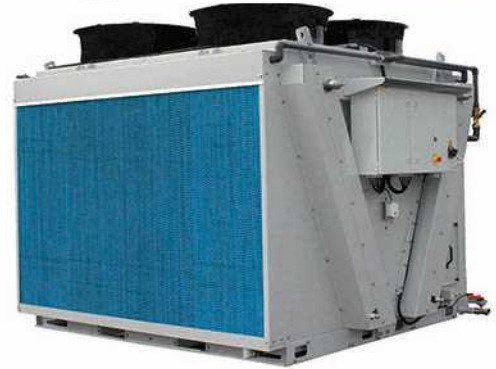


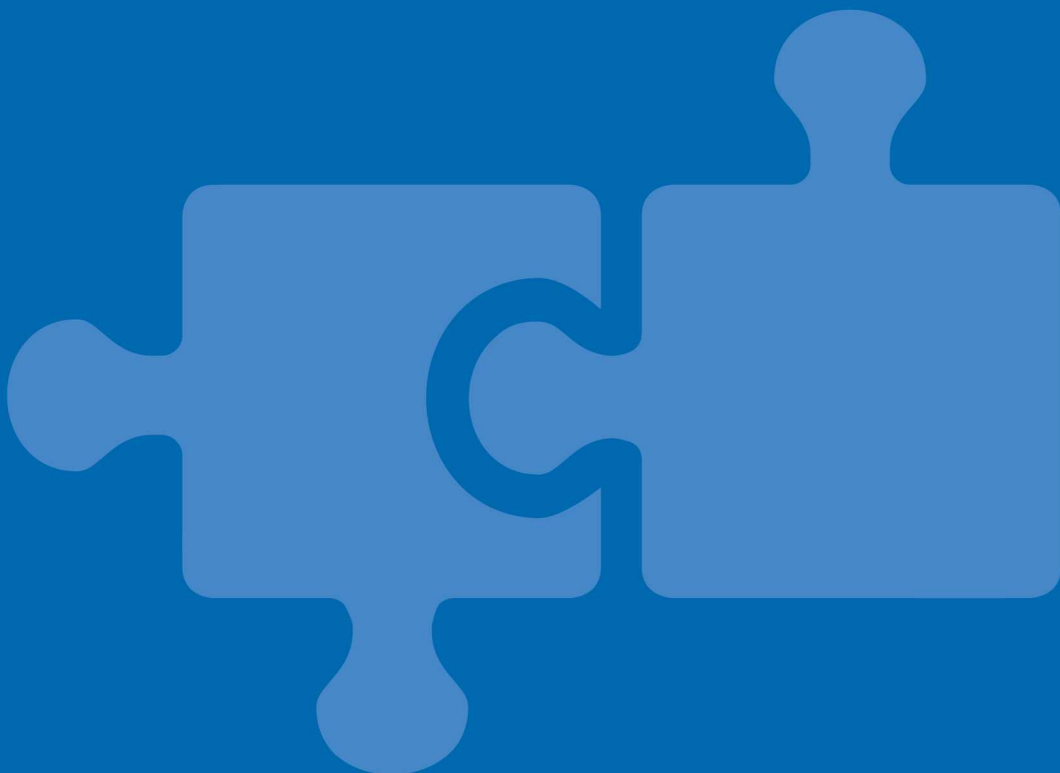


**BALTIMORE
AIRCOIL COMPANY**



TVC Adiabatic Condenser

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

Checks and adjustments	Start-Up	Every month	Every 3 months	Every 6 months	Every start of adiabatic season, Spring
Adiabatic pre-cooler water flow	X		X		X
Level switches (optional)	X				X
Tighten electrical connections	X			X	X
Rotation of fan(s)	X				
Motor voltage and current	X			X	X
Unusual noise and/or vibration	X		X		X

Inspections and monitoring	Start-up	Every month	Every 3 months	Every 6 months	Every start of adiabatic season, Spring
General condition of the equipment	X		X		X
Adiabatic pre-cooling pads	X		X		X
Heat transfer coil	X			X	
Water distribution pipe	X			X	X
Float switch (ball can move freely)	X	X			X

Cleaning procedures	Start-up	Every month	Every 3 months	Every 6 months	Every start of adiabatic season, Spring
Adiabatic pre-cooling media	X		X		X
Adiabatic gutter system				X	X
Sump				X	X
Coil (remove dust)					X



Auxiliary equipment integrated in the cooling system may require additions to the table above. Contact suppliers for recommended actions and their required frequency.

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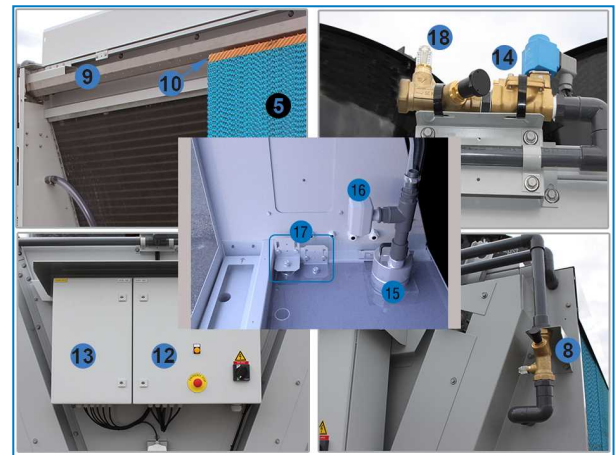
The service expert for BAC equipment

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More information

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TVC CONSTRUCTION DETAILS



Details

1. Heat exchanger
2. Coil headers
3. Casing
4. Fans
5. Pre-cooler media
6. Pre-cooler drain valve
7. Pre-cooler drain
8. Pre-cooler flow valve/meter
9. Pre-cooler water distribution gutter
10. Pre-cooler water distribution pads
11. Ambient temperature sensor
12. Power panel
13. Control panel
14. Make-up
15. Recirculation pump (optional)
16. Flow switch (optional)
17. Level switch (optional)
18. Make-up flow balancing valve
19. Coil connections



TVC 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 representative.
- **Seismic Risk:** For safe operation of equipment installed in moderate and high hazard area's contact your local BAC representative.

Ambient temperature at continuous full speed; full load operation ranges from -10°C to + 45°C. For cold climates, if optional thermostatically controlled heaters are employed, the temperature range can be extended from -40°C to + 45°C.

HEAT EXCHANGER COIL

- Design pressure: 25 bar
- Test pressure: 50 bar
- Maximum coil inlet temperature for Stainless Steel coils (NH₃ applications): 120°C
- Maximum coil inlet temperature for copper coils (other Halocarbon refrigerants): 125°
- Fluids circulated through the inside of the coils must be compatible with the coil construction material.

ADIABATIC PRE-COOLER OF TRILLIUMSERIES™ CONDENSER

- Design water supply pressure: 3-10 bar
- The water distributed on the adiabatic pre-coolers should be of potable supply.
- In case of non-treated water, the temperature should be kept below 20°C.

PURGE REQUIREMENTS

The installer of BAC condensers must ensure proper air purging of the system prior to operation.

Entrained air can obstruct free drainage of refrigerant and reduce condensing capacity, resulting in higher operating pressures than designed.

To verify absence of non condensables in the refrigeration system, follow the instructions in the BAC Application Handbook – EU Edition (<https://www.baltimoreaircoil.eu/downloads/pdf-Application-Handbook-EU-Edition>), Section "Condenser Engineering Guidelines".

CIRCULATED WATER QUALITY

The standard heat exchanger coils are made of copper and use CuP 181 and CuP 284 (ISO 17672) as a brazing material. They are intended for application on closed; pressurized system which are not open to the atmosphere in order to prevent excessive fouling and/or internal corrosion of the coil and possible leaks.

The circulating water quality needs to remain within the following limits:

	Copper
pH	6.5 - 10.5
Hardness (as CaCO ₃)	0 - 500 mg/l
Alkalinity (as CaCO ₃)	0 - 500 mg/l
Conductivity	< 3300 µS/cm
Chlorides	< 250 mg/l
Total suspended solids	< 10 mg/l
COD	< 50 ppm

In any case, a competent water treatment company should be consulted for the specific water treatment to be applied, suitable for all materials of construction used in the entire system. For higher pH levels, it is recommended to add a specific copper corrosion inhibitor such as TT or BZT with a target residual concentration of above 2 ppm (multiple dosages might be required).

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.

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

Surface of coil/piping can be hot.

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 in place and properly secured.

Since the equipment operates at variable speeds, steps must be taken to avoid operating at or near the installation's "critical speed".

For more information consult your local BAC 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 any more
- 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.

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.

About water care

The adiabatic pre-cooler of the unit has been designed as direct-water system, without water re-circulation, without pump.

Therefore it is essential that the main cold-water supply connected to the adiabatic pre-cooler has adequate pressure and flow rate for the pre-cooler being installed.

The primary water treatment control method for the adiabatic pre-cooler is to provide sufficient water to the pre-cooler medium to keep it flushed. If sufficient water is not provided to completely wet and flush the entire pre-cooler medium surface, deposition will occur.

Many water related problems can be avoided if good system design and basic housekeeping practices are followed. However, water treatment chemicals should NOT be used INSTEAD of following these practices:

- Provide, good, even water distribution

(See table: Minimum recommended adiabatic pre-cooler water flow rates)

- Clean distribution header on a regular basis
- Clean city water strainer on a regular basis
- Replace damaged or spent pre-cooler media

Refer to "Construction details" on page 6. Mains cold water is supplied to (6), and is fed to the water distribution system, via a flow valve/meter (9). The recommended mains water supply pressure is minimum 3 bar. The flow valve/meter (8) needs to be adjusted at installation to feed a minimum water flow over the adiabatic pre-cooler (See table: "Minimum recommended adiabatic pre-cooler water flow rates")

Recommended adiabatic pre-cooler water flow rates

The minimum water flow to be distributed over the adiabatic pre-cooler depends on:

- Climate conditions, i.e. evaporation rate at design conditions
- General water quality
- Water scaling tendency (practical scaling index)

The minimum water flow rates given in table "Minimum recommended adiabatic pre-cooler water flow rates", are valid for the following operating conditions:

- Maximum ambient temperature of 35 °C at minimum relative humidity of 30 %.
- Minimum supply water quality (See table below "Minimum supply water quality").
- Practical scaling index of 5.5 – 8.0.

If any of the following happens:

- at ambient conditions exceeding the given maximum ambient conditions,
- with supply water quality data exceeding one or more of the concentration limits of above table "Minimum supply water quality",
- if the supply water has a Practical Scaling Index below 5.5,

Then:



- the water flow needs to be increased to higher levels to avoid rapid fouling and scaling of the pre-cooler medium. Contact your local BAC representative for support.

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).

When operating with the optional recycling pump and water is circulating across the pre-cooler, the cycles of concentration need to be determined to prevent excessive build-up of impurities. The cycles of concentration are the ratio of the concentration in the circulating water compared to the concentration in the make-up water. For example: If a given make-up water had 100 ppm of chlorides, it would be possible to run the system at 300 / 100 equals 3 cycles of concentration without exceeding the 300 ppm of chlorides allowed for a Baltibond® unit.



This calculation process needs to be repeated for all the guideline parameters (hardness, sulphates, alkalinity, etc.) and the lowest resultant cycles of concentration used.

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

When the PLC is set for recirculation of water, the value for the deconcentration after refills is equal to the cycles of concentration. This is standard set at 3. In the PLC manual is described how this value can be adjusted.

Water quality guidelines for adiabatic pre-cooler Frame	Baltibond® Hybrid Coating
Temperature	< 20 °C
PH	6.5 – 9
Hardness as (CaCO ₃)	30 – 500 mg/l
Alkaline as (CaCO ₃)	< 500 mg/l
Total dissolved solids	< 1500 mg/l
Chlorides	< 200 mg/l
Sulfates	< 300 mg/l
Conductivity	1800 µS/cm
Bacteria Rate (CFU/ml, KBE/ml)	< 1000

Minimum supply water quality

To determine the practical scaling index, below instructions need to be followed:

This calculation needs to be done based on the make-up water quality (when operating with the optional recycling pump, this means the expected worst case recirculating water quality needs to be used).

- Obtain values of A, B, C and D from below table
- $pH_s = (9.3 + A + B) - (C + D)$
- Practical Scaling Index = $2 pH_s - pH_{eq}$
 - if Index is above 6.0, water is scale dissolving
 - if Index is 6.0, water is stable
 - if index is below 6.0, water is scale forming

With Practical Scaling Index below 5.5, the water flow needs to be increased. Contact your local BAC representative for support.

Data for rapid calculations of Practical Scaling Index for adiabatic pre-cooler

Conductivity (µS/cm)	A	Temperature °C	B	Calcium hardness (PPM as CaCO ₃)	C	Total alkalinity (PPM as CaCO ₃)	D	Alkalinity (PPM as CaCO ₃)	pHeq
50-300	0.1	10-13	2.3	10-15	0.70	10-15	1.10	50	7.0
301-1000	0.2	14-17	2.2	16-25	0.90	16-25	1.30	100	7.5
1001-3000	0.25	18-21	2.1	26-40	1.10	26-40	1.50	200	7.9
3001-5000	0.27	22-27	2.0	41-70	1.35	41-70	1.75	300	8.2
				71-100	1.55	71-100	1.90	400	8.4
				101-140	1.70	101-140	2.10	500	8.5
				141-200	1.85	141-200	2.25		
				201-250	1.95	201-250	2.35		
				251-300	2.05	251-300	2.45		
				301-350	2.12	301-350	2.52		
				351-400	2.18	351-400	2.58		
				401-450	2.24	401-450	2.63		
				451-500	2.28	451-500	2.68		

Calculation of Practical Scaling Index

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

Biological control

The adiabatic pre-cooler and its controls have been designed to minimize the risk of uncontrolled growth of algae, slimes and other micro-organisms such as Legionella:

1. No standing water
2. Complete drying of the pre-cooling system after each adiabatic cycle
3. Complete draining of all water distribution piping installed on the unit after each adiabatic cycle



CAUTION

The owner of the equipment is responsible for draining of all water piping feeding the adiabatic pre-cooler to avoid stagnant water conditions.

4. Use of potable water supply at temperatures of 20 °C or less, where Legionella is dormant
5. Aerosol free operation

When basic housekeeping practices are followed, and when the guidelines for operation and maintenance of this bulletin are followed, problems related to uncontrolled growth of micro-organisms will be avoided.

Chemical treatment

A biocide program for biological control can be implemented in conjunction with the maintenance program for increased operational safety. However, biological control should not be used in place of good housekeeping.



The two most commonly available biocides are chlorine and bromide. These chemicals have widespread success in general application; however, caution should be practiced when using them in the adiabatic pre-cooling system. Continuous dosages of chlorine or bromide could delignify the cellulose fibres of the pre-cooler media, and degrade the stiffening agents.

RECOMMENDED CHLORINE / BROMIDE DOSAGES

Continuous Treatment: Not required when basic housekeeping practices are followed, and when the guidelines for operation and maintenance of this bulletin are followed.

Shock Treatment: 3.0 – 5.0 PPM Free Halogens. Not recommended more often than once per quarter.



TVC FAN MOTOR COMMUNICATION

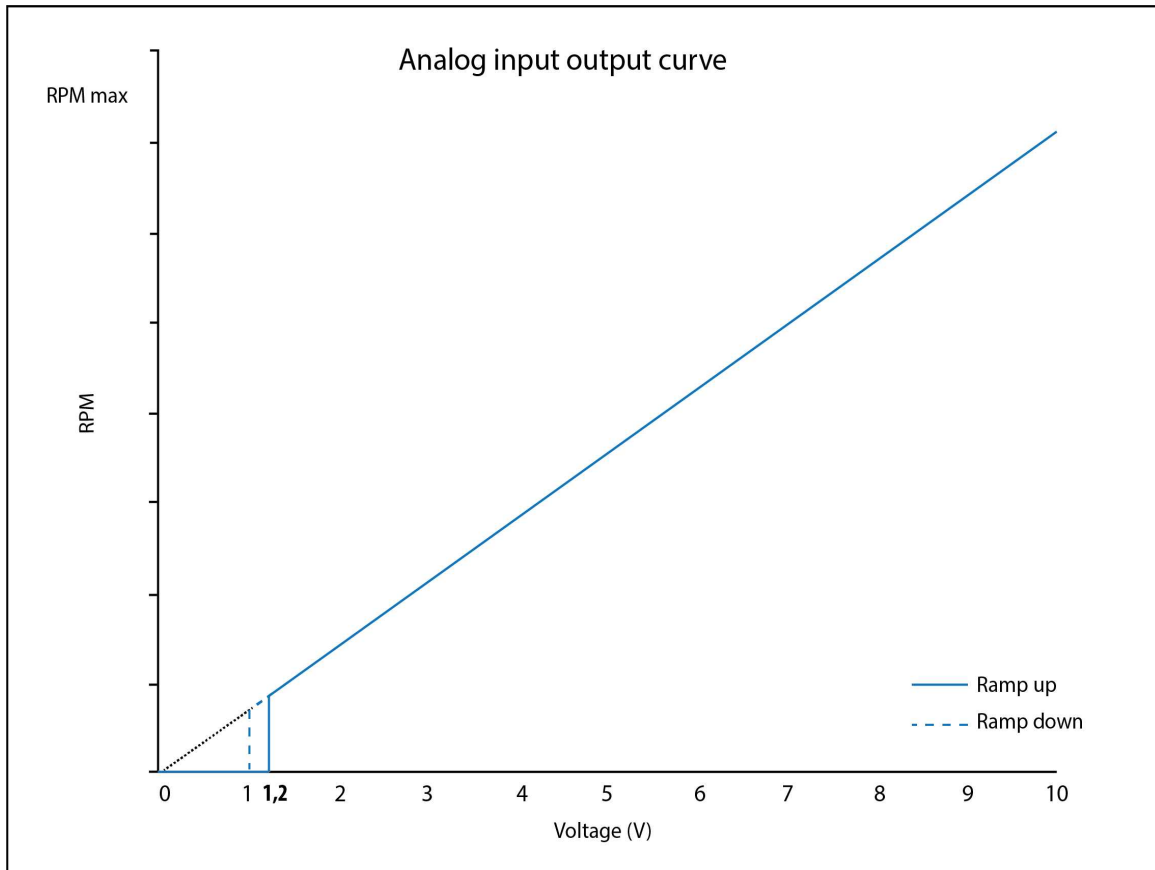
Introduction

The basis for the air movement system of a TVC unit are axial fans, direct driven by EC motors.

LEPLC3-XXE-XXX-KE	Electronically commutated fan motor	EC
PLC3-XXE-XXX-MP	Permanent magnet fan motor	PM
PLC3-XXE-XXX-MD	Alternating current fan motor	AC

Fan control with a 0-10V signal

The fans will start when the input voltage reaches 1,2V. The fan speed is linear with the input voltage (see picture below). The fan will go to 0 RPM when the applied voltage is below 1V. The maximum RPM of the fan is 1430.



Specific functions

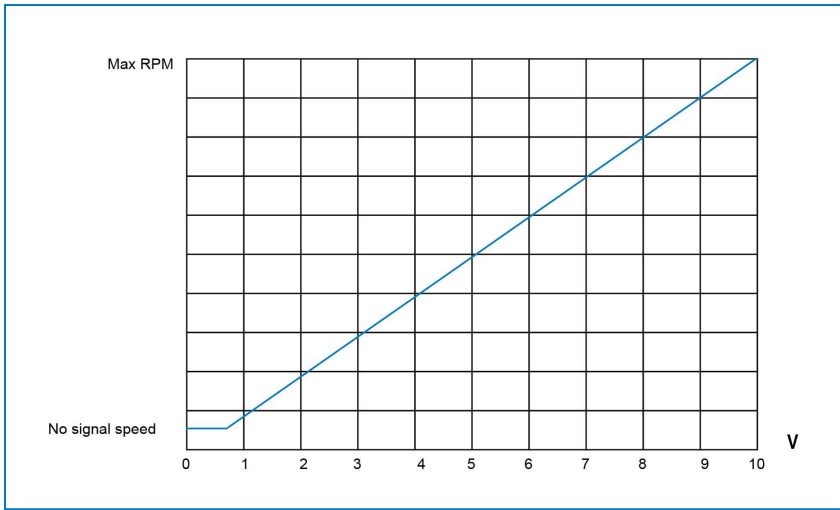
The integrated speed controller of each EC motor contains the following specific functions (activated by default for 0-10V as well as ModBus RS485 control).

EC Fans controlled through 0-10V signal

In case of 0-10V control without error contact option, no alarms or warnings are available.

In case of 0-10V control with error contact option, the following alarm will be detected:

- braking mode: set in case of external drive in opposite direction at high speed for lengthy period
- actual speed is lower than running monitoring speed limit
- open circuit at analog input or PMW input for set value



ALARMS AND WARNINGS

Fans controlled over ModBus RS485

Following alarms are available over the bus system:

UzLow	DC-link under voltage
RL_Cal	Rotor position sensor calibration error
n_Limit	Speed limit exceeded
BLK	Locked motor
HLL	Hall sensor error
TFM	Motor overheated
FB	Fan bad (general error, set for every error that occurs)
SKF	Communication error between master controller and slave controller
TFE	Power module overheated
PHA	Phase failure

If an alarm is detected, the motor will be stopped and only start again after the error has been resolved.

The following warnings are available over the bus system:

LRF:	Shedding function active (see also shedding function)
UeHigh:	Supply voltage high
OpenCir.:	Open circuit at analog input or PWM input for the set value (voltage at analog input < open circuit limit value, or signal at PWM input statistically high)
n_Low:	Actual speed is lower than speed limit for running monitoring
RL_Cal:	Calibration of rotor position sensor in progress
UzHigh:	DC-link voltage high
Brake:	Brake operation: set if an external force drives the motor in opposite direction with high speed for a prolonged period.
UzLow:	DC-link voltage low
TEI_high:	Electronics interior temperature high
TM_high:	Motor temperature high
TE_high:	Output stage temperature high
P_Limit:	Power limitation activated
L_high:	Line impedance too high (DC-link voltage unstable)
I_Limit:	Current limitation activated

When a warning is detected, the motor remains in operation.

Settings

The different fan motors can be integrated in a BMS system through ModBus RS485. The main PLC needs to be configured as a ModBus RTU master.

Additionally, the following settings apply:

- Baudrate: 19200
- Parity: Even
- Nr of start bits: 1
- Nr of stop bits: 1
- Nr of databits: 8
- Set the timeout parameter to approx. 150ms

Each fan has a default address that is structured as follows:

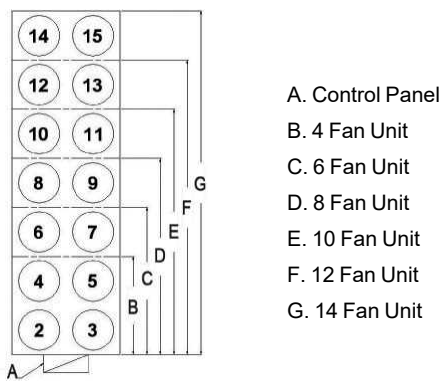




Diagram showing sequence of fan motor address

COMMUNICATION TABLE



Variable	Register	Read/Write	Register type: Holding/Input
Set value (%)	D001	RW	H
Operating hours	D009	R	H
Current speed (rpm)	D010	R	I
Motor status	D011	R	I
Warning	D012	R	I
DC link voltage	D013	R	I
Power module temperature (°C)	D015	R	I
Motor temperature (°C)	D016	R	I
Electronics temperature (°C)	D017	R	I
Power (W)	D021	R	I
Device address	D100	RW	H
Set value source	D101	RW	H
Motor stop enable (P1)	D112	RW	H
Maximum speed (rpm)	D119	R	H
Ramp up time (s)	D11F	RW	H
Ramp down time (s)	D120	RW	H
Reference Uz	D1A0	R	H
Reference Iz	D1A1	R	H

 Unless specified otherwise, parameters are encoded in 'big endian' format i.e. the byte with the highest-value bits come first.

 Reading Holding registers: use Command 0X03 / Reading Input registers: use Command 0X04

SPECIFIC PARAMETER INFO

Set Value

Address: D001

$$Setvalue [\%] = \frac{Databytes}{65536} \cdot \frac{nMax[rpm]}{780}$$

nMax [rpm] - see [D119] Maximum speed

Operating hours

Address: D009

$$\text{Operatingtime [h]} = \text{Databytes}$$

The maximum value that can be counted is 65535 hours (approx. 7.5 years) after which the counter is no longer incremented and stays at 65535.

Current Speed

Address: D010

$$\text{Actualspeed [rpm]} = \frac{\text{Databytes}}{64000} \cdot nMax [rpm]$$

nMax [rpm] - see [D119] Maximum speed



If the actual speed exceeds the value "1.02 * maximum speed", the display will be limited to the value "1.02 * maximum speed" (0xFFFF0)

Motor Status

Address: D011

The motor status specifies errors currently detected in the fan.

Encoding:

MSB	0	0	0	UzLow	0	RL_Cal	0	n_Limit
LSB	BLK	HLL	TFM	FB	SKF	TFE	0	PHA

If a bit is set, the error described below has been detected:

UzLow	DC-link undervoltage
RL_Cal	Rotor position sensor calibration error
n_Limit	Speed limit exceeded
BLK	Locked motor
HLL	Hall sensor error
TFM	Motor overheated
FB	Fan bad (general error, set for every error that occurs)
SKF	Communication error between master controller and slave controller
TFE	Power module overheated
PHA	Phase failure

Warning

Address: D012

A warning is a stage preliminary to an error message, i.e. the limit value for the error message has almost been reached. Encoding: A set bit makes the warning active:

MSB	LRF	UeHigh	0	UzHigh	0	OpenCir	n_Low	RL_Cal
LSB	Brake	UzLow	TEI_high	TM_high	TE_high	P_Limit	L_high	I_Limit

LRF	Shedding function active (see also shedding function)
UeHigh	Supply voltage high
UzHigh	DC-link voltage high
OpenCir.	Open circuit at analog input or PWM input for the set value (voltage at analog input < open circuit limit value, or signal at PWM input statistically high)
n_Low	Actual speed is lower than speed limit for running monitoring
RL_Cal	Calibration of rotor position sensor in progress
Brake	Brake operation: set if an external force drives the motor in opposite direction with high speed for a prolonged period
UzLow	DC-link voltage low
TEI_high	Electronics interior temperature high
TM_high	Motor temperature high
TE_high	Output stage temperature high
P_Limit	Power limitation activated
L_high	Line impedance too high (DC-link voltage unstable)
I_Limit	Current limitation activated

DC Link Voltage

Address: D013

$$UzV = \frac{Databyte}{256} \cdot ReferenceUzV$$

Reference Uz(V) at address (D1A0)

Power Module Temperature

Address: D015

$$T_{Modul} [^{\circ}C] = Databytes$$

Motor Temperature

Address: D016

$$T_{Motor} [^{\circ}C] = Databytes$$

Electronics Temperature

Address: D017

$$T_{EI} [^{\circ}C] = Databytes$$

Power

Address: D021

$$P [W] = \frac{Databytes}{65536} \cdot ReferenceUz [V] \cdot ReferenceIz [A]$$

$$ReferenceUz [mV] = Databytes \cdot 20mV$$

$$ReferenceIz [mA] = Databytes \cdot 2mA$$

ReferenceUz[mV] at address [D1A0]

ReferenceIz[mA] at address [D1A1]

Device Address

Address: D100

$$Fanaddress = Databytes(LSB)$$



Set Value Source

Address: D101

The parameter specifies the source from which the set value is taken:

Value	Motor Stop
0	Analogue input 0 tot 10V
1	RS485 (default set value to parameter D001)

Motor Stop enable (P1)

Address: D112

Value	Motor Stop
0	Motor runs continuously (even if set value = 0)
1	Motor stops if set value = 0

Maximum speed

Address: D119

$Maximumspeed [rpm] = Databytes$

Ramp up time

Address: D11F

$Ramptime [s] = Databytes \cdot 2,5s$

Ramp down time

Address: D120

$Ramptime [s] = Databytes \cdot 2,5s$



TVC

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 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 coil freezing



On a standard unit, full coil drain of the heat exchangers is not possible and as such, this method cannot be relied upon to protect fluid coolers operating under ambient temperatures that could drop below freezing point, from damage to the coil.

Protection against pre-cooler freezing

The integrated controls automatically prevent adiabatic operation once the ambient temperature drops below 4°C. No extra attention to the unit itself is required except for the pre-cooler water piping.

The customer has to take the necessary precautions to prevent freezing with regard to the piping towards the unit, as well as the piping inside the unit up to the make-up valve.

Protection of electrical components

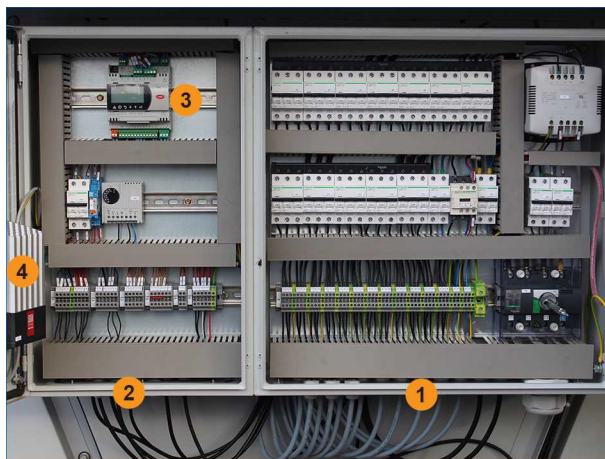
The components inside the electrical panel are designed to operate in ambient temperatures down to -10°C. In case colder temperatures can be expected, the control panel needs to be equipped with a heating element in order to avoid the temperature inside the panel to drop below -10°C.

Controlling the fan speed will have a direct impact on the heat transfer of the unit. A low fan speed will lower the airflow through the unit, resulting in a low heat transfer. A high fan speed will result in a higher heat transfer. It is only useful to activate the pads when the ambient temperature is high enough.

OPERATIONAL SAFETY

If BAC does not deliver the controls, this is the customer's responsibility. The unit's controls are - in part - responsible for the proper operational safety of the unit as a whole. Hence, these controls need to be designed to make sure that no unsanitary situation can present itself due to a poor operation of the unit.

Electrical panels



1. Power panel
2. Control panel
3. Optional Digital controller with LCD interface
4. Optional heater (required for ambient temperatures between - 10°C and - 40°C)

Electrical panel for unit with EC fans

CONTROL PANEL

At the outside of the panel, the following components can be found:

- Emergency stop: Push to activate; rotate to de-activate.
- Reset button (restart after emergency stop).
- 24VAC power indicator light.

POWER PANEL

At the outside of the power panel, the following components can be found:

- ON/OFF switch

Control Logic Restrictions

SERVICE LIFE OF PADS

It is required to program the operation of the adiabatic pre-cooling sections. There is a maximum of 1 start and stop per day per adiabatic pre-cooling side, this to increase the service life of the pre-cooler media. The pre-cooler can be operated to allow a higher number of starts and stops which could reduce total annual water consumption. However, this practice will drastically reduce the service lifetime of the adiabatic pre-cooler media.

PRE-COOLER ACTIVATION

During regular operation the pre-cooler should not be activated when ambient temperature is below 15°C. For cleaning purposes, ambient temperature should be above 4°C.

SUMP

In case of an adiabatic condenser, equipped with recirculation, the sump with pump(s) will be located at the bottom of the unit at the side with the electrical panel. When no adiabatic operation is required, this sump needs to be fully drained.

During adiabatic operation, the sump needs to be drained regularly in order to avoid that the cycles of concentration rise too high.

PRE-COOLER WATER SUPPLY

The water supply is located above the pre-coolers.

In case of a once through unit, it needs to be opened when adiabatic operation is required and closed when the unit needs to operate dry.

In case of a recirculation unit, it needs to be opened when adiabatic operation is required and closed when the high water level in the sump is reached. At this point, the pumps can be started. It needs to be re-opened when the low water level is reached.

Checks and adjustments

ADIABATIC PRE-COOLER WATER FLOW

The water flow will depend on the supply water pressure, and can be set with the 2 concentric hex screws on the water flow valve on the flow meter. First open the plastic cover plate of the water flow adjustment screw.



Water flow adjustment screw

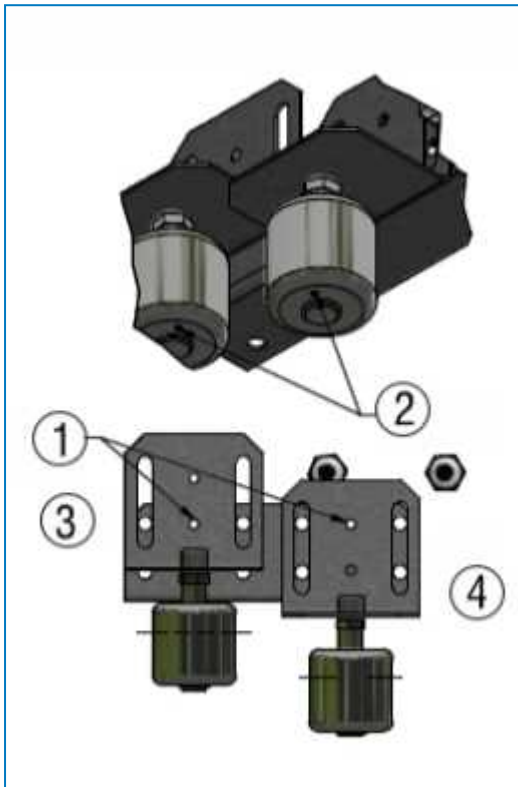
Model	Number of fans	Recommended pre-cooler water flow per unit		
		Once Through	Recirculation	
			Make-up	Pump
TVC-EC-8022-*	4 fans	2x 7 l/min	1x 14 l/min	1x 30 l/min
TVC-EC-8023-*	6 fans	2x 11 l/min	1x 22 l/min	1x 40 l/min
TVC-EC-8024-*	8 fans	2x 14 l/min	1x 28 l/min	2x 30 l/min
TVC-EC-8025-*	10 fans	2x 18 l/min	1x 36 l/min	2x 35 l/min
TVC-EC-8026-*	12 fans	2x 22 l/min	1x 44 l/min	2x 40 l/min
TVC-EC-8027-*	14 fans	2x 25 l/min	1x 50 l/min	2x 50 l/min

LEVEL SWITCHES

Level switches are only available for recirculation units.

Two industrial grade stainless steel float switches maintain the water level in the sump between a minimum and maximum level in order to make sure there is always enough water available to ensure a proper wetting of the pre-cooler pads.

All switches are factory set at the correct level. This can be verified visually or with the help of a tool like a screw driver when the matching holes are properly aligned (see drawing below).



Measurements of the float switch construction

1. Matching holes
2. Witness mark
3. High level
4. Low level

Use a metal cylinder profile like a screwdriver to position high and low level float switch. Float switch operation can be reversed, for correct operation witness mark is at the bottom.

The minimum and maximum water level can be adjusted for site specific conditions by changing the vertical position of the float switches.



CAUTION

Changing the set points may lead to overflowing the basin, or damaging the pump(s).

Instructions to change the height:



1. Loosen the M8 bolts
2. Adjust the vertical position of the float switch to the desired height
3. Tighten the M8 bolts

ELECTRICAL CONNECTIONS

Check and tighten electrical contacts if required before commissioning the unit. Transport may loosen some of the contacts, posing a risk for overheating or voltage drops. Also during operation, half-yearly checks are recommended.

ROTATION OF FANS

Fans must rotate without obstruction in the direction indicated by arrows on the equipment.

MOTOR VOLTAGE AND CURRENT

Check the voltage and the current of all three legs of the fan motors. The current should not exceed the nameplate rating.

After prolonged shutdown the motor insulation should be checked with a Megger insulation tester prior to restarting.

The voltage must not fluctuate more than +/-10% and the imbalance between phases must not be greater than +/-2%.

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 representative for assistance.

Inspections and corrective actions

GENERAL CONDITION OF THE EQUIPMENT

Once a year the general condition of the equipment should be inspected.

The inspection should focus on:

- Signs of corrosion
- Accumulation of dirt and debris

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 160550). Larger damages should be reported to the local BAC representative.

ADIABATIC PRE-COOLING MEDIA

About Adiabatic Pre-Cooling

Airborne debris is caught in the adiabatic pre-cooling media. They act as an air filter and as such protect the heat exchanger coil from rapid and excessive fouling. During adiabatic operation the media is 'rinsed' by water overfeed. The debris, that is rinsed from the media, will drain together with the excess water.

The pre-cooling media can be removed during cold seasons, as soon as it is guaranteed that the ambient temperature will no longer exceed the dry-to-adiabatic switch point. This will extend the service lifetime of the media. It will however increase the speed of fouling of the dry heat exchanger coil.

At least every quarter an inspection of the adiabatic pre-cooler media is recommended, also during mid-season and winter season when usually no adiabatic cycles would be needed.

The inspection should focus on:

- Signs of excessive fouling and scaling of the media
- Full and even wetting of the face area

Float switches

- Check that the float switches can move freely

Fouling

If excessive dirt and debris has accumulated on the pre-cooling media, it is recommended to rinse the media. Refer to "Adiabatic pre-cooling media" on page 36 for the recommended procedure for cleaning and rinsing of the media.

Scaling

Scaling will deposit on the pre-cooling media, every time that the pre-cooling media dries at the end of each adiabatic cycle. The rate of scaling will depend upon:

- The number of adiabatic starts and stops per day
- The water quality
- The water flow over the adiabatic pre-cooler

The expected service lifetime of the pre-cooling media is 5 to 7 years if basic housekeeping practices and these operating and maintenance guidelines are followed.

If excessive scaling is accumulating too fast on the pre-cooling media, the following checks and adjustments need to be made:

- Check and adjust water quality:
refer to section "About water care" on page 11
- Check and adjust water flow distributed over Adiabatic Pre-Cooler:
refer to section "About water care" on page 11.

HEAT EXCHANGER COIL

The finned heat exchanger coil is susceptible to corrosion and entrapment of airborne particulates (coil fouling). The speed of coil fouling can be reduced, and the service lifetime of the finned coil can be extended, if the pre-cooling media is kept in place also during cold seasons, to act as air filter.

The heat exchanger coil requires periodic cleaning to maintain the highest operating efficiency possible under the environmental conditions in which the dry 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.

Fan replacement

In case of replacement, any safety hazards stemming from the fan must be re-evaluated once it is installed on the cooler.

Observe the following when working on the fans:

- Do not make any modifications, additions or conversions to the fan without the approval of the cooler manufacturer.
- Terminals and connections may have residual voltage after unit shutdown.
Wait five minutes after disconnecting the voltage at all poles before opening the fan.
- In the event of failure, there is electric voltage at the rotor and impeller.
Do not touch the rotor and impeller once they are installed.
- Shut down the fan immediately if you detect a missing or ineffective protective feature.

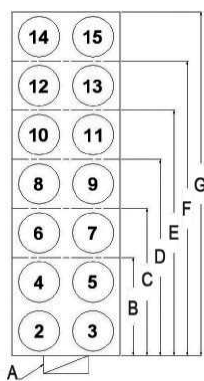
The fans are controlled via a 0-10V signal or via a digital bus system (MODBUS RTU).

For the bus communication each fan needs to be assigned a unique address, starting with "2, 3, 4.....", leaving 1 free for any replacement fan. The sequence of the above system is shown on the diagram below.

In case of a fan replacement it will be necessary to specify the assigned fan number shown on the diagrams, so that the replacement fan will be programmed accordingly.



For models with "80" or "87" in their nomenclature (EC80nn-xxxx or EC87nn-xxxx), please refer to the instructions below.



- A. Control Panel
- B. 4 Fan Unit
- C. 6 Fan Unit
- D. 8 Fan Unit
- E. 10 Fan Unit
- F. 12 Fan Unit
- G. 14 Fan Unit

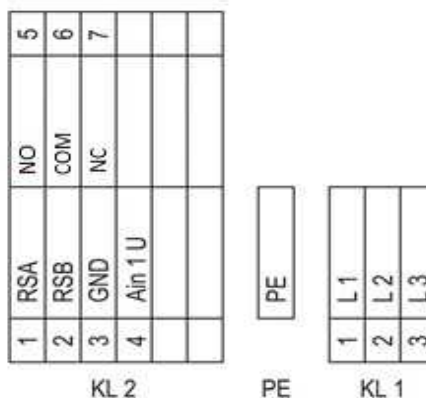


Diagram showing sequence of fan motor address

Schematic of internal motor terminal strip

No.	Conn.	Designation	Function / assignment
KL 1	1	L1	Mains supply connection, supply voltage 3~380÷480 VAC; 50/60 Hz
KL 1	2	L2	Mains supply connection, supply voltage 3~380÷480 VAC; 50/60 Hz
KL 1	3	L3	Mains supply connection, supply voltage 3~380÷480 VAC; 50/60 Hz
PE		PE	Earth connection, PE connection
KL 2	1	RSA	Bus connection RS-485, RSA, MODBUS RTU; SELV
KL 2	2	RSB	Bus connection RS-485, RSB, MODBUS RTU; SELV
KL 2	3	GND	Signal ground for control interface, SELV
KL 2	4	Ain 1U	Analogue input 1 (set value) 0-10 V, Ri=100 kΩ, parametrizable curve, only usable as alternative to input Ain1 SELV
KI 2	5	NO	Status relay, floating status contact, close by failure
KI 2	6	COM	Status relay; floating status contact; changeover contact; common connection; contact rating 250 VAC / 2 A (AC1)
KL 2	7	NC	Status relay, floating status contact, break for failure

Cleaning procedures



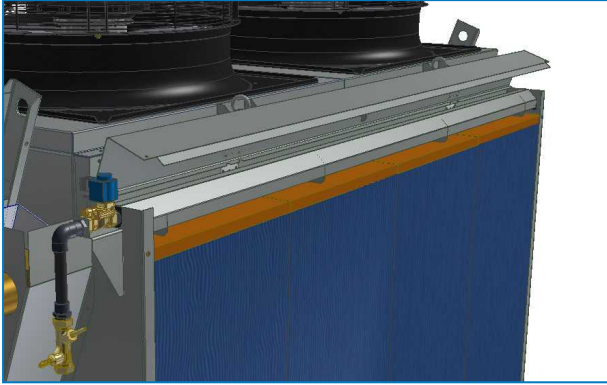
CAUTION

**Stainless steel parts can be sharp.
Avoid risk for cutting injury by wearing the proper protective equipment !**

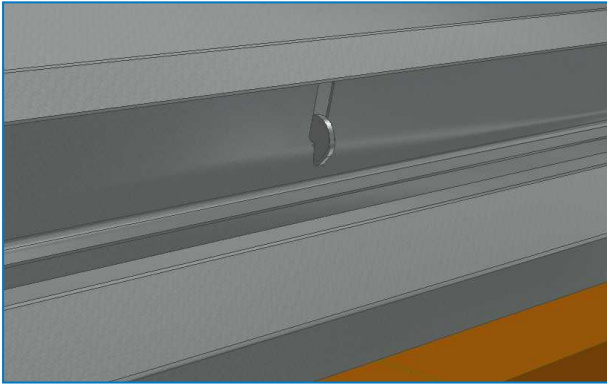
WATER DISTRIBUTION OF ONCE-THROUGH PRE-COOLERS

The recommended procedure for cleaning of the water distribution header is:

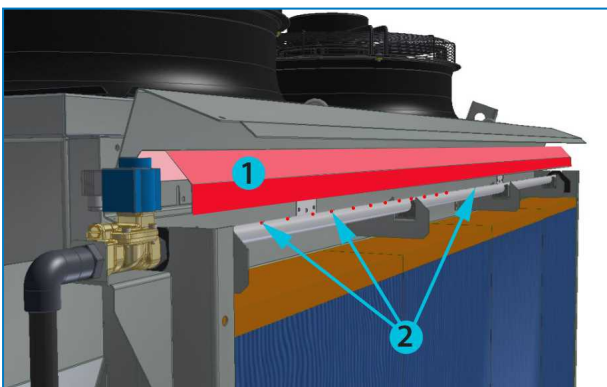
1. Open the hinged pre-cooling media cover (the 1st time, remove the tappers that secure the cover during transport first)



The cover can be secured in the open position by means of a hook that is positioned in the middle.

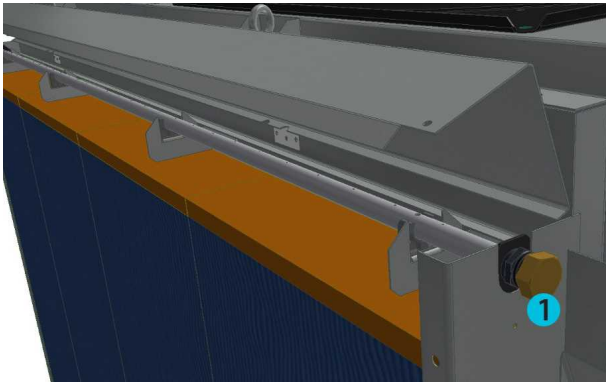


2. Lift the water deflection plates and remove them.



1. Water deflection plates
2. Water holes

3. Activate the pre-cooler water from the digital controller's maintenance menu to verify if any holes are clogged and need cleaning. If water is spraying out of the tube (+/- 10 cm high) at regular intervals, all holes are free. This applies to both drain holes at the extremities of the distribution pipe as well.
4. Unscrew the cap at the end of the tube to flush any debris that might be caught in the water distribution pipe.

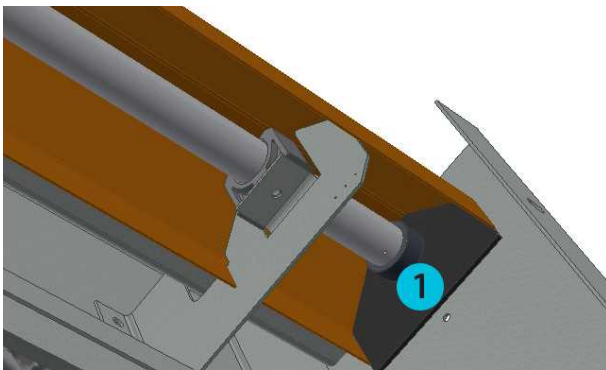


1. Cap on water distribution tube

5. After the tube is flushed, stop the flow of water by exiting the maintenance menu. Put everything back in place in the reverse order. Close the cover by gently lifting the securing hook.



When reinstalling the water deflection plates, make sure to slide the rubbers to the side in order to provide a proper seal as indicated in the following picture.



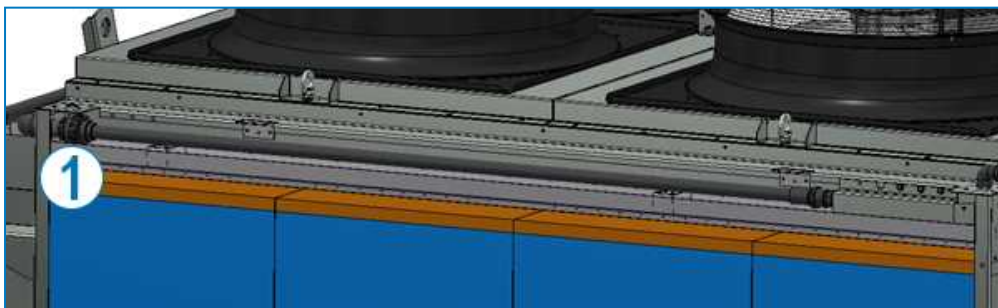
1. Side rubbers on the water distribution tube

WATER DISTRIBUTION OF PRE-COOLERS EQUIPPED WITH RECIRCULATION PUMP

The strainer at the pump is sized to keep debris out of the water distribution gutter. However, some dirt could accumulate overtime. As a result the water distribution gutter at the top should be cleaned twice a year as a preventive measure.

The recommended procedure for cleaning of the water distribution header is:

1. Open the hinged pre-cooling media cover (the 1st time, remove the tappers which secure the cover during transport first)



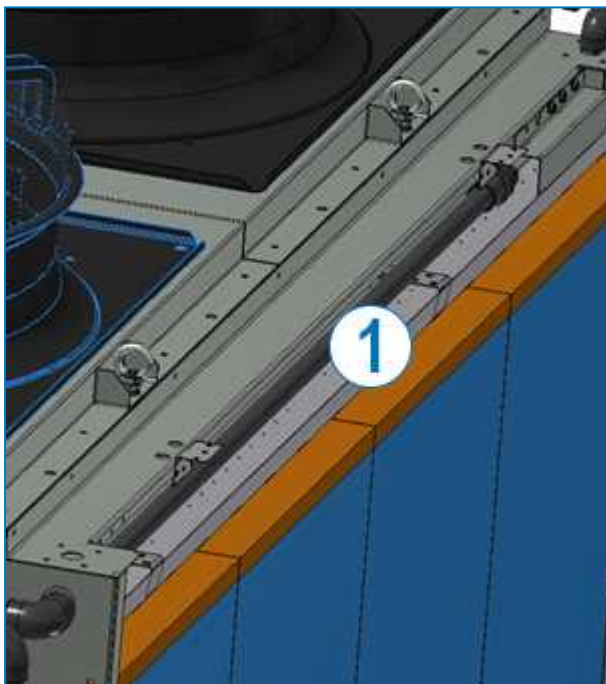
1. Three-part coupling
2. Clean the piping in case of blockages by disconnecting the threaded end cap.



1. Threaded end cap

In case there are still some blockages that will not flow out, you can loose the whole pipe by disconnecting the three-part coupling.

3. Use a clean piece of cloth to remove any dirt or debris from the gutter.



1. Distribution gutter

4. After the gutter is cleaned, put everything back in place in the reverse order and close the cover.

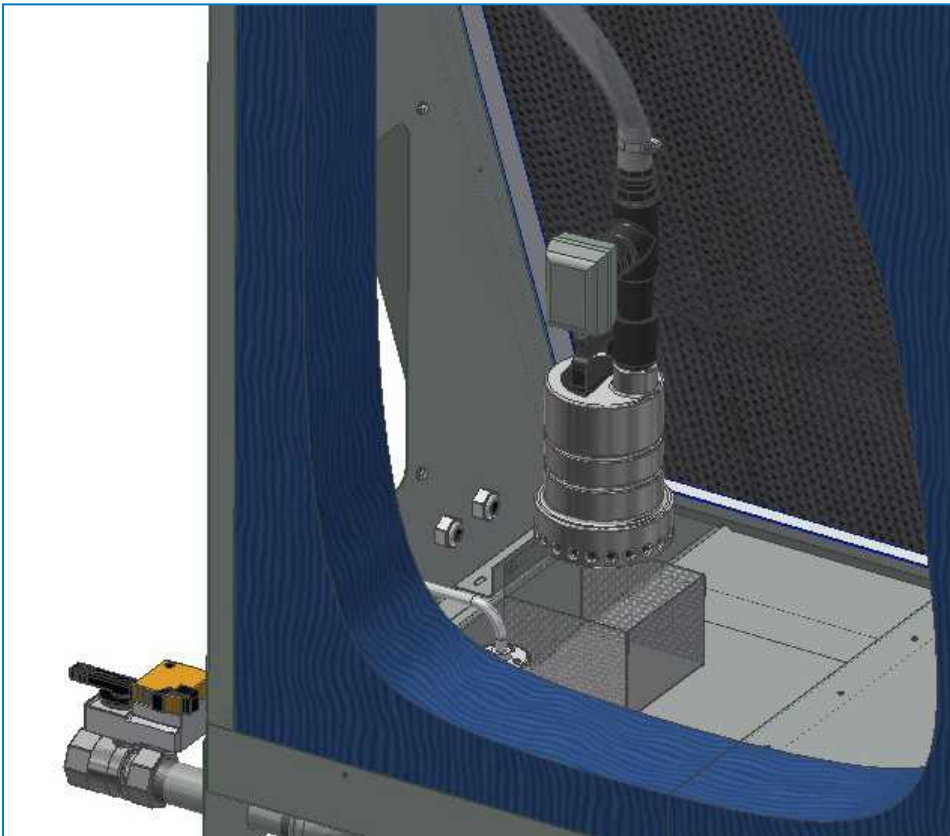
STRAINER AND PUMP OF PRE-COOLERS EQUIPPED WITH RECIRCULATION PUMP

Both the pump and strainer can be cleaned during adiabatic operation. Before performing any maintenance on the pumps, cut the power to the pumps in the electrical panel first. Adiabatic operation can be ensured through the controller's maintenance menu.

1. Loosen the knobs and remove the inspection panel (in case of two pumps, the unit is equipped with two panels).



2. Lift the pump out of the strainer and remove it through the inspection panel.



3. Remove the bolts securing the strainer in the sump to remove this as well in order to clean it outside of the unit.
4. Reinstall in the reverse order.



Adiabatic pre-cooling media

CLEANING

After a prolonged period of dry operation, the pre-cooler pads should be rinsed to avoid deposits of dust and/or debris. Timing and duration depend on the ambient conditions.

REMOVAL AND REPLACEMENT

The expected service lifetime of the pre-cooling media is 5 to 7 years if basic housekeeping practices and these operating and maintenance guidelines are followed. If severe disposition causes reduced humidification efficiency and reduced airflow, it is recommended that the pre-cooling media is replaced. New adiabatic pre-cooling media are available from your local BAC representative.

Media removal/replacement procedure:

1. Verify that the pre-cooling media are DRY! Removing a wet pad will create debris falling into the unit.
2. Remove top plate.
3. Remove pre-cooling media.

Start in the middle first and work your way to the sides.

Re-install in reverse. Make sure the pre-cooling media is properly pressed down on the supports in the water collection gutter beneath.



CAUTION

The pre-cooling media have a front side and a back side and need to be (re)installed in the correct position to ensure full wetting over the depth of the media and to ensure maximum efficiency. The blue coloured side needs to be at the outside.

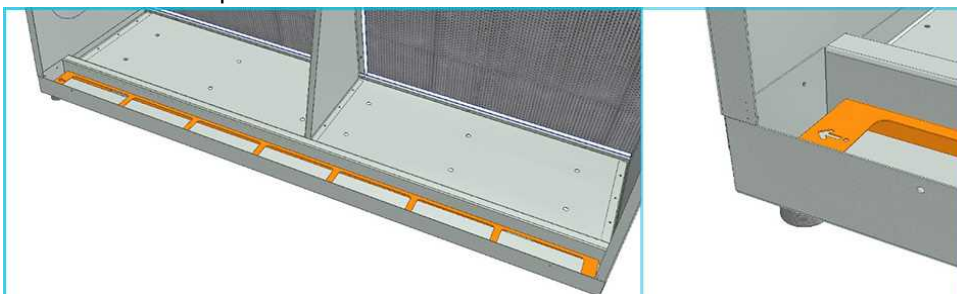
WATER COLLECTION GUTTERS BENEATH THE PRE-COOLING MEDIA

The water that is passed over the pre-cooling media and did not evaporate is collected through a gutter that guides this water either to a drain (in case of a once through pre-cooler) or to a sump (in case of a pre-cooler with recirculation).

Once a year it needs to be verified that the gutter is free of debris and that the water outlet connections are free of obstructions.

This can be done by removing the pre-cooling media as described here above.

When reinstalling the pre-cooling media support, make sure the arrow points toward the water outlet connection as indicated in the pictures below:





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 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 representative. Make sure you include the unit serial number when ordering any parts.

Prolonged outdoor stay

Should the unit(s) be stored outside 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 desiccant bags to control panel interiors to absorb moisture.
- Keep drains open on the cold water basins.
- Ensure unit(s) is stored on level ground surface and free from ambient vibration.
- Ensure hot water basins are covered.
- Remove and store fan belts and access door gaskets.
- 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.
- Motors should be removed and stored inside whenever possible. When indoor storage is not possible the motors must be covered with a tarpaulin (do not use plastic). This cover should extend below the motor and be secured; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors. BAC motors are standard duty motors designed for storage at ambient temperatures of -25°C to 40°C. Prolonged periods of exposure below or above these specified conditions could degrade components of the motor and cause malfunction or premature failure.
- Coils must be empty and closed-off.
- Avoid cold temperatures.
- Avoid condensation.
- Check battery of Controller.

For complete instructions, please contact your local BAC representative.

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We offer tailored services and solution for BAC cooling towers and equipment.

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- Service solutions - preventive maintenance, repairs, refurbishments, cleaning and disinfection for reliable trouble-free operation.
- Upgrades and new technologies - save up energy and improve maintenance by upgrading your system.
- Water treatment solutions - equipment for controlling corrosion scaling and proliferation of bacteria.

For more details, contact your local BAC representative for further information and specific assistance at www.BACservice.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. Ministerie 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 raumluftechnische Anlagen. VDI 6022.

INTERESTING WEBSITES

Baltimore Aircoil Company	www.BaltimoreAircoil.com
BAC Service website	www.BACservice.eu
Eurovent	www.eurovent-certification.com
European Working Group on Legionella Infections (EWGLI)	EWGLI
ASHRAE	www.ashrae.org
Uniclîma	www.uniclîma.fr
Association des Ingénieurs et techniciens en Climatique, Ventilation et Froid	www.aicvf.org
Health and Safety Executive	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.



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COOLING TOWERS

CLOSED CIRCUIT COOLING TOWERS

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