 77p.
- Legionnaires' Disease. The Control of Legionella Bacteria in Water Systems. Health & Safety Commission. 2000, 62p.
- Hygienische Anforderungen an raumlufttechnische Anlagen. VDI 6022.

INTERESTING WEBSITES

- www.BaltimoreAircoil.eu
- www.eurovent-certification.com
- www.ewgli.org
- www.ashrae.org
- www.uniclima.org
- www.aicvf.org
- www.hse.gov.uk

ORIGINAL DOCUMENTATION

This manual is originally made in English. Translations are provided for your convenience. In the event of discrepancies, the English original text shall prevail over the translation.

COOLING TOWERS

CLOSED CIRCUIT COOLING TOWERS

ICE THERMAL STORAGE

EVAPORATIVE CONDENSERS

HYBRID PRODUCTS

PARTS, EQUIPMENTS & SERVICES

BLUE by nature
GREEN at heart

www.BaltimoreAircoil.eu

info@BaltimoreAircoil.eu

Please refer to our website for local contact details.

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