



Liebert® EFC

The Highly Efficient Indirect Evaporative Freecooling Unit

User Manual

English, cod. 265386, rev. 16.03.2018

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This document, written in English, is the original version.

Conventions

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation that, if not avoided, may result in minor or moderate injury.

NOTICE indicates a property damage message.



NOTICE

The manual is retained for the entire service life of the machine;

The user reads the manual carefully before carrying out any operations on the machine;

The unit control must be used exclusively for the purpose which it is intended for; the manufacturer takes no liability in case of an incorrect use or a modification of the unit control



WARNING

This manual was prepared to enable the end user to carry out only the operation that can be done with the panels closed.

Only qualified personnel are allowed to carry out operations that require opening of the door or the equipment panels. The panel key supplied with the unit must be kept by a person responsible for the maintenance.



CAUTION

Before proceeding with installation, read all instructions, verify that all parts are included and check the nameplate to make sure the voltage matches available utility power.

For identification of the unit (model and serial no.) in case of the necessity for assistance or spare parts, locate the identification label on the outside of the unit.



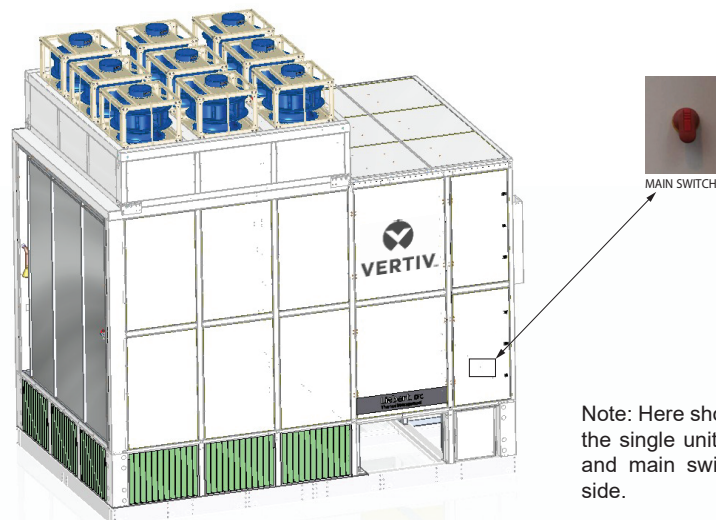
WARNING

This unit operates and restarts automatically.

If the electrical connection is live, there are residual risks: electric shock, burns, moving parts, automatic restarting from the remote control.

- **Before any operation that requires opening of the door or the equipment panels (maintenance, cleaning, etc.), disconnect the unit from the power supply.**

The ON/OFF switch on the control panel does not isolate the power from the unit, even in the “unit off” mode. To cut off the power supply, open the insulation device (main switch) which is positioned on the electrical panel cover, behind the door:



Note: Here shown the single unit left, on the single unit right the electrical panel and main switch are on the opposite side.

Unscrew the door and open it to access the main switch.

- After opening the door pay attention to the cable and components still energized.
- **Open the main switch to cut off the power before removing any protective cover.**



WARNING

The supply cable of the main switch contains live high-voltage.

- It is mandatory to install an external main switch on site easy to reach, to facilitate a quick and easy shutdown enabling the power of the unit to be cut off.

Refer to the unit electrical schematics for the installation. Follow all local codes.

If the unit is installed above some support, some electrical components will result higher: use a ladder to compensate the increased height.



CAUTION

If the unit door is open while the fans are operating, the airflow may suddenly slam the door open or close.

There is a risk of being hit by the door and hands being crushed.

- Before opening the door, switch off the unit using the local or remote control panel or the external main switch (if installed).

If small objects are left loose in the fans bay after any maintenance operation, it may result in the object ejection at the fans start-up.

There is a risk of being hit by small objects.

- Install all protection panels or a grid before starting up the fans after any maintenance operation.



WARNING

If the internal compartments are open immediately after the machine has been switched off, there might be some hazards related to:

- Components still at high temperature.
- Rotating elements (fan impellers, they might continue to rotate for a while by inertia)
- Sharp edges, splinters and exposed fasteners

Pay attention to the warning labels on the unit.



WARNING

Do not walk on unit's top



WARNING

This unit may contain recirculated chemically treated water (if a water treatment is in place in the refilled water) or biological contaminants. Please be aware that the mist / water vapor from this unit could be harmful if inhaled or ingested. Personal protective equipment (PPE) should be worn at all times when carrying out maintenance activities to minimize direct exposure to the discharge airstream and the associated drift / mist generated during water recirculation.

The unit should be installed and maintained strictly in accordance with prescribed local legislation. The unit should be positioned and installed in accordance with local planning and building regulations in order to prevent any drift / biological activity, or other unit discharge from entering the building's air system or from exposing people that are not trained/educated on the hazards that may arise from the unit.



Vertiv S.r.l.
Via Leonardo da Vinci, 16/18 35028 Piove di Sacco - Padova - Italy
Manufactured at Piove di Sacco plant (Italy)



model (35)
SERIAL N. (36)
VOLTAGE-PHASE-FREQUENCY (37)

COMPRESSOR
FLA (1) LRA (2) QT. (3)
COMPRESSOR
FLA (1) LRA (2) QT. (3)
FAN MOTOR INT.
FLA (4) LRA (5) QT. (6)
FAN MOTOR EXT.
FLA (7) LRA (8) QT. (9)
PUMP MOTOR
FLA (10) LRA (11) QT. (12)
TOTAL FLA AC TOTAL FLA DC Ipk (15) KA
A (13) A (14) Icw (16) KA

REFRIGERANT TYPE (17) GWP (38)

CIRCUIT 1	REFRIGERANT CHARGE	CIRCUIT 2	REFRIGERANT CHARGE
ON FACTORY	ON SITE	ON FACTORY	ON SITE
(18) Kg	(19)Kg	(20) Kg	(21)Kg
CO2 Tones		CO2 Tones	

MAX ALLOWABLE PRESSURE
HP SIDE(P.S) (22) Bar LP SIDE(P.S) (23) Bar
HIGH PRESS. SWITCH-MANUAL
SET (24) Bar RESET (25) Bar
LOW PRESSURE SWITCH
SET (26) Bar RESET (27) Bar
OPERATING AIR TEMPERATURE
min (28) 0C max (29) 0C
OPERATING AIR HUMIDITY
min (30) % max (31) %
CIRCUIT MAX. PRESSURE
Bar (32)
NET WEIGHT
Kg (33)
MANUFACTURING DATE (34)



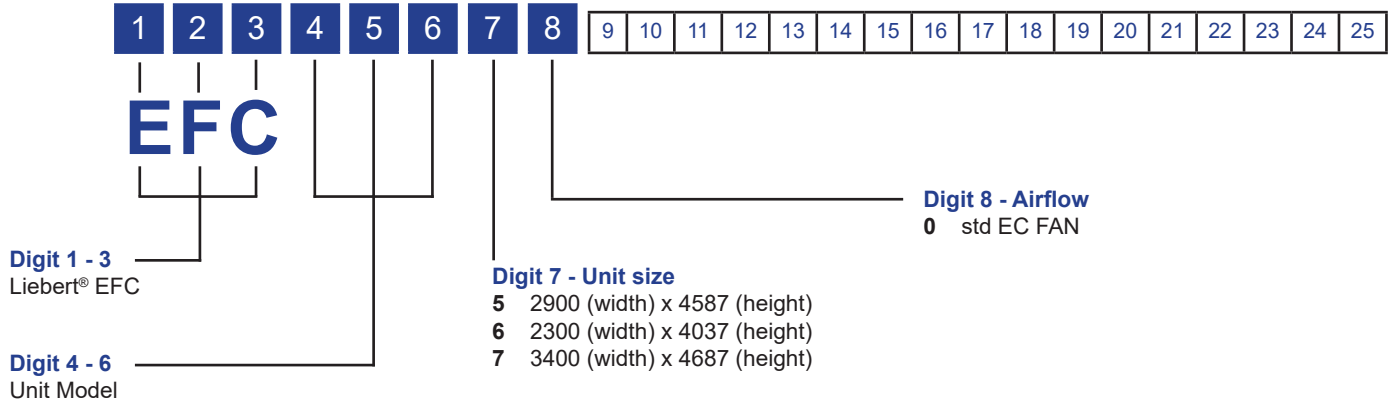
Attention: data relevant to the unit supplied is indicated on the inboard label (see the blank facsimile on the left).

Data in the manual is referred to standard conditions and can be modified without any advance notice.

Pos.	Description
1	Compressor Full Load Ampere [A]
2	Compressor Locked Rotors Ampere [A]
3	Compressor Quantity
4	Primary Side Fan Full Load Ampere [A]
5	Primary Side Fan Locked Rotor Ampere [A]
6	Primary Side Fan Quantity
7	Process Side Fan Full Load Ampere [A]
8	Process Side Fan Locked Rotor Ampere [A]
9	Process Side Fan Quantity
10	Evaporative System Pump Full Load Ampere [A]
11	Evaporative System Pump Locked Rotor Ampere [A]
12	Evaporative System Pump Quantity
13	Max. Unit AC Ampere [A]
14	Max. Unit DC Ampere [A]
15	Rated Peak Withstand Current [kA]
16	Rated Short-time Current [kA]
17	Refrigerant Type
18	Circuit 1 on Factory Refrigerant Charge [kg]
19	Circuit 1 on Site Refrigerant Charge [kg]
20	Circuit 2 on Factory Refrigerant Charge [kg]
21	Circuit 2 on Site Refrigerant Charge [kg]
22	High Pressure Side Maximum Allowable Pressure [bar]
23	Low Pressure Side Maximum Allowable Pressure [bar]
24	High Pressure Switch Stop [bar]
25	High Pressure Switch Restart [bar]
26	Low Pressure Switch Stop [bar]
27	Low Pressure Switch Restart [bar]
28	Min. Ambient Operation Temperature [°C]
29	Max. Ambient Operation Temperature [°C]
30	Min. Ambient Operation Humidity [%]
31	Max. Ambient Operation Humidity [%]
32	Max. Hydraulic Circuit Pressure [bar]
33	Unit Net Weight [kg]
34	Manufacturing Date
35	Model
36	Serial Number
37	Power Input
38	Refrigerant's Global Warmig Potential

Digit Nomenclature

The unit is fully defined by twenty five digits.



Digit 9 - Cooling system

P Evaporative, recirculating pumps

Digit 10 - Backup

0 None
X Backup (1 single digital)
T Backup (1 tandem digital)
D Backup (2 tandem digital)

Digit 11 - Modular

S Single Unit Left
D Single Unit Right

Digit 12 - Data Center Air Delivery

F Frontal

Digit 13 - External Air Discharge

T Top air discharge
A All (top+sides) discharge

Digit 14 - Data Center Air Suction

B Back Air Suction

Digit 15 - External filters

0 Metallic Filter
2 G2 + Clogged Filter

Digit 16 - Internal filters

1 G4 + Clogged Filter
2 M5 + Clogged Filter

Digit 17 - Devices

0 None
1 Predisposition for Low Ambient Kit
2 Overpressure Protection
3 Predisposition for Low Ambient Kit + Overpressure Protection

Digit 18 - Dual Power Supply / Control Backup

0 400 / 3 / 50 + N
1 400 / 3 / 50 + N + ATS
2 400 / 3 / 50 + N + ATS + UltraCap
3 400 / 3 / 50 + N + UltraCap

Digit 19 - Display and Switch

A Small Display
B Small Display + Network Switch
C Large Touch Screen + Network Switch

Digit 20 - Monitoring

0 None
1 Modbus 485 monitoring (digit 19=B,C)
2 Modbus IP monitoring (digit 19=B,C)
3 Bacnet MSTP monitoring (digit 19=B,C)
4 Bacnet IP monitoring (digit 19=B,C)
5 SNMP monitoring (digit 19=B,C)

Digit 21 - Sensors

0 None
1 Energy Meter
2 Water Meter
3 Energy Meter + Water Meter

Digit 22 to 24 - Free

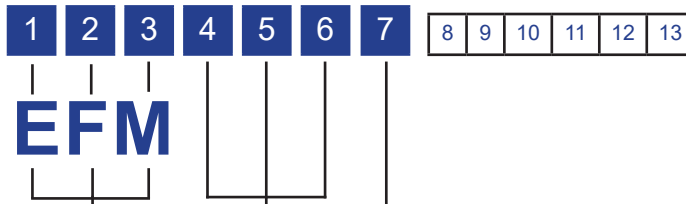
000 Standard Unit

Digit 25 - Special Requirements

0 None
X SFA

Digit Nomenclature (Fan Module)

The unit is fully defined by thirteen digits.



Digit 1 - 3
Fans modules

Digit 4 - 6
Fans modules type

Digit 7 - Fan Type (IT HAS TO BE EQUAL TO UNIT DIGIT 8)
0 Std EC FAN

Digit 8 - Backup (IT HAS TO BE EQUAL TO UNIT DIGIT 10)

- 0 None
- X Backup (1 single digital)
- T Backup (1 tandem digital)
- D Backup (2 tandem digital)

Digit 11 - Used to match unit power supply

- 0 400 / 3 / 50 + N

Digit 9 - External Air Discharge (IT HAS TO BE EQUAL TO UNIT DIGIT 13)

- T Top air discharge
- A All (frontal+top+sides) discharge

Digit 12 - Free

- 0 Free

Digit 10 - Packing

- P PLP and pallet
- C PLP and pallet
- S Seaworthy

Digit 13 - Special Requirements

- 0 None
- X SFA

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1 - General Description

Liebert® EFC is Vertiv answer to the latest and future Data Center needs.

The Data Center environment is growing constantly in terms of cooling needs consequently asking for cooling solutions that provide exactly what the servers need without wasting energy over-cooling as well as avoiding hot spots. **Liebert® EFC** as a result of EC fans and air-to-air aluminum heat exchanger maximizes efficiency at part loads, despite the variable conditions, as well as common cooling redundancy. **Liebert® EFC** results to be a top efficient solution at full load, while maximizing its benefit at part load conditions.

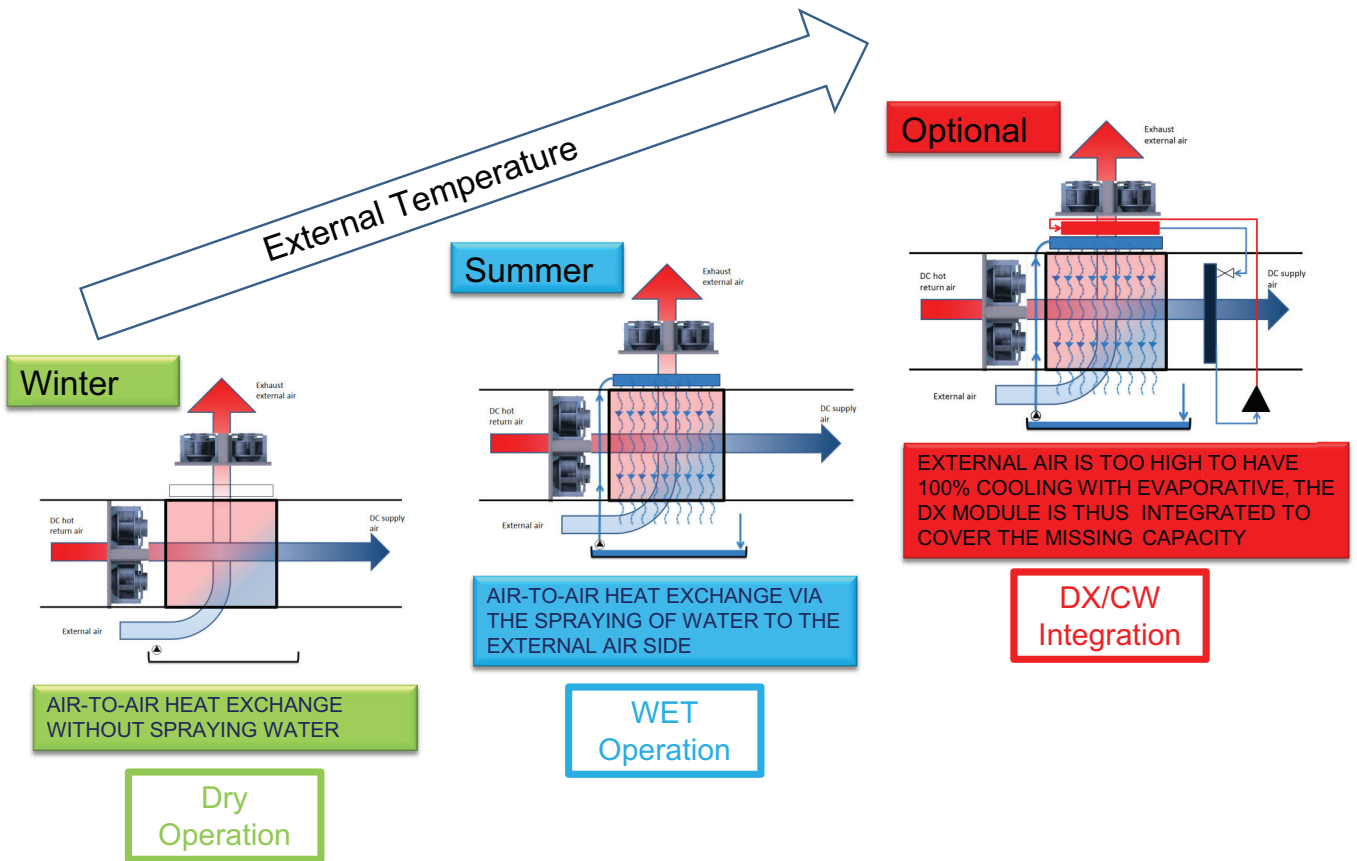
Liebert® EFC Operation Modes

Liebert® EFC works in different modes depending on the external air conditions:

- ▶ During the cold season (winter operation mode) return

air from the data center is cooled down, leveraging the heat exchange process with external cold air. There is no need to run the evaporative system and the fan speed is controlled by the external air temperature;

- ▶ During the warm season (summer operation mode) the evaporative system must run in order to saturate the air. This enables the unit to cool the data center air even with high external air temperatures. By saturating the air, the dry bulb temperature can be reduced;
- ▶ In the case of extreme external conditions, a Direct Expansion (DX) system is available to provide additional (Top-Up) cooling. As an alternative, the Chilled Water (CW) coil can be installed. DX and CW systems are sized to provide partial back up for the overall cooling load and are designed to provide maximum efficiency with minimum energy consumption.

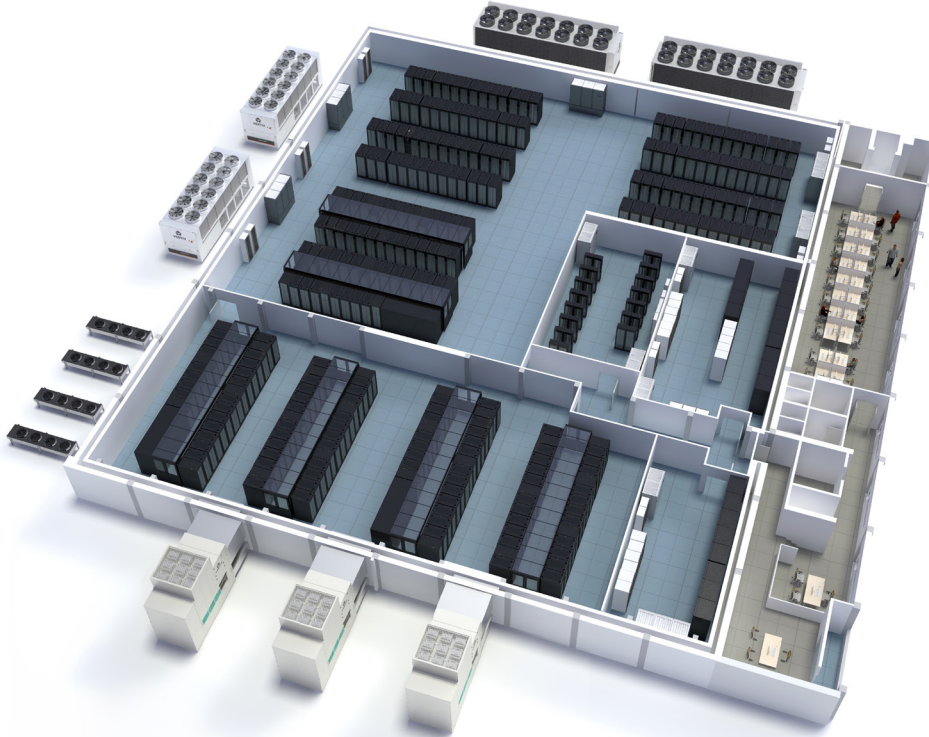


Smart Aisle™ Solution – When Smart Means Efficient

Liebert® EFC as part of Smart Aisle™ cooling solution is the best answer to ensure the right cooling while minimizing operating costs. Vertiv's cold aisle containment solution, can achieve an energy saving of up to 65% higher than other manufacturers' cooling units with standard technology. The intelligent control of the EC fans in order to get the needed cooling capacity, driven by cold aisle con-

ditions, guarantees increased savings.

Smart mode is a control algorithm developed for Smart Aisle™ applications (Cold Aisle containment) meeting the cooling and airflow needs of the servers without wasting a single Watt on unnecessary cooling or air movement.



Unit Control - Data Center Knowledge Matters!

The Unit Control makes a great difference and **Liebert® EFC** can exploit the knowledge of more than 20 years of data center cooling.

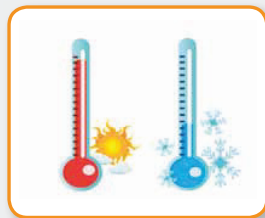
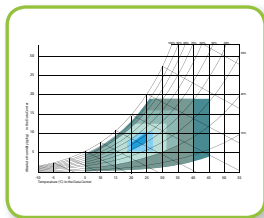
To guarantee ASHRAE RECOMMENDED guidelines - Extreme Winter Operation (i.e. temperatures <-20°C) can cause the unit's unrequired internal dehumidification causing it to exceed ASHRAE recommended minimum humidity. **Liebert® EFC** offers a constant control of data center air via its integrated iCOM™ control logic, ensuring dew point temperature is lower than heat exchanger surface temperature, thus avoiding unrequired dehumidification.

To provide PRECISE TEMPERATURE and AIRFLOW CONTROL - The SmartAisle™ control logic embedded in the iCOM™ optimizes internal air volumes and temperatures according to spe-

cific server needs.

SmartAisle logic allows **Liebert® EFC** to exactly match the servers' airflow needs, ensuring that not even a single Watt is wasted in moving or cooling unrequired air.

To optimize WATER and ELECTRICITY costs - The user friendly iCOM Control exploits the management of energy and water also at teamwork level. The system collects information from the different units' key parameters and operating modes (dry, wet and DX/CW) while taking into account water and electricity costs. The control predictively calculates and then implements the combination which optimizes operating costs.



Utmost Efficiency Even at the Data Center System Level

The iCOM Control manages the operation of the **Liebert® EFC** units, in order to ensure top reliability in all conditions. Access to the units installed in the data center, is granted through the Eth-

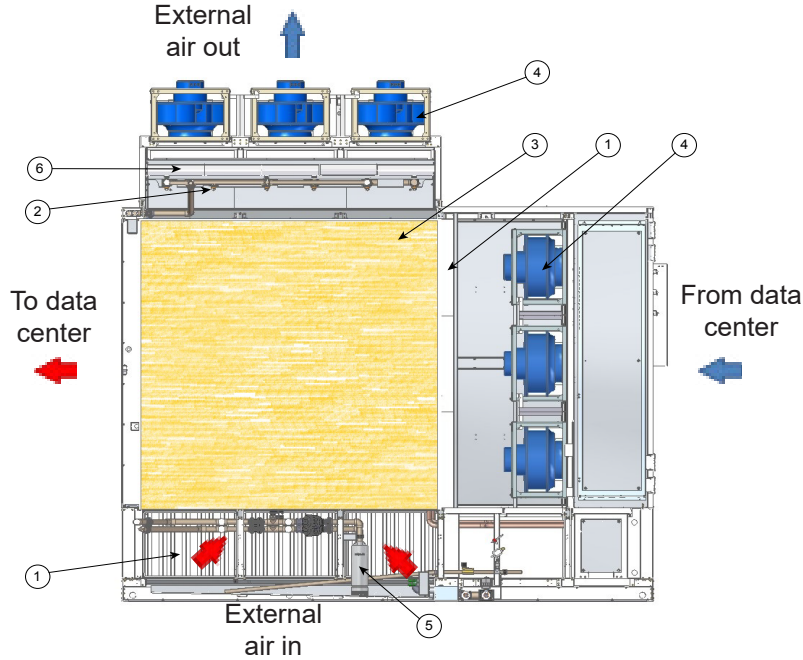
ernet connection, that is capable of coordinating the multiple on-site installations. The high-level supervision of multiple units allows these to work together as a single system, thus optimizing overall system performance.

Liebert® EFC Cooling Options

Evaporative Cooling Working Mode

The Liebert® EFC standard unit is provided with EC fans (4) that push the data center air and pull the outdoor air through an air-to-air epoxy coated aluminum heat exchanger (3), where the outdoor air absorbs heat from the data center air. The Data Center air passes through the air filters (1) and the heat exchanger (3)

where it cools down. The outdoor air passes through air filters (1) and through the heat exchanger (3) where it absorbs heat from the Data Center air. If required, the evaporative system, composed of sprinklers (2), pumps (5) and droplet separator (6), cools down the outdoor air as it passes through the heat exchanger (3), increasing thus its capacity to extract heat from the Data Center air.

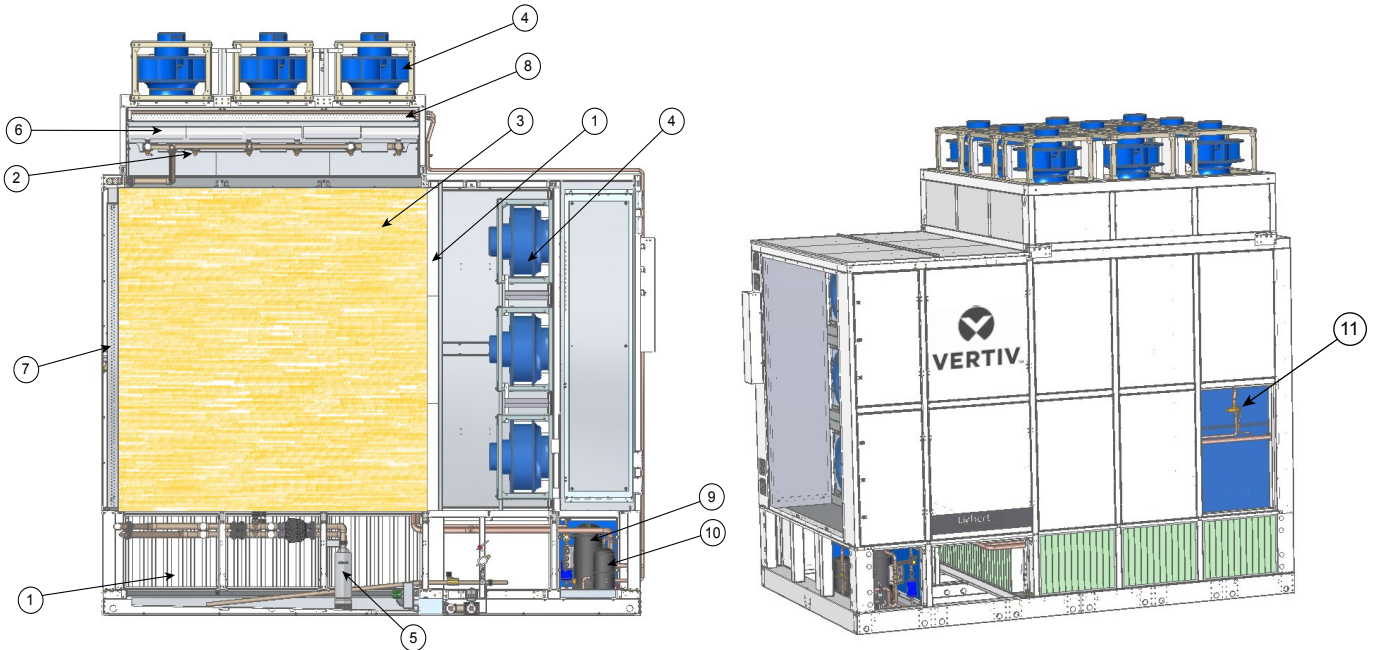


In climates featuring high levels of humidity the unit requires the integration of a Direct Expansion (DX) System or the installation of a Chilled Water (CW) Coil.

Evaporative Cooling and DX Cooling Working Mode

When the unit is equipped with a DX backup system the Data Center air passes, after it exits the air-to-air heat exchanger (3),

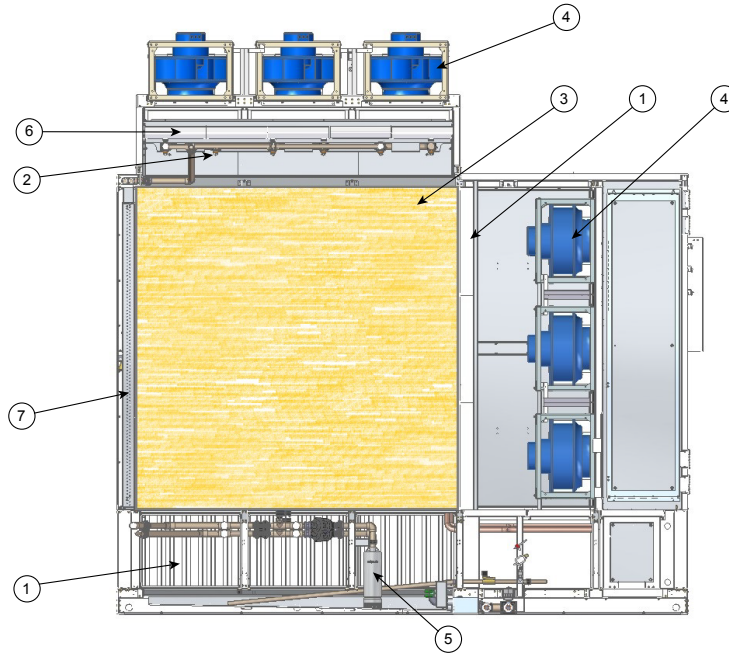
through an evaporator (7) which cools down the air to the desired temperature. The other main components of the DX system are: the condenser (8) mounted at the exit of the heat exchanger (3) on the outdoor air side, the digital scroll compressor (9), the liquid receiver (10), the safety valve and the thermostatic expansion valve (11).



Evaporative Cooling and CW Cooling Working Mode

When the unit is equipped with a CW backup system the Data Center air passes, after it exits the air-to-air heat exchanger (3),

through a CW coil (7) which cools down the air to the desired temperature. The waterflow through the chilled water coil is adjusted with a two-way or three-way valve.

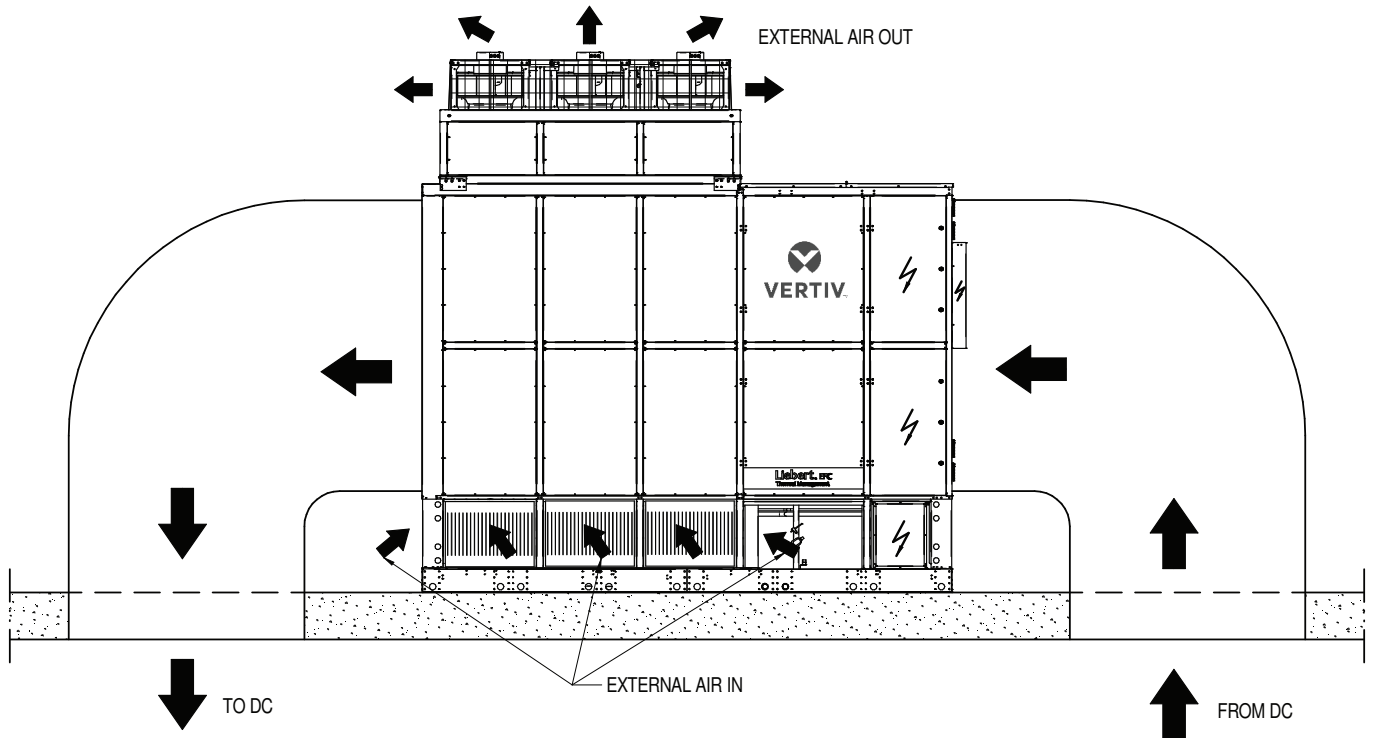


Air discharge version (digit 12, 13 & 14)

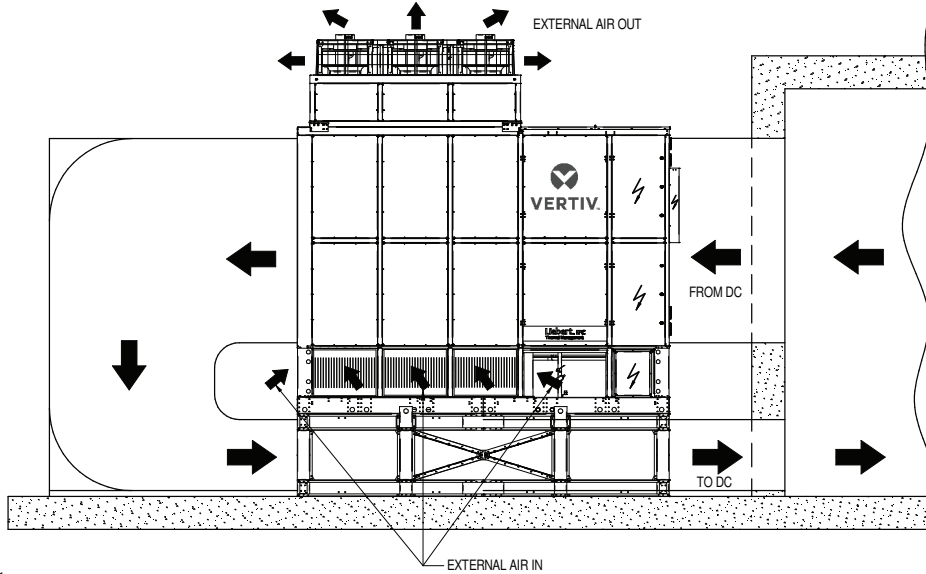
Liebert® EFC offers multiple options for air discharge position, both on the data center side and on the side of the outside air, in order

to meet all the possible data center configurations (perimeter configuration or roof configuration).

Roof Configuration



Perimeter Configuration



1.1 - Operating limits

Liebert® EFC units are provided for operating within the following working ranges (the limits concern new units on which correct installations have already been made):

Tab. a - Operating limits

For all units

Room air conditions	Temperature:	from 20°C to 50°C
Storage conditions/ambient running condition <i>*with evaporative cooling working</i>	from:	- 30°C(*10°C)
	to:	50°C
Power supply tolerances		V ± 10%, Hz ± 2

For units with remote condenser

Outdoor temperature: lower limit Exceeding the winter low temperature limits could stop the compressor(s) by Low Pressure transducer. Reset to normal operation can only be carried out manually through the unit control.	
down to - 20° C	between - 20° C and - 30° C
Remote condenser fan speed control (VARIEX) required	Remote condenser fan speed control (VARIEX) + Head pressure control valve (LOWTEX) + increased liquid receiver required.
Outdoor temperature: higher limit This limit is determined by coupled condenser model. Exceeding this limit (or a lack of maintenance), the compressor(s) could stop by High Pressure switch. Reset to normal operation can only be carried out manually.	
Approved Remote Air Condenser To ensure correct operation, best performance, and longest life the units must be connected to remote condensers approved by Vertiv. The warranty clauses are no longer valid if the unit is connected to an unapproved remote condenser.	

Note: The above information is related to remote condenser installation only

- (1) Positive difference in height: condenser above conditioner
- (2) Negative difference in height: condenser below conditioner

Relative position room unit vs. remote condenser	
From unit to condenser, max distance	up to 60 m equivalent length
From unit to condenser, max geodetic height ^{(1) (2)}	from 20 m to - 3 m
Requirements	
Pipe diameter	see Tab. 4.1
Oil traps on vertical upward line of refrigerant gas	every 6 m, max
Extra oil charge	see Tab. B.3
Remote condenser fan speed control (VARIEX) installation	mandatory
Condenser	design
Additional non return valve on delivery line, at 2 m from compressor	recommended
Insulation external liquid pipe line	allowed

For units with chilled water coil

Chilled water circuit		
Inlet water temperature	min. 5°C	
Water pressure	max. 16 bar	
Max. differential pressures on the modulating valve (2 or 3 ways)		
- Max. differential pressure through the closed valve: Δp_{cv}		
- Max. differential pressure across the valve for modulating service: Δp_{ms}		
Models	Δp_{cv}	Δp_{ms}
	(kPa)	(kPa)
EFC220, EFC300, EFC320, EFC400 (chilled water circuit)	300	200

1.1.1 - Noise level limits

The sound pressure level in free field at 1m (average value in accordance with standard ISO 3744, data center side ducted, free process side discharge), is 85.3 dBA with unit in operation at 100% of process fan speed and 77.4 dBA with unit in operation at 75% of process fan speed.

2 - Preliminary Operation

2.1 - Safety Information WARNING!

**WARNING!**

Risk of top-heavy unit falling over! Improper handling can cause equipment damage, injury, or death! Read all of the following instructions before attempting to move, lift, remove packaging, or preparing unit for installation.

**CAUTION!**

Risk of sharp edges, splinters and exposed fasteners! Can cause personal injury! Only properly trained personnel wearing appropriate safety headgear, gloves, shoes, glasses and safety sling hook on scaffolding to work at height, should attempt to move, lift, remove packaging from the unit or prepare the unit for installation.

**CAUTION!**

Risk of overhead interference! Can cause unit and/or structure damage! The unit may be too tall to go through low and narrow passageway. Measure the unit and doorway heights and refer to the installation plans prior to moving the unit to verify clearances.

**NOTICE!**

Risk of unit damage if improperly stored! Keep the unit protected from water before unit ducts installation.

**NOTICE!**

The unit will always be shipped in two packages, one containing the unit and one containing the process fans module.

**WARNING**

Do not walk on unit's top

2.2 - Equipment Inspection

Upon arrival of the unit, and before unpacking, verify that the labeled equipment matches the Bill of Lading.

Carefully inspect all items for either visible or concealed damage. Damage should be immediately reported to the carrier and a damage claim filled in with a copy sent to Vertiv or to your sales representative.

2.3 - Packing material

All material used to package this unit is recyclable. Please save for future use, or dispose of the material appropriately.

2.4 - Recommended Unit Handling

**Lifting Procedure**

The operators must wear helmet, safety shoes, gloves. Place two lifting tubes in the holes indicated on the unit basement. The capacity of the lifting tube must be adequate to support the unit load.

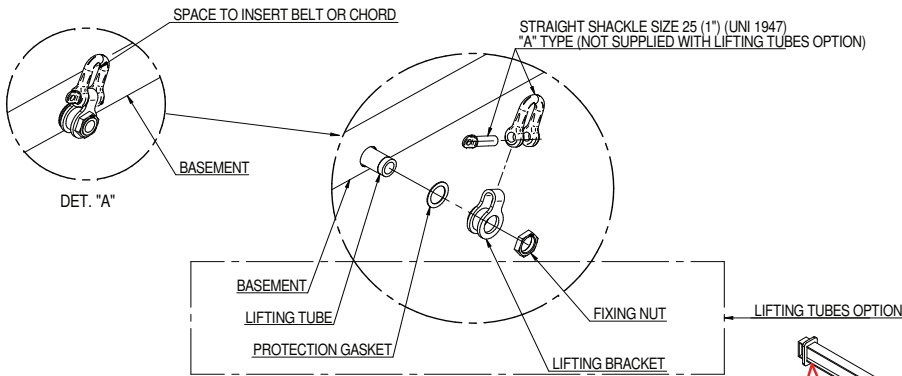
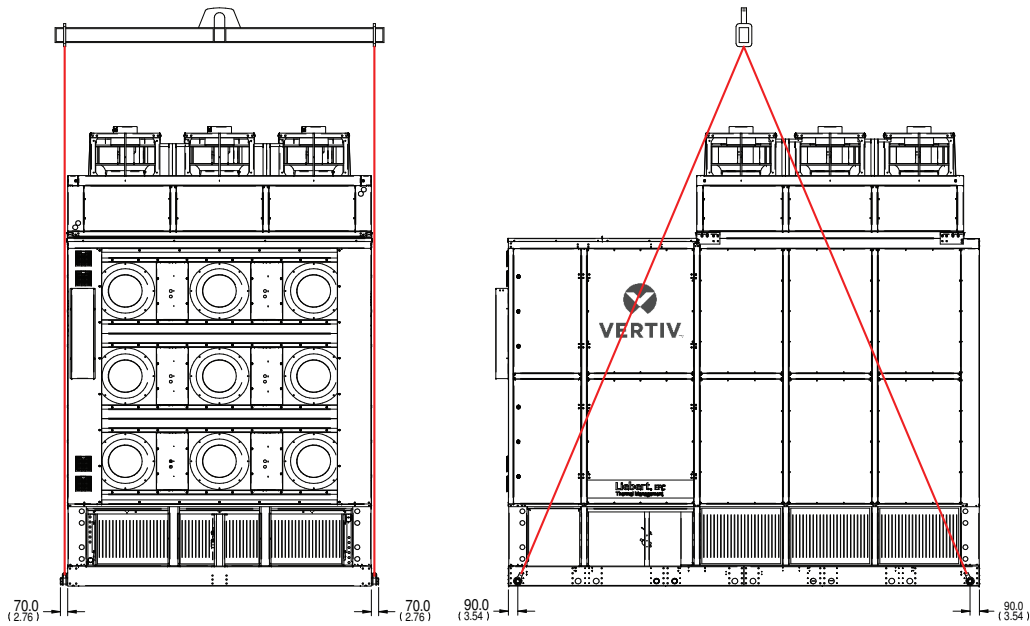
Remove lifting tubes after unit installation.

The unit basement holes diameter is 56 [mm].

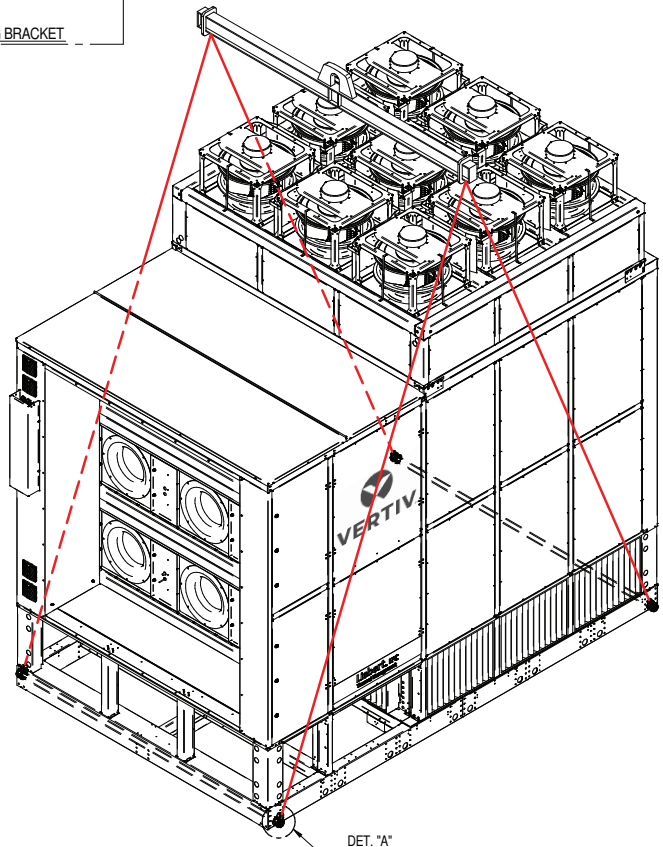
**WARNING!**

Do not lift the entire unit using eyebolts placed on fan module top.

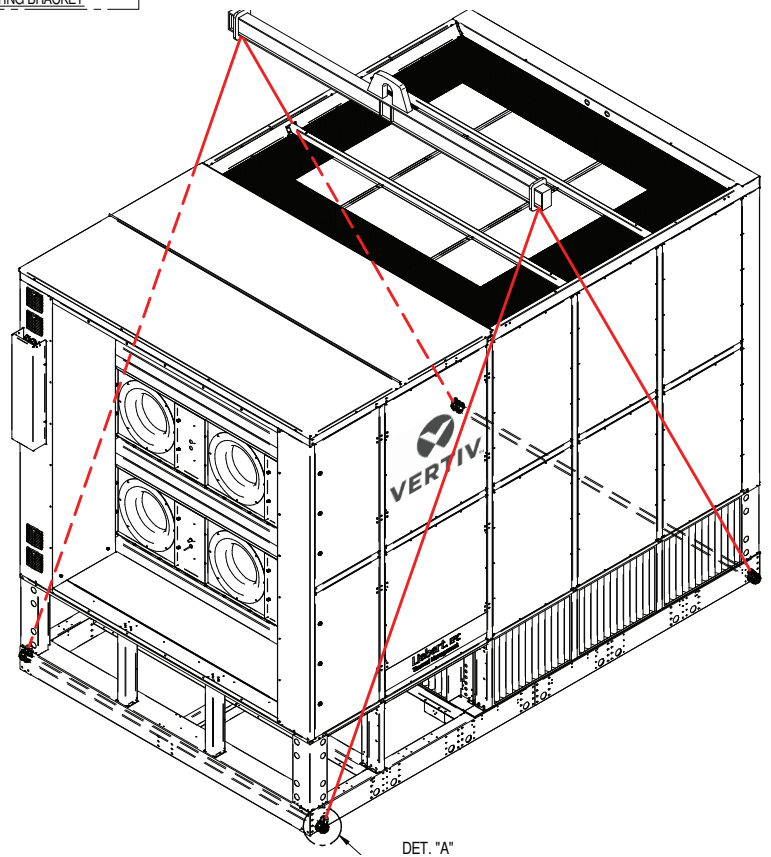
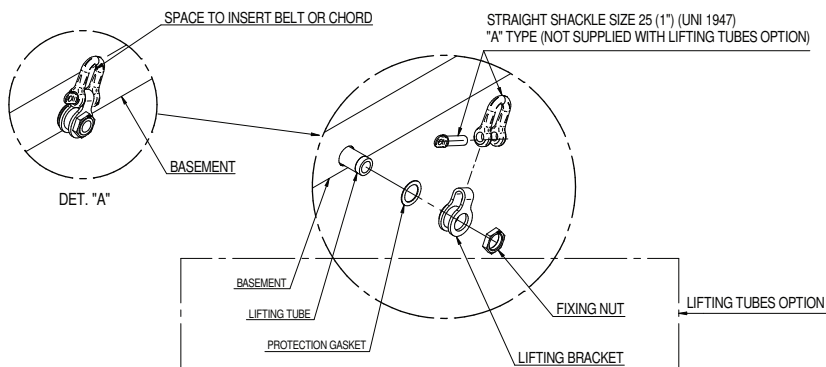
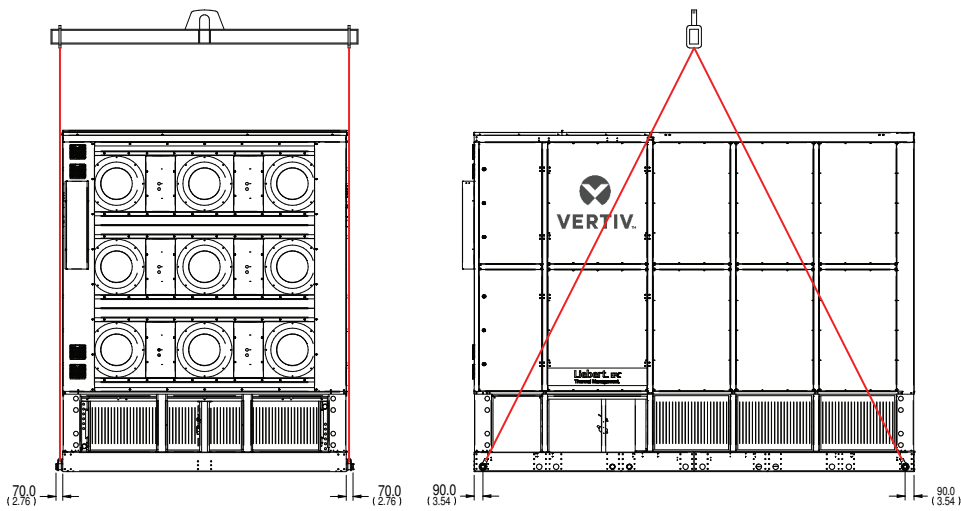
Assembled unit recommended handling



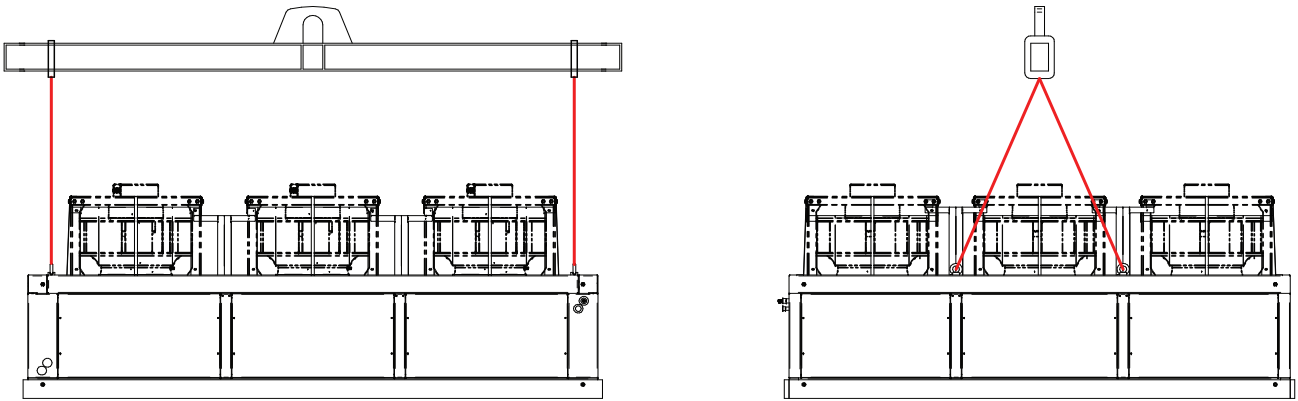
WARNING!
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Remove lifting tubes after unit installation.



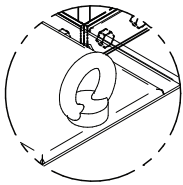
Heat exchanger module recommended handling



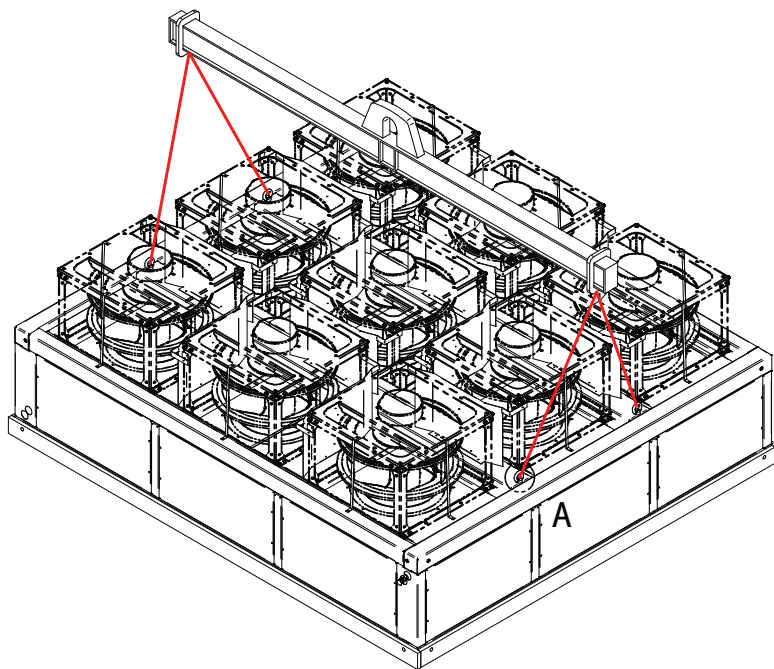
Fan module recommended handling



WARNING!
Do not lift the entire unit using eyebolts placed on fan module top.



DET. A
EYEBOLT DETAIL
TYP. 4 PLACES



2.5 - Unit Weight

The total unit weight must be calculated by adding the heat exchanger module weight and fan module weight.

Note: data above refer to standard units without any option.

Tab. 2.1 EFC220 Unit Weight

Unit	Weight [kg]
EFC22060PO	3100
EFC22060PX	3300
EFC22060PT	3400
EFC22060PD	3250
EFM2200O	630
EFM2200X	690
EFM2200T	730
EFM2200D	630

Tab. 2.2 EFC300 Unit Weight

Unit	Weight [kg]
EFC30050PO	4800
EFC30050PX	5050
EFC30050PT	5170
EFC30050PD	4950
EFM3000O	1280
EFM3000X	1380
EFM3000T	1480
EFM3000D	1280

Tab. 2.3 EFC320 Unit Weight

Unit	Weight [kg]
EFC32050P0	4100
EFC32050PX	4350
EFC32050PT	4470
EFC32050PD	4250
EFM32000	1055
EFM3200X	1160
EFM3200T	1200
EFM3200D	1055

Tab. 2.4 EFC400 Unit Weight

Unit	Weight [kg]
EFC40050P0	5330
EFC40050PT	5600
EFC40050PD	5680
EFM40000	1240
EFM4000T	1380
EFM4000D	1390

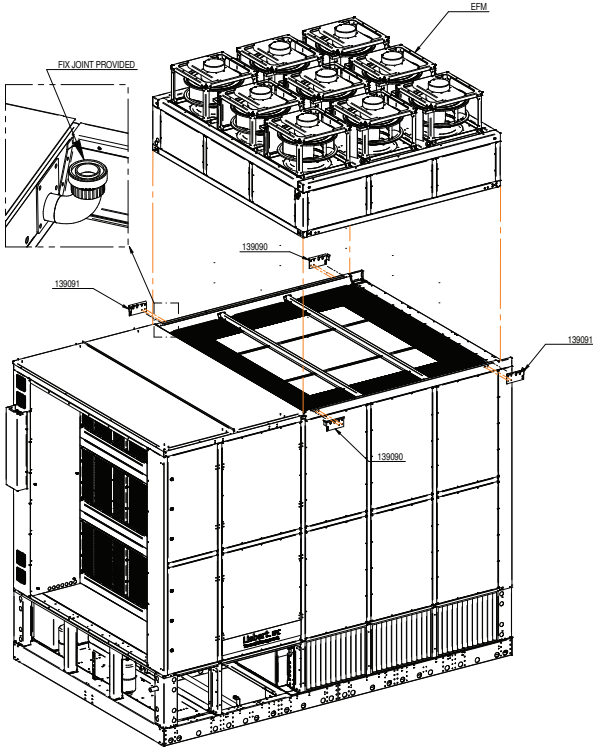
3 - Assembly

The Liebert® EFC unit is supplied in two modules, the heat exchanger module and the process fans module. The unit modules must be connected close to or on the final working position.

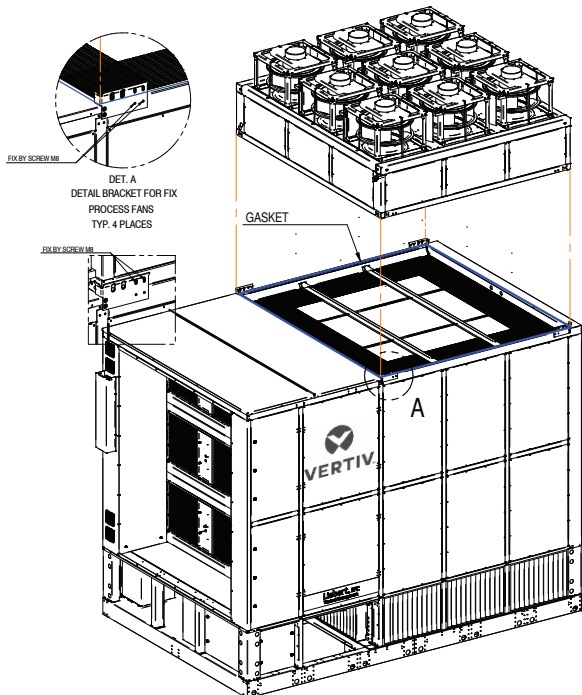
Make sure you have the space available for mounting operations. After the assembly the unit can be moved and positioned in the working site. See chapter 5 - Positioning.

For a correct assembly you must follow the next steps:

1. Place the two modules (heat exchanger module and process fan module) close to or on the final position.

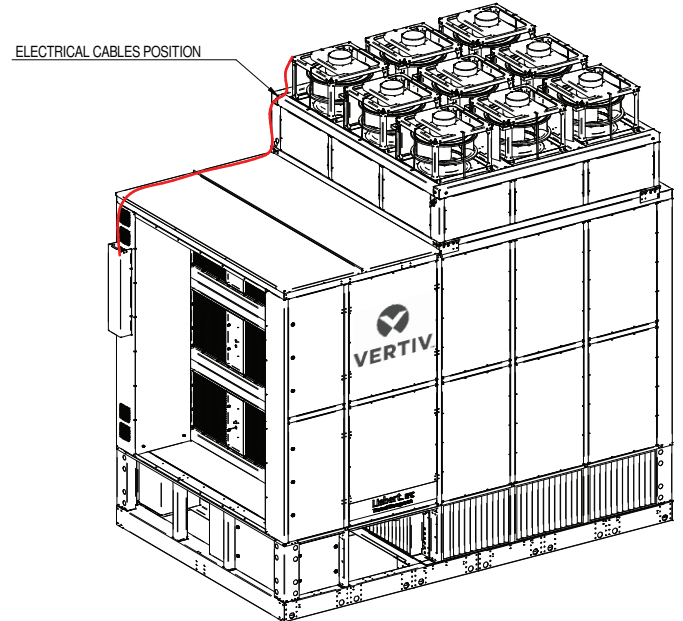


2. Put the gasket on the heat exchanger module, fix the four brackets on heat exchanger module.



Fix the joint provided, see picture

3. Fix the two modules with the supplied four brackets (for each bracket use four M8 screws).
4. Run the electrical cable positioned in the fan module to the electrical connectors.

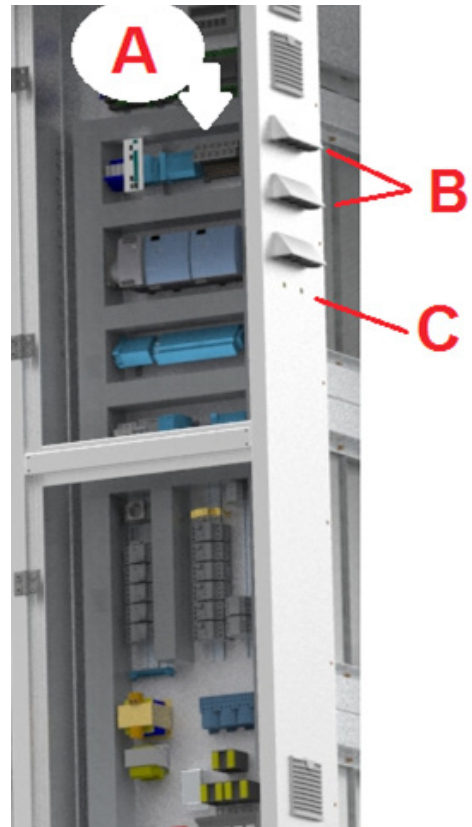


Fans cables has to be connected on connectors A using the holes B for entering with the cables.

Ensure to install the grommets supplied to keep the holes closed and secure the cables with cable ties provided inside the electrical panel.

Pressure hose has to be connected with connector C (only with overpressure protection option)

See the picture below.



5. Connect the pipes to the evaporative system racks.

Connect the pipes to the evaporative system rack: remove the fan module panels (see drawing and det. C), inside there is one connecting pipe, remove from shipping position, remove protection plugs, oil the gaskets supplied (one for each joint) and connect piping with the joints

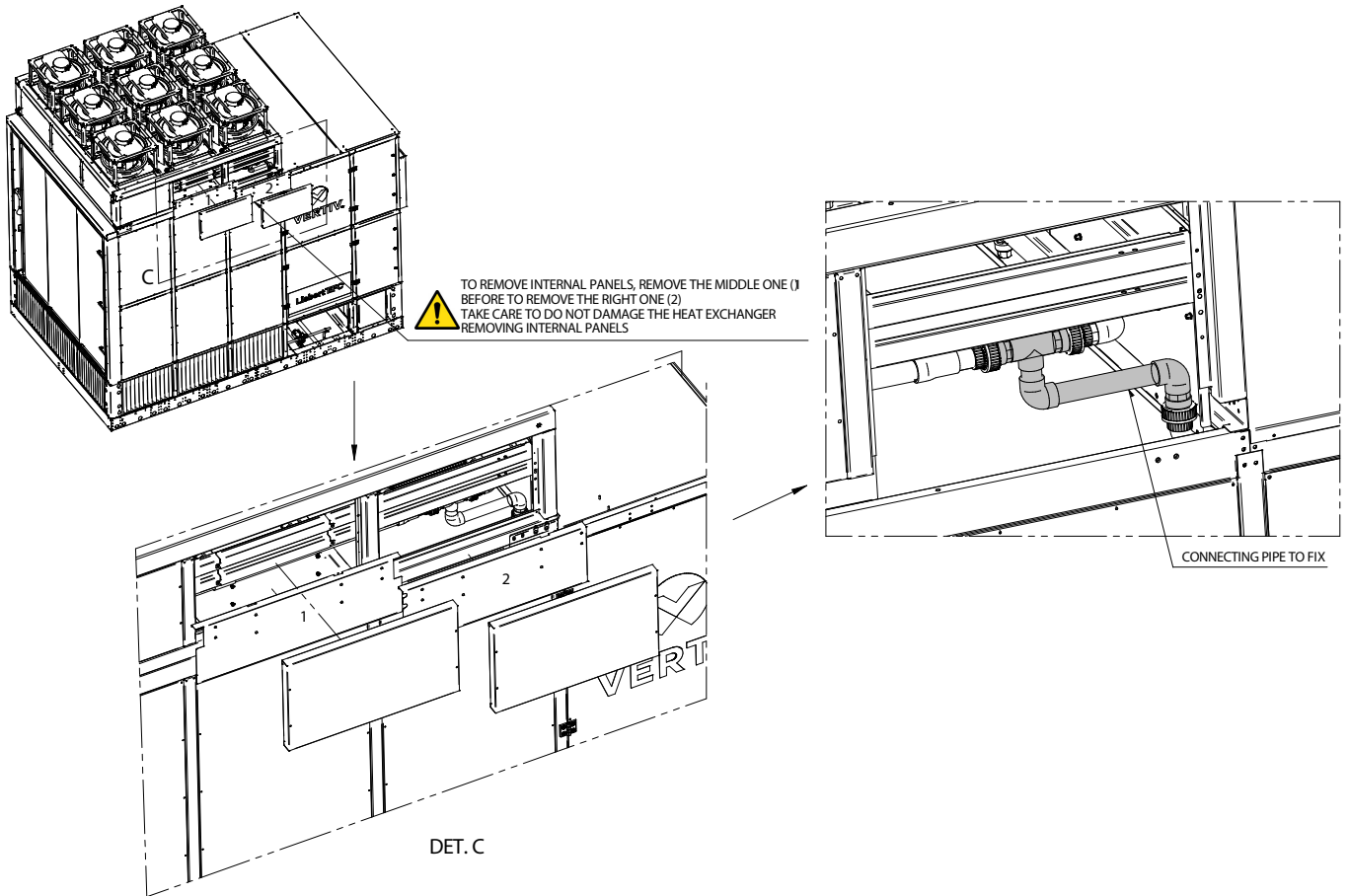


Pay attention not to damage the heat exchanger fins fixing joints.



Remove protection plugs from joints before assembly.

HYDRAULIC CONNECTIONS EFC 220, EFC 300, EFC 320, EFC400



6. If the unit is equipped with a DX system the connections between the condenser and the compressor must be done on site (see Chapter 4 - Refrigeration connections).



In order to remove fan module panels, remove before external panels (painted), then remove the middle internal panel prior to removing right and left internal panels. Pay attention not to damage the heat exchanger while removing internal panels.

4 - Refrigeration connections

4.1 - Refrigeration pipeline connections

The condensing coil, installed inside the fan module is delivered helium-pressurized at 2 bar. In case of remote condenser installation, the air condensing units are delivered helium-pressurized at 2 bar.



CAUTION: The discharge operation of the heat exchanger module unit pressurized with helium (at 2 bar) and the unbrazing of the bottoms from the connections must be carried out as last operations, immediately followed by the connection and emptying of the whole system. During brazing operation, protect components around from superheating/damaging.

4.1.1 - General layout

For the standard unit with the condensing coil installed inside the fan module, the piping to do the refrigerant connections are supplied with the unit. In case of remote condenser installation follow the steps below:

1. In soft or hard copper. The diameter required is stated in Tab. 4.1.
If the installer intends to use pipes of a larger diameter (e.g. for long winding runs) then consult Technical Sales Support. Use as short refrigeration pipelines as possible to minimize the total charge of refrigerant and the pressure drops. Lay the horizontal gas pipes with 1% downward gradient towards the refrigerant flow.
2. Reduce the number of bends, which must be of large radius, to a minimum.
3. Insulate the piping. If the pipes are put next to the electrical cables it is advised to insulate them to avoid damage to cable insulation.
4. There must be a minimum separation of 20 mm between the gas and liquid pipelines. If this is not possible insulate both lines.
5. Support both horizontal and vertical pipes with vibration-dampening clamps (which include rubber gaskets). Place these every 1.5 - 2 m.

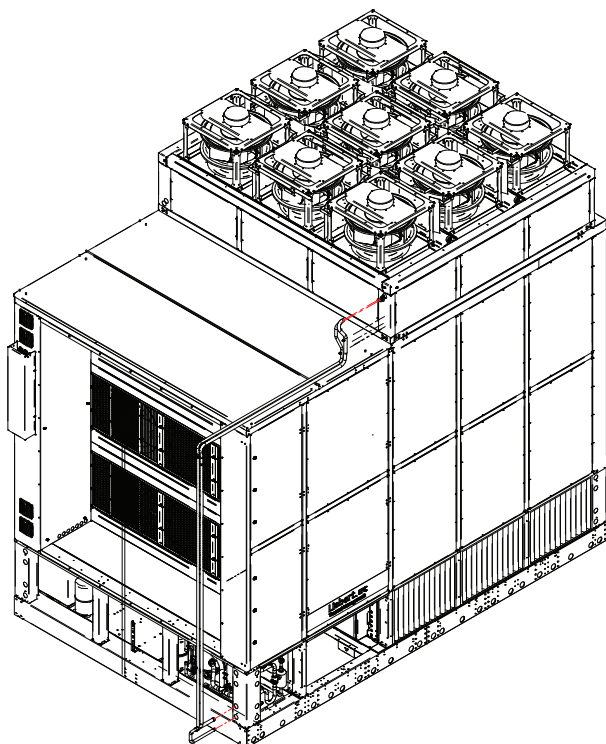
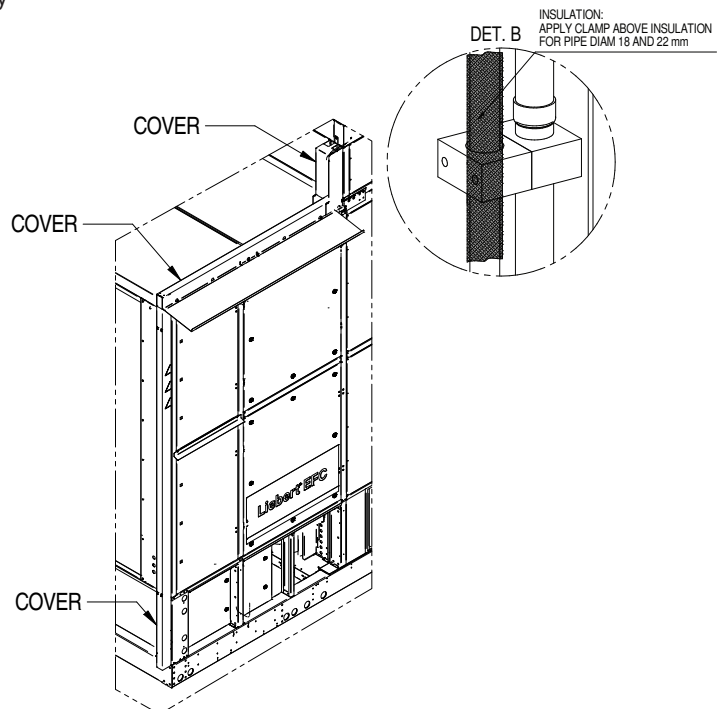
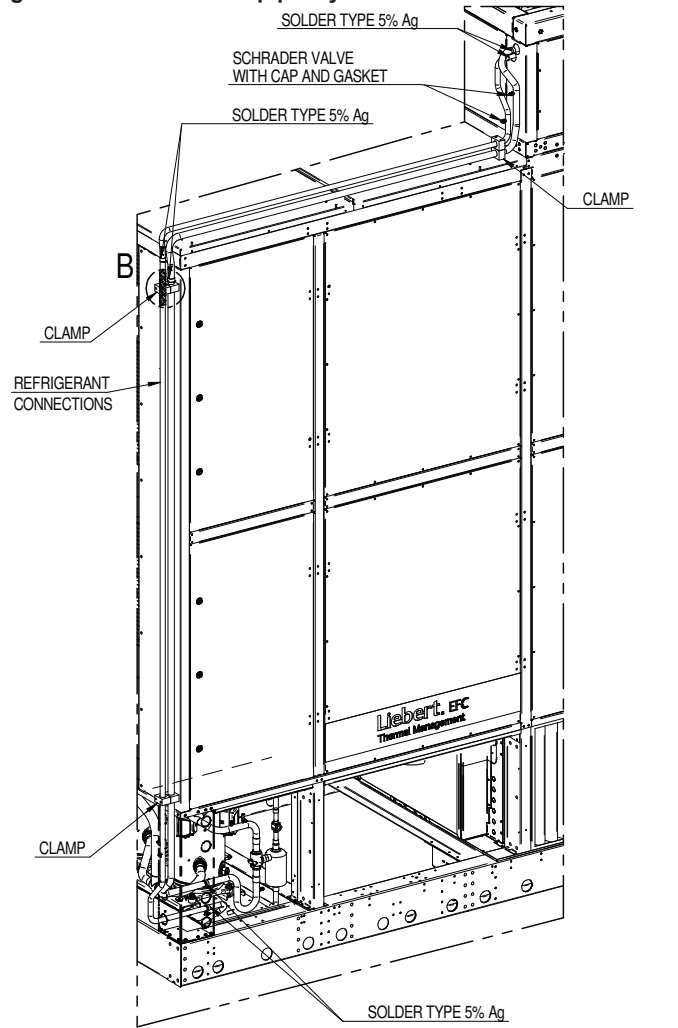
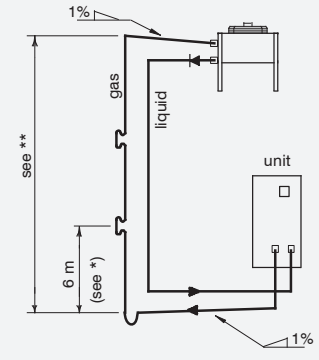
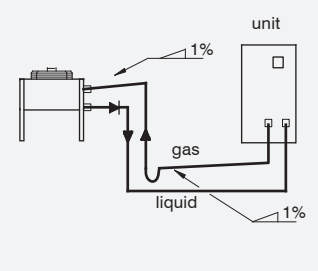
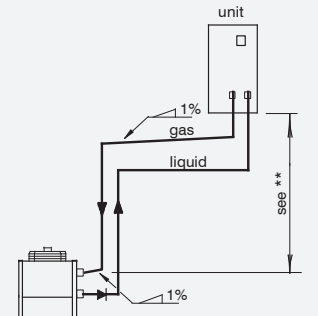


Fig. 4.1 - Recommended pipe layout



CONDENSER POSITION			CONDENSER ABOVE CONDITIONER	CONDENSER AND CONDITIONER AT SAME LEVEL	CONDENSER BELOW CONDITIONER (not recommended)
INSULATION	gas	int.	necessary	necessary	necessary
		ext.	only for aesthetic reasons	only for aesthetic reasons	only for aesthetic reasons
	liq.	int.	absolutely not	not necessary	no (expose to cold underfloor air)
		ext.	only for aesthetic reasons	only if exposed to sun	only if exposed to sun
LAYOUT					
			(*) Oil traps every 6 m of vertical piping		

4.1.2 - Pipe diameter (remote condenser)

In case of remote condenser installation, the diameters of the connecting pipes between the unit and the condensing unit listed in Tab. 4.1 must be respected, otherwise the guarantee becomes invalid.

WARNING: Due to higher pressure with R410A, use copper pipes and copper fittings with thickness at least 1,5 mm when external pipes diameter are higher than 18 mm and lower than 42 mm, in any case suitable for the refrigerant circuit working pressure.



Tab. 4.1 Standard pipes diameters

STANDARD PIPE DIAMETERS (Valid for equivalent lengths up to 60 m)		
MOD.	copper tube external diameter x thickness [mm] R410A	
	Gas	Liquid
	EFC30050PX	28 x 1.5
EFC30050PT	35 x 1.5	28 x 1.5
EFC22060PX	28 x 1.5	22 x 1.5
EFC22060PT	35 x 1.5	28 x 1.5
EFC32050PX	28x1,5	22x1,5
EFC32050PT	35x1,5	28x1,5
EFC40050PT	35x1,5	28x1,5
EFC40050PD	35x1,5	28x1,5

4.1.3 - Installing pipelines

THE FOLLOWING OPERATIONS MUST BE CARRIED OUT BY AN EXPERIENCED REFRIGERATION TECHNICIAN.



CAUTION: The discharge operation of the refrigerant circuit pressurized with helium (at 2 bar) and the unbrazing of the bottoms from the connections must be carried out as last operations, immediately followed by the connection and emptying of the whole system.

- Lay the piping, taking note of the following:
 - Welding:
 - All joints must be braze-welded.

- Avoid butt welds by using sleeves or enlarging one of the pipes using a pipe opener.
 - Use silver-based solders and the correct apparatus.
 - Guarantee a correct weld as a refrigerant leak, or a faulty weld which leads to a leak later on, can seriously damage the air conditioner.
 - Always use large-radius curves (bending radius at least equal to pipe diameter). Bend the pipes as follows:
 - Soft copper: by hand or bending device.
 - Hard copper: use preformed curves. Do not overheat the pipes when welding so as to minimize oxidation.
- Connect the pipes to the condenser:
 - Condensers with butt-welded pipe connections: cut the pipe, enlarge it and weld it to the pipeline.
 - Condensers with threaded tap connections: flange the pipes and connect.

RESPECT THE DIRECTION OF THE REFRIGERANT FLOW (SEE LABELS ON REFRIGERANT CONNECTIONS).

- Wash out the pipelines as follows:
 - Plug up the free ends of the pipes.
 - Connect a helium or nitrogen cylinder, fitted with a reducer (max. pressure 10 bar), to the 1/4" SAE Schrader valve of the condenser.
 - Pressurize the pipes with helium or nitrogen.
 - Unplug the pipes instantaneously.
 - Repeat a. - d. several times.

THIS OPERATION IS IMPORTANT TO AVOID REFRIGERANT FILTER CLOGGING, ESPECIALLY WHEN HARD COPPER PIPING IS USED.

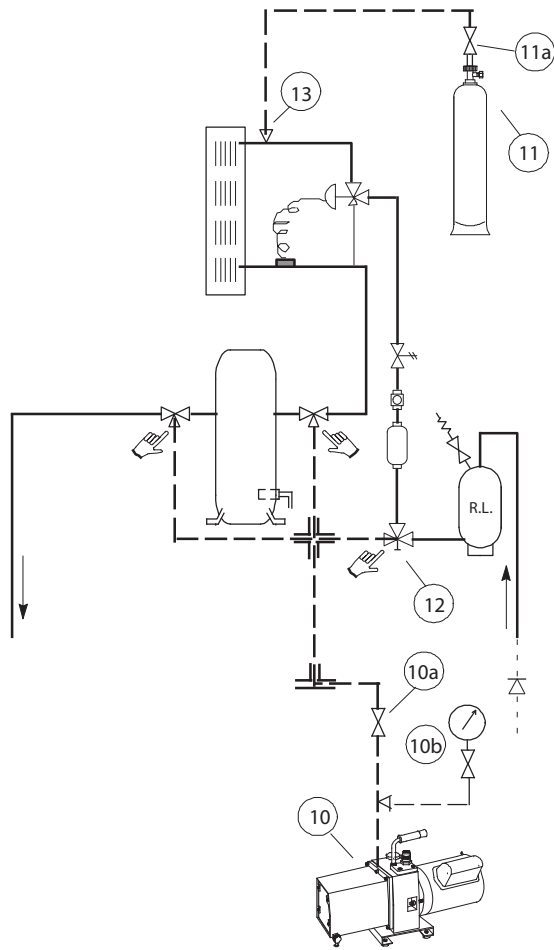
- Open the heat exchanger module unit shut-off valve.
- Discharge the heat exchanger module unit pressurized with helium (at 2 bar) opening the charge valves so that all the branches of the circuit are discharged (e.g. on the receiver, on the low pressure side and on the compressor delivery).
- Unbrazing the bottoms from the connections of the heat exchanger module unit.
- Fix (weld) the pipes.

4.2 - Vacuum creation and refrigerant charge



NOTICE: Check the refrigerant type to be used on the data plate of the unit and on the refrigerating compressor.

Fig. 4.2 - Vacuum Pump and refrigerant charging cylinder connections for vacuum creation and refrigerant charge



4.2.1 - R410A precharge

1. Open all valves of the system including those used for pressurizing and energize the solenoid valve. With this operation all the components of the refrigerant circuit are subjected to vacuum.
2. Connect a proper, high efficiency vacuum pump (10) suitable for polyester oils to the couplings:
 - Compressor intake and delivery using the 5/16 Schrader valves welded on the piping.
 - Schrader coupling (12) fit on the liquid receiver.
3. Provide for a connection with refrigerant cylinder before making vacuum.
4. Make the system vacuum up to 0.3 absolute mbar and after 3 hours check if 1.3 absolute mbar have not been exceeded. This condition ensures a humidity lower than 50 ppm inside the system. If the complete vacuum is not possible, this means that there are some leaks (to be removed according to the instructions in 6 below). The additional oil charge is already charged in factory. Check the right oil level in sight glass during the commissioning (see 7.1). If the level is too low see 8.6.2.

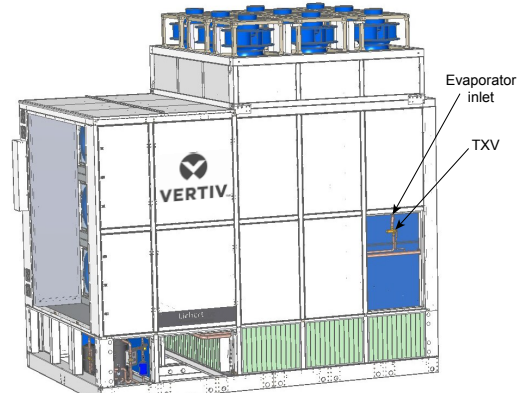


NEVER USE THE COMPRESSOR TO CREATE A VACUUM (THIS INVALIDATES ITS GUARANTEE).

5. Break the vacuum as follows:
 - a. Close the valve (10a) for the vacuum pump (10).
 - b. Open the valve of the refrigerant cylinder (11a) until the system reaches a pressure value of about 1 bar.



NOTICE: The refrigerant must be introduced and charged on the evaporator inlet (5/16 Schrader valve) taking only liquid fluid from the cylinder.

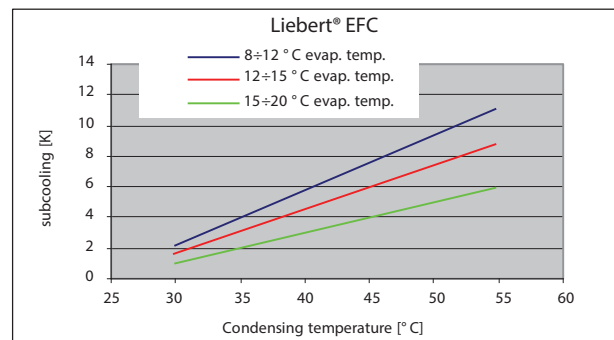


Note: With low ambient kit, remove low ambient kit external panel to reach the TXV.

- c. At this point both the vacuum pump and the refrigerant cylinder can be disconnected as follows:
 - c1. close the cylinder cock (11a)
 - c2. close the way 5/16" SAE of the connected Schrader valves.
6. Inspect all connections/joints using a leak detector. If a leak is found, empty the pipes and the condenser, seal the leak and repeat the instructions in 3) - 6).
 7. Now the machine is ready for completing the charge and the start-up.
 8. Charge the refrigerant (ONLY LIQUID) by means of the charge valve placed at the evaporator inlet.

4.2.2 - R410A refrigerant charge

1. Start the unit.
2. Manually start the compressor (when the unit is equipped with tandem compressors start both of them), ensure the unit is not in the dehumidification phase).
3. Guarantee a constant condensing temperature (preferably 42-45°C); if necessary, partially obstruct the condenser coil surface or limit its ventilating power to obtain these conditions.
4. Charge the unit until the working conditions of the entire refrigeration circuit have become normal.
5. Using a manometer, check that the evaporating temperature is above 0°C.
6. Verify that the superheat is 6-8 K.
7. Follow the diagram below to define the charge. Measuring condensing temperature and evaporating temperature at the compressor, find in the diagram the target subcooling then adjust the charge to match the target subcooling found (subcooling should be measured at the expansion valve inlet). With digital scroll compressor cooling systems, during the charge adjustment, the compressors have to be at the full capacity.



4.3. Refrigerant circuits

The refrigerant circuits are presented in Enclosure D.

5 - Positioning

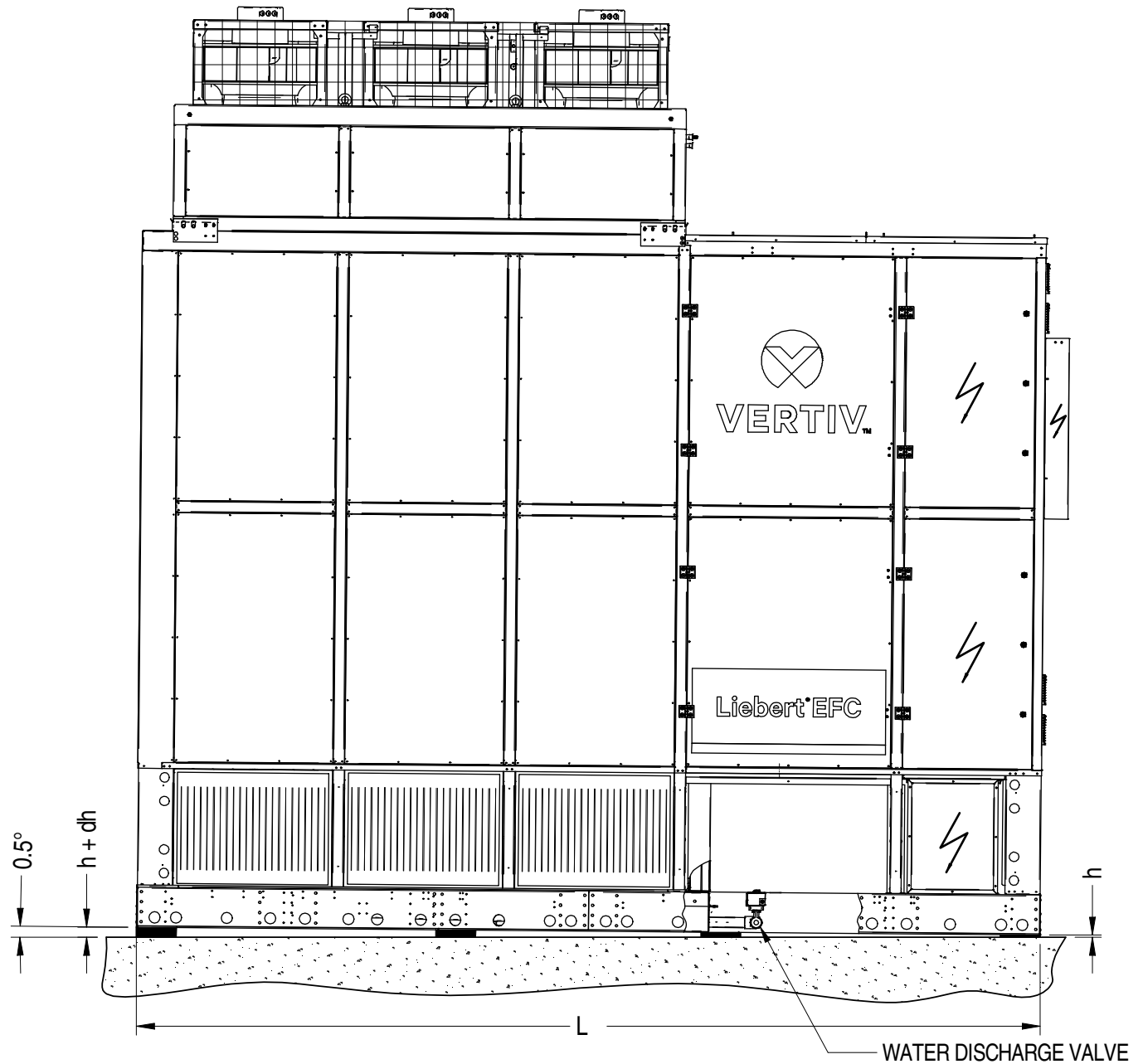
5.1 - Preliminary remarks

Prior to proceeding with unit installation it is recommended to check the following:

- The structure (concrete or other) supporting the unit must be adequately designed for the unit static and operating weight; water mass forecasted in unit sumps must also be considered;

- supporting base should have a flat and regular surface;
- Electric supply lines must be adequately sized according to the unit electric characteristics, indicated in the unit name plate;
- Plumbing and drainage are available in accordance to unit requirements.

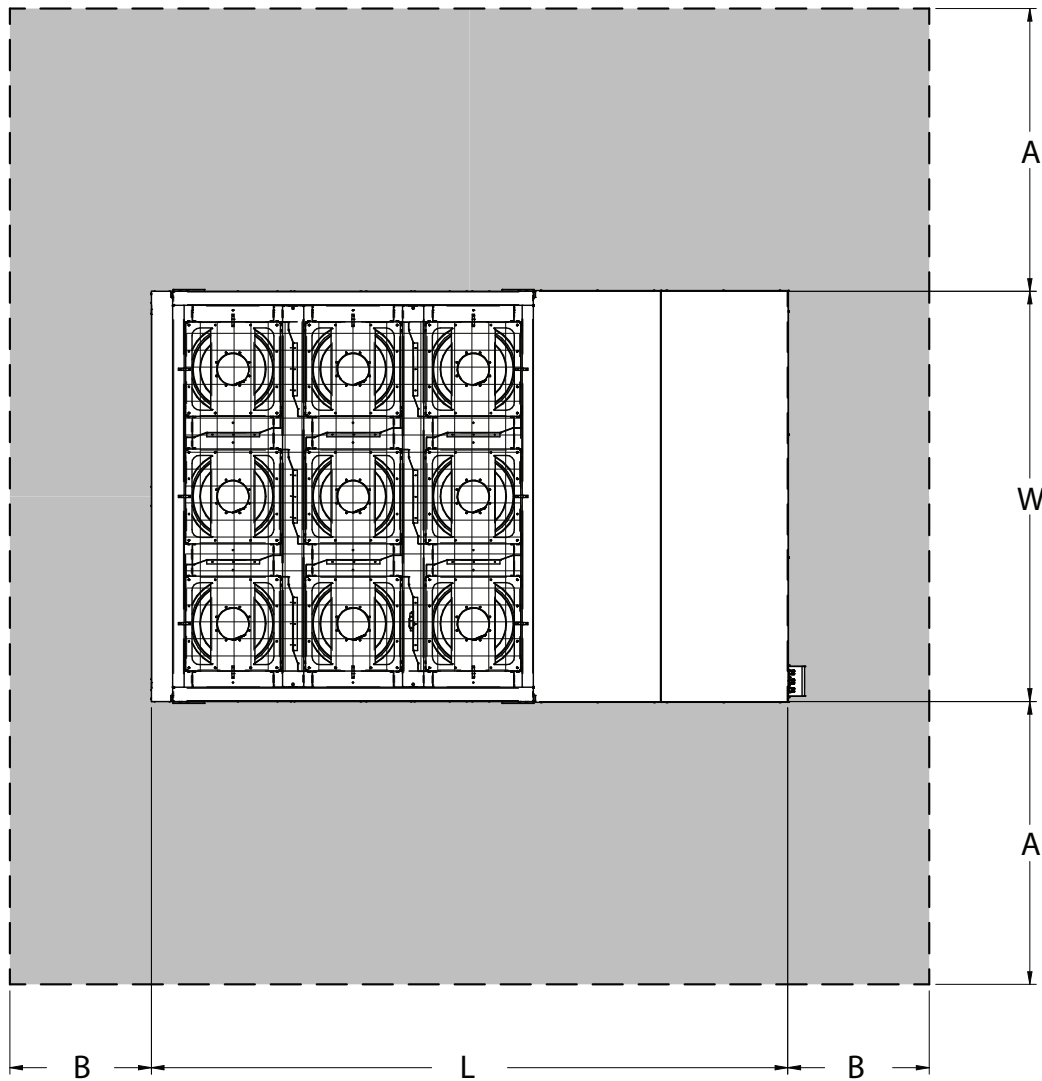
Allow a 1% gradient (0.5°) towards the water discharge valve (see drawing below) to facilitate good drainage. Example calculation: $dh=L/100$.



5.2 - Suitability of installation area

Area chosen for unit assembly must allow sufficient clearance space, around and on top of the unit, for unit installation and further ordinary and extraordinary maintenance operations.

Particularly important is the service area on the inspection and connection side, in order to allow panels to open completely. The following figure and table shows minimum clearances (mm) requested. This space must be free from obstacles and walkable.



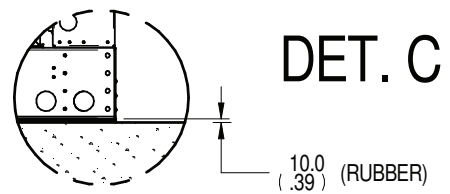
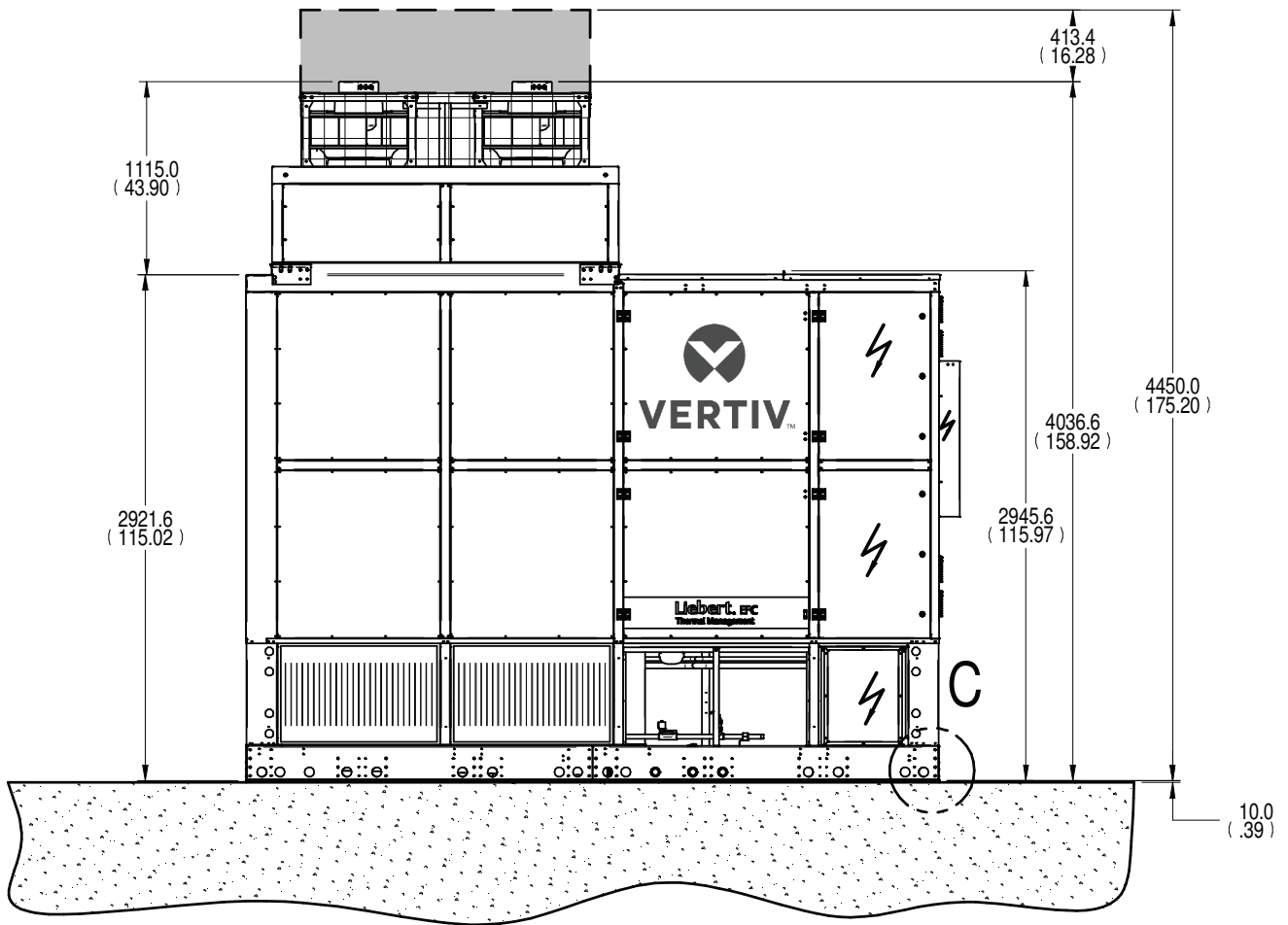
Tab 5.1 Dimensions

Unit	Dimensions			
	L(mm)	W(mm)	A(mm)	B(mm)
EFC220	4000	2300 (3300 with Low Ambient Kit)	1500	1000
EFC300	4500	2900 (3900 with Low Ambient Kit)	2000	1000
EFC320	3650	2900 (3900 with Low Ambient Kit)	2000	1000
EFC400	3650	3400 (4400 with Low Ambient Kit)	2000	1000

Notes:

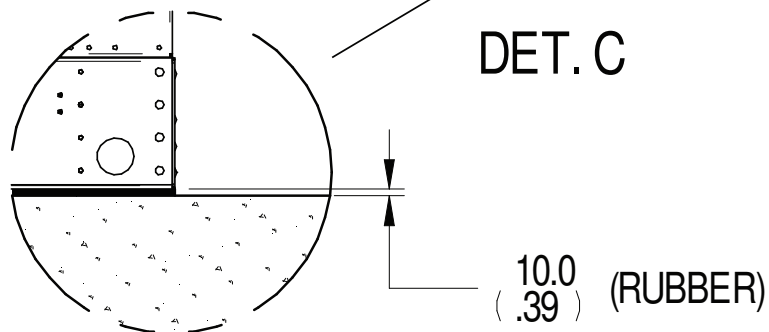
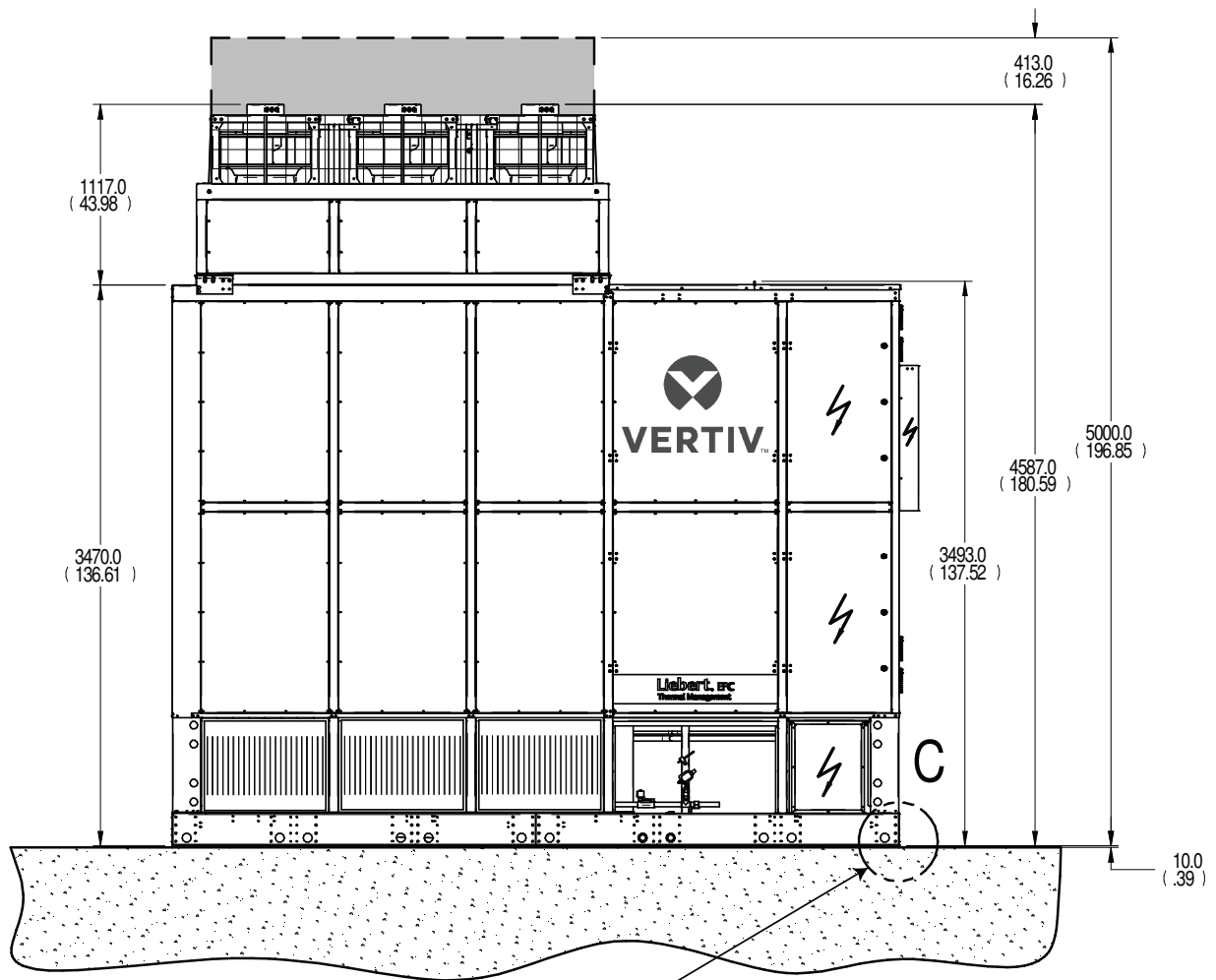
- (1) space for ordinary maintenance: for extraordinary maintenance (heat exchanger, finned coils and fan module removal) the unit wide dimension space is required

Overall unit dimensions EFC220



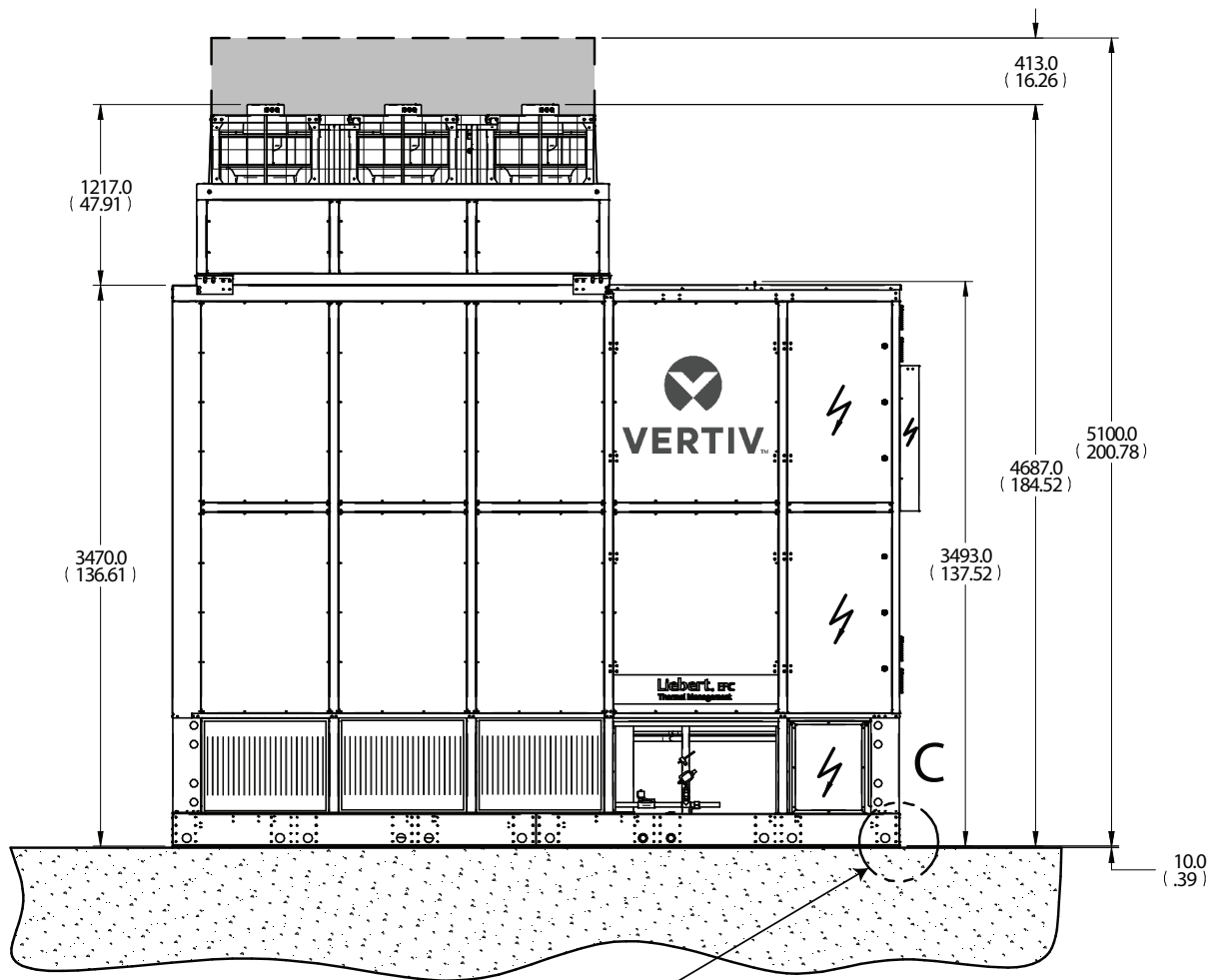
Note: Insert rubber the between the basement and the structure that supports the unit.

Overall unit dimensions EFC300, EFC320



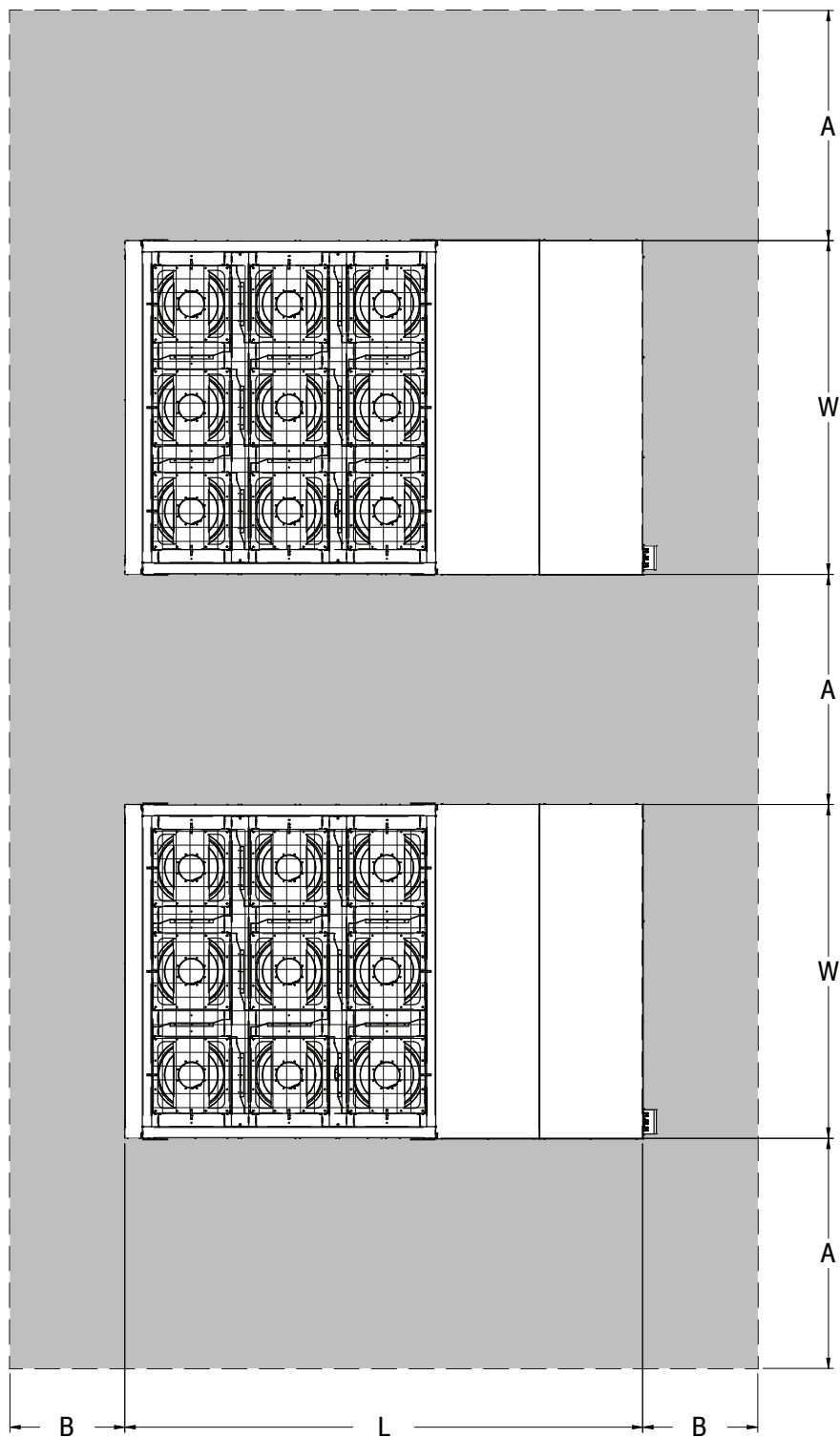
Note: Insert rubber the between the basement and the structure that supports the unit.

Overall unit dimensions EFC400



Note: Insert rubber the between the basement and the structure that supports the unit.

Distance between units



Tab 5.2 Dimensions

Unit	Dimensions			
	L(mm)	W(mm)	A(mm)	B(mm)
EFC220	4000	2300 (3300 with Low Ambient Kit)	1500	1000
EFC300	4500	2900 (3900 with Low Ambient Kit)	2000	1000
EFC320	3650	2900 (3900 with Low Ambient Kit)	2000	1000
EFC400	3650	3400 (4400 with Low Ambient Kit)	2000	1000

Notes:

(1) space for ordinary maintenance: for extraordinary maintenance (heat exchanger, finned coils and fan module removal) is required the unit wide dimension space

5.3 - Water and drain connections

The following minimal requirements are recommended for any type of installation.

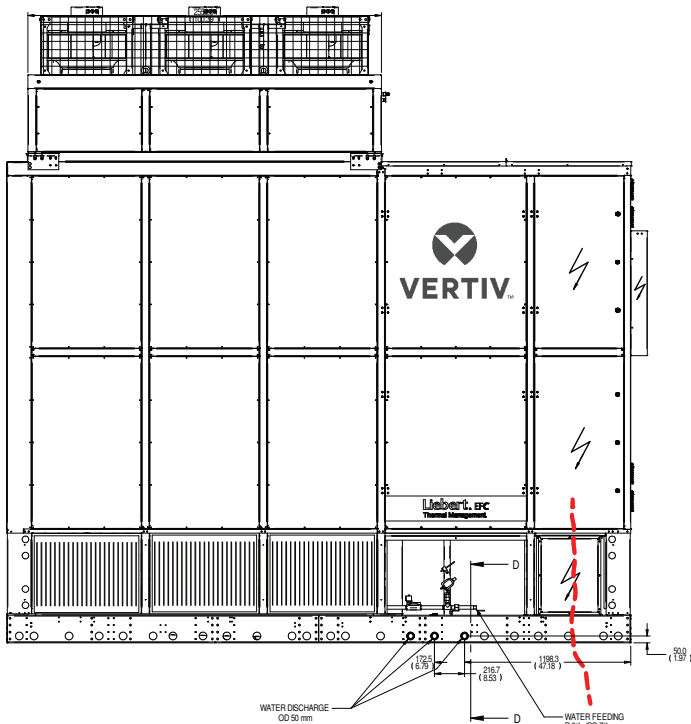
- Provide adequate supports for external circuit and thermal expansion joints with vibration isolators.
- Position water pipes and water circuit devices, checking inspection panel openings and access to any unit section.
- Avoid damages to water connection soldering by fastening mechanical connections with care without applying any torsion to the same.

Furthermore, water circuit should be provided with:

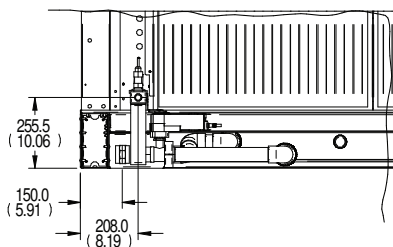
- Water drain to be positioned at the unit lowest point;
- For chilled water coil (CW Backup), vent valve at the circuit highest point to allow easy replenishment;
- Shut-off valves, on water inlet and outlet.

Installer must obviously guarantee the requested value of water flow.

The water and drain connection of the **Liebert® EFC300 and EFC320** unit are presented in the picture below.

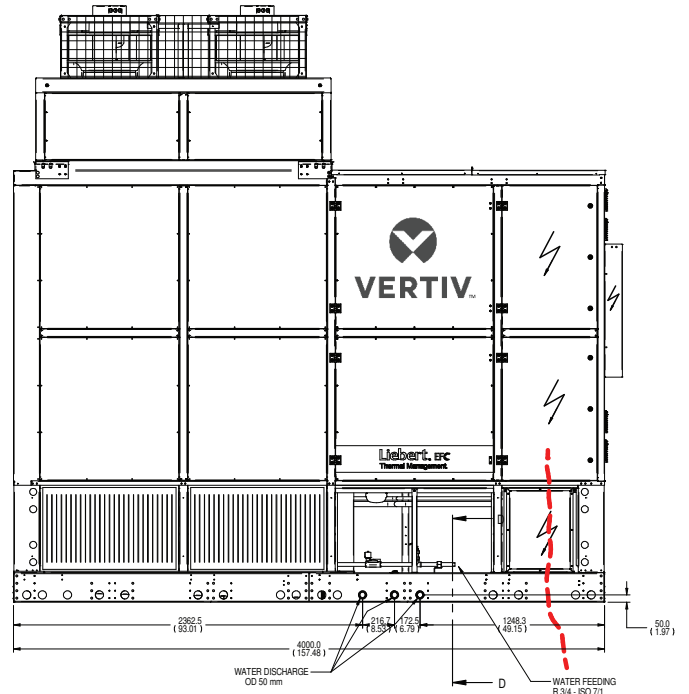


SECT. D-D



All connections should be made with the best available current workmanship practice according to the indicated dimensions of inlet and outlet diameters, using stainless steel, PVC or polythene tubing. Outlet connections should be complete with water traps, avoiding any restriction and obstruction. If there is no height space for water traps, install a check valve for water discharge line.

The water and drain connection of the **Liebert® EFC220** unit are presented in the picture below.



The evaporative system doesn't work when the external ambient temperature is low (near water freezing point).

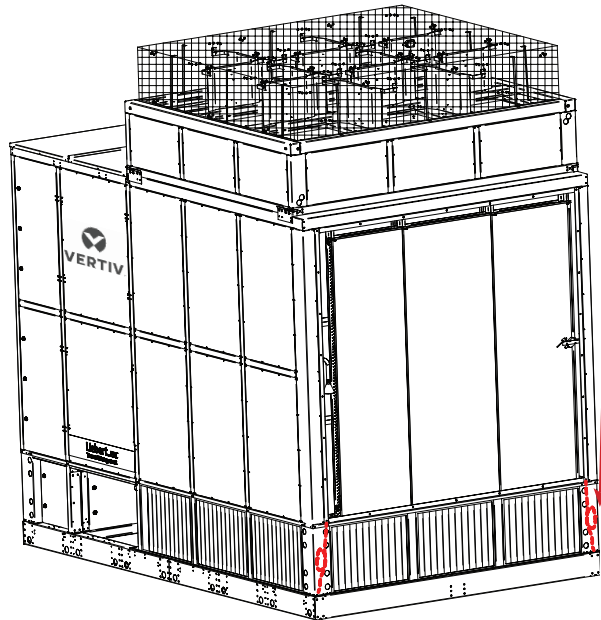
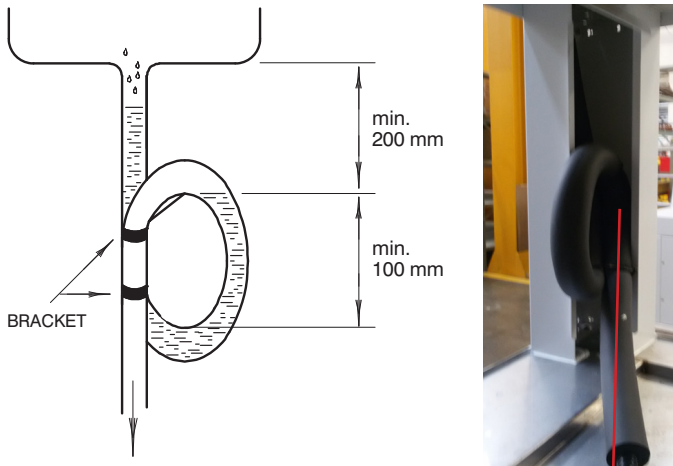


Ensure there is no risk of freezing on water traps and on evaporative system water feeding and discharge line.



The unit must be periodically cleaned/disinfected using liquid that must be recovered. We suggest to prepare the discharge line ready to receive the liquid used for the cleaning/disinfection.

Condensate drain: the unit is supplied with 2 traps placed on condensate drain panel bottom. The condensate is discharged on unit basin. Fill in the drain trap with water before unit start up.



and carefully following all procedures and standards. Grounding of the unit is a fundamental requirement to comply with safety codes against electrical/electrostatic accidents.

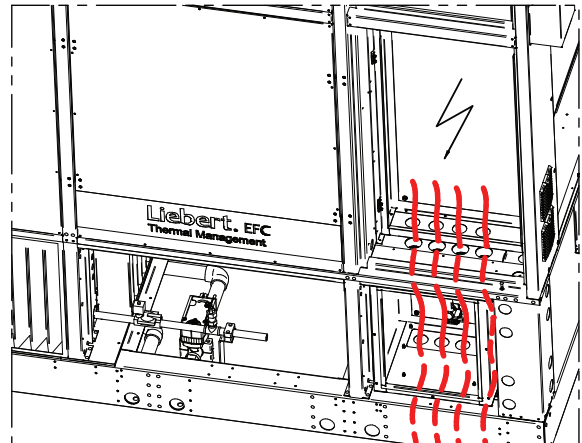


Lack or inadequate grounding relieves manufacturer from electrical/electrostatic accidents liability.



Installer is liable by law for the proper activation of safety devices installed in accordance with EU Directives.

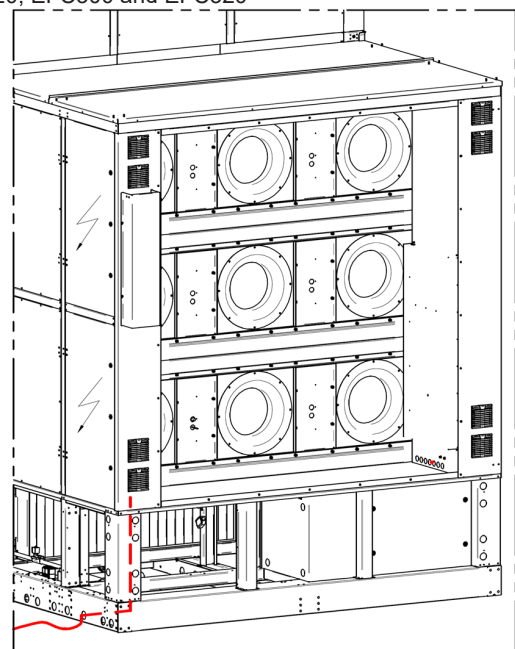
All cables and connections of electric parts should comply with the current IEC standards, or the standard national requirements of the country.



The supply cable of the main switch contains live high-voltage.

- It is mandatory to install an external main switch on site easy to reach, to facilitate a quick and easy shutdown enabling the power of the unit to be cut off. Refer to the unit electrical schematics for the installation. Follow all local codes. If the unit is installed above some support, some electrical components will result higher: use a ladder to compensate the increased height.

Refer to pictures below for electrical connections path - For EFC220, EFC300 and EFC320



SINGLE UNIT LEFT (DIGIT 11) WITHOUT ATS (DIGIT 18)

5.4 - Air connections

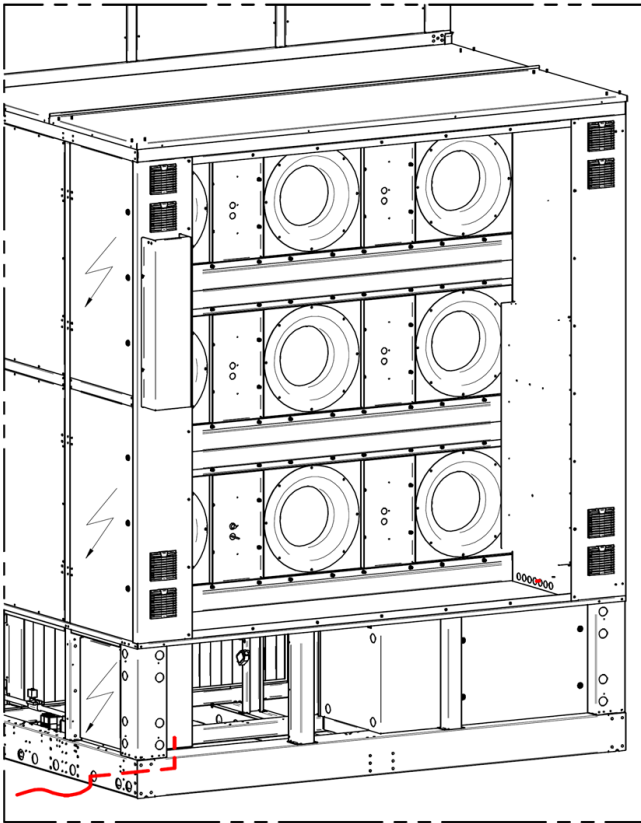
Air flow connections, to supply-suction and possible exhaust-recycle duct works, should be made with flanges of the same dimensions of those existing on the central station unit and indicated on the general drawing supplied (see Enclosure C); all screws supplied must be used and sealing gasket should be interposed. Install antivibrating joints between duct and unit, to avoid vibration transmission.

5.5 - Electrical connections

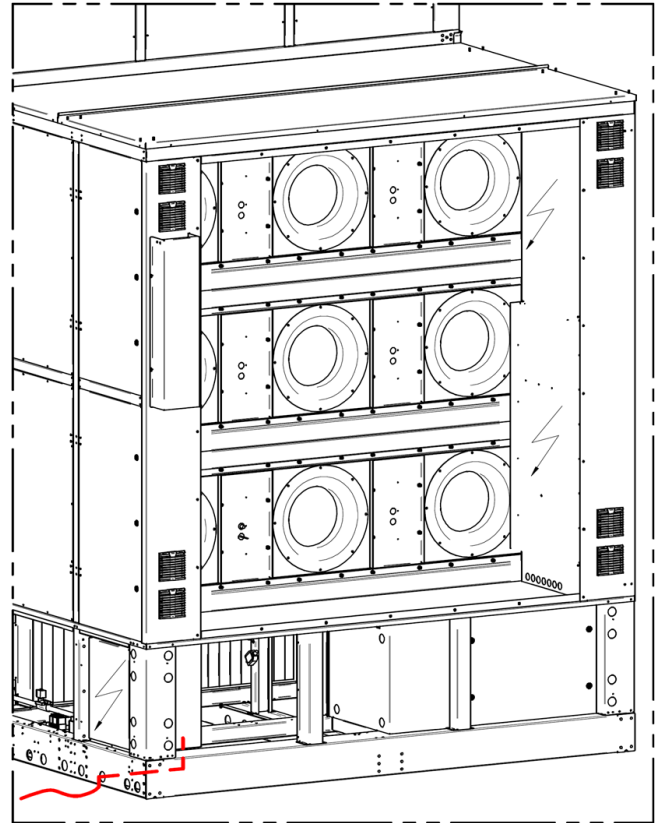
The unit name plate and the literature supplied with the unit show the electric features and the maximum full-load current input of all electric motors. Different main supplies, voltage and phases, may be needed for different uses, for this reason check carefully data on the name plate. Always use appropriate ports provided on the unit for cable passage way. Refer also to electrical diagram supplied with the unit.

Unit ground connection

Unit ground connection should be made using the appropriate terminals provided outside the unit, with cables of adequate section

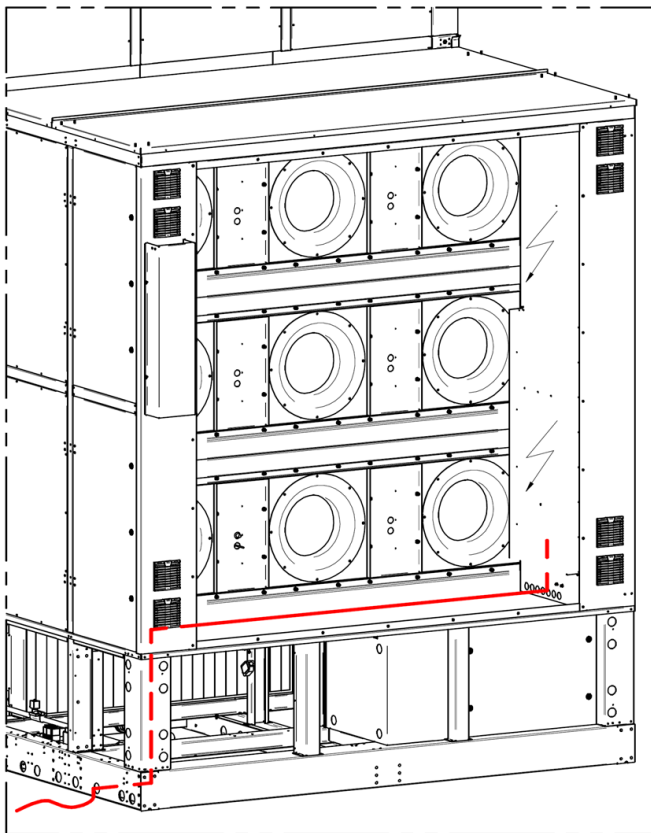


SINGLE UNIT LEFT (DIGIT 11) WITH ATS (DIGIT 18)

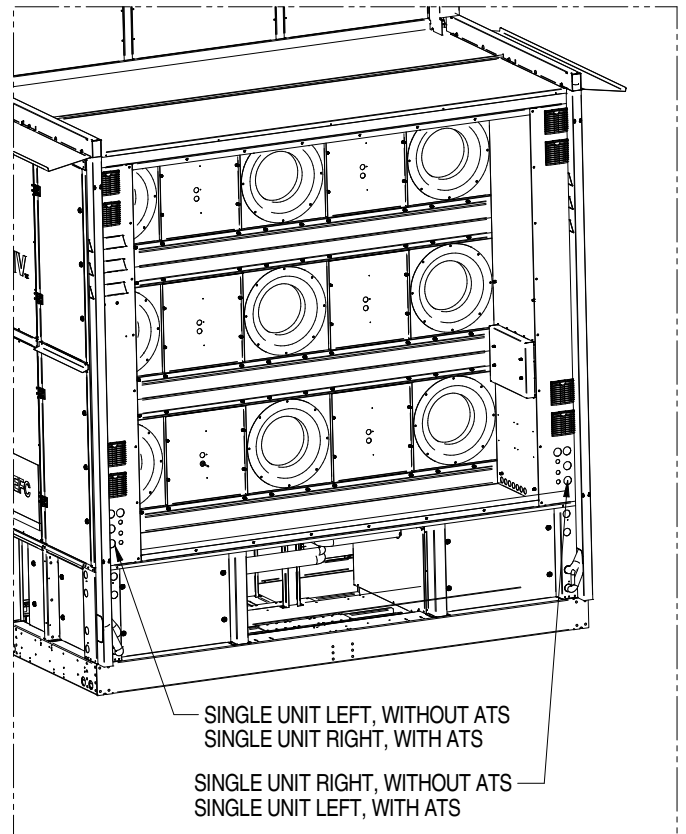


SINGLE UNIT RIGHT (DIGIT 11) WITH ATS (DIGIT 18)

Refer to pictures below for electrical connections path - For EFC400 unit



SINGLE UNIT RIGHT (DIGIT 11) WITHOUT ATS (DIGIT 18)



SINGLE UNIT LEFT, WITHOUT ATS
SINGLE UNIT RIGHT, WITH ATS

SINGLE UNIT RIGHT, WITHOUT ATS
SINGLE UNIT LEFT, WITH ATS

5.6 - Protection degree IP2x check

After checking that all connections and installations work, comprising ceiling elements (plenum, ducting) and floor elements (base frame), check and verify the protection degree IP2x (protection against finger access, std. IEC 60364- 1) at the boundary of the unit.

6 - Before Start-Up



ENSURE THERE IS NOT ANY DUST OR FOREIGN BODIES ON UNIT SUMP THAT COULD DAMAGE THE PUMP. CLEAN THE SUMP AND REMOVE ANY FOREIGN PART BEFORE UNIT START-UP. IF THE EXTERNAL AIR FILTERS SHOW DIRTY, CLEAN OR CHANGE THEM BEFORE UNIT START UP



TO PREVENT COMPRESSOR DAMAGE THE CRANK-CASE(S) MUST BE PREHEATED FOR AT LEAST 4 HOURS BEFORE THE COMPRESSOR STARTS-UP

The following preliminary checks are essential before proceeding with specific start-up verifications:

1. The provided safety systems are present and activated;
2. No foreign matters or dirt should be left close to rotating parts or in the unit sections;
3. All drains should be free and adequately trapped;
4. Hydraulic circuits should be regularly fed;
5. Coil circuits should be fed and valves open.

6.1 - Safety systems

Safety systems operation and reliability must be verified by specifically checking their actual intervention on emergency conditions and ensuring that moving parts are effectively stopped; unit shall be de-energized as soon as safety devices show their proper effect.

6.2 - Electric motors, fans and drives

- a. Check for the correct rotating direction of fans, which must be the one shown on the fan housing by an arrow; wrong rotation can be corrected by switching motor electric connections on the three-phase line.
- b. Verify the actual current input and compare it with nominal value (indicated on the unit plate); in case it is higher, it is necessary to check that:
 - Motor-fan group rotates freely by hand
 - Fan speed is the prescribed one
 - Electric supply is correct.
- c. Ensure also that all protective guards on rotating parts are held in strong position.

6.3 - Air filters

Check that filters have not been damaged during transportation and/or installation and that are free from dirt or other foreign matters.

6.4 - Evaporative system

For evaporative systems spraying nozzles, check that water jet of each nozzle is regular and clean those nozzles that appear to be clogged.

Set water feeding valve speed to limit water hammering (see enclosure A)

6.5 - Coils

Check that fin packs are not damaged and are clean; in case of any bend or flattening of fins for previous mishandling, use fin calibrated combs and restore proper fin conditions and spacing. For chilled water coil (CW backup), the chilled water circuit should be vented repeatedly with pumps in operation.

In case the unit is expected to intake air at a temperature below 0° C during cold seasons or that can be held idle in freezing ambient temperature, it is mandatory that all water circuits not in use must be completely drained in order to avoid ruptures due to freezing. To avoid this risk, anti-freezing solutions, such as water glycol, can also be used, with adequate component percentages related to the minimum temperature that could be reached in the area.

Glycol % in the solution by volume	Freezing point °C
0	0
10	- 5.5
20	- 9
30	- 15
40	- 25
50	- 33

An informative table is given, showing solution percentages according to various minimal temperatures; in any case it is recommended to follow the tables supplied by the glycol producer.

6.6 - Dampers (if installed)

For manually operated dampers, check that operation is smooth and it is possible to block damper in the desired position easily and efficiently.

For motorized dampers ensure there are no slowdowns or stopping in the damper movement along the entire sector. Instructions on electric connections are given by the control manufacturer and supplied with the unit.

7 - Operation

7.1 - Unit Operation

Unit operation is completely automatic. The below sequence explains how unit operates:

- The data center air, pushed in by the fans, enters the unit.
- The air is immediately filtered (if filters are installed) and passes through the heat exchanger.
- The temperature sensor on the unit delivery verifies the state of delivery air and relays this information to the control system. The control system compares this temperature with the unit set point and, as a function of that, the EC fans speed is modulated to reach the unit set point. If the outdoor air condition, that flows on the other heat exchanger side, does not permit the heat transfer from data center air, the evaporative system and/or the backup cooling system (if available) is activated. The outdoor air is filtered as it enters the unit.
- The treated and cooled data center air is then dispersed in the data center.
- The outdoor air, after it absorbs heat from the data center air through the heat exchanger is dispersed in the atmosphere.

COOLING

Air-to-air cooling mode

If the outdoor air condition is favorable, the unit works on air-to-air cooling mode: the outdoor air absorbs heat from the data center air.

Evaporative cooling mode

When the outdoor air is too hot and the air-to-air exchange is not enough, the evaporative system is turned on and the outdoor air is cooled down.

A conductivity sensor keeps under control the water conductivity stored on the drain panel: when the water conductivity exceeds the maximum admitted value, the water is discharged and new water is supplied to the unit.

The water discharge is controlled by a motorized ball valve, normally opened, with spring return, and the water feed is controlled by a solenoid valve.

Two level switches keep the correct water level on the drain panel. The unit control discharges the water when there is risk of water freezing, when the water level is too high on the drain panel or when there is risk of scaling and when the unit shut down. The water is discharged periodically also to carry-out anti-legionella cycle.

DX expansion mode (DX)

In extreme outdoor conditions, when there is the need of partial or full backup, the digital scroll compressor (with modulating capacity) is started and the cold refrigerant flows through the evaporator, thus cooling the air passing over it.



TOPREVENTCOMPRESSORDAMAGETHECRANK-CASE(S) MUST BE PREHEATED FOR AT LEAST 4 HOURS BEFORE THE COMPRESSOR STARTS-UP

Check oil level inside compressor after 30 min. of compressor running at maximum capacity: oil level must be between 1/2 and 3/4 of sight glass. In tandem compressors the oil level must be checked with both compressors running at maximum capacity (note: when only one compressor is running, the oil level inside the compressor that is not currently running could be at the minimum and the compressor, that is running, at the maximum capacity; when one compressor is running at maximum capacity and one compressor is running in modulating capacity, the oil level in the latter one could be between 1/2 and the minimum).

CW mode

In extreme outdoor conditions, when there is the need of partial or full backup, the control system opens the valve which permits the cold water to enter the coil, thus cooling the air passing over it.

8 - Maintenance

8.1 - Maintenance and Spare Parts

8.1.1 - Safety instructions

All maintenance operations must be strictly carried out by observing the European and National accident prevention regulations. We refer especially to the accident prevention regulations concerning electrical systems, refrigerators, and manufacturing resources. Maintenance may be done to air conditioning equipment only by authorized and qualified technicians.

In order to keep all warranties valid, the maintenance must adhere to the manufacturer's regulations.



DANGER: The work must be done in the system only when it is at standstill. Do this by switching off the air conditioner at the controller and the main switch. Post a warning sign saying: "DO NOT SWITCH ON."

Electrical components of device have to be switched off and be checked that they are not under voltage.

Ignoring the safety instructions can be dangerous to people as well as to the environment.

Soiled parts always cause a loss of performance while switches or control devices can lead to the break-down of a plant.



WARNING

Do not walk on unit's top

8.1.2 - Spare parts

Only original spare parts made by Vertiv may be used. Using third-party material can invalidate the warranty.

When making inquiries always refer to the "Component List" supplied with the equipment and specify the model number, serial number and, if available, also the part number.

NOTES:

- 1) When a faulty component is replaced, follow the relevant manufacturer instructions.
- 2) When the spare parts must be welded, be careful not to damage the internal parts (gaskets, seals, o-rings, etc.).

8.1.3 - Maintenance schedule

Monthly, quarterly, biannual and annual checks are to be conducted according to the following guidelines.

All tasks and periods listed here are regulations from the manufacturer and need to be documented in an inspection report.



CAUTION: All these tasks should be carried out only by an authorized and trained technician. We recommend the Vertiv Customer Service.

8.2 - Periodical maintenance



WARNING: The operators must wear helmet, gloves, shoes and safety glasses.



WARNING: Operators must wear safety harness and use a scaffolding or an aerial platform to reach components on higher positions (ex: fans, condenser, droplet separator, etc).

Before the warm season, when the evaporative system could be activated, the unit must be disinfected and the sump must be cleaned; if heat exchanger and sump show hard limescale deposition, descaling procedure is necessary. Check the sump condition monthly: if it shows dirty, clean and remove any dust to keep the unit cleaned and to avoid pump premature failure.

Any activity should be carried out by qualified and trained technicians.

General maintenance procedures:

- In compliance with local regulations relating to the workers health, verify the need and frequency of legionella monitoring,

we recommend to make quarterly analysis to verify the presence of legionella in the system. If contamination is detected, contact local certified and authorized water treatment companies and local authorities where required by legislation;



CAUTION!

Risk of sharp edges, splinters and exposed fasteners! Can cause personal injury! Only properly trained personnel wearing appropriate safety headgear, gloves, shoes glasses and safety sling hook on scaffolding to work at height, should perform unit maintenance

8.3 - Air filters

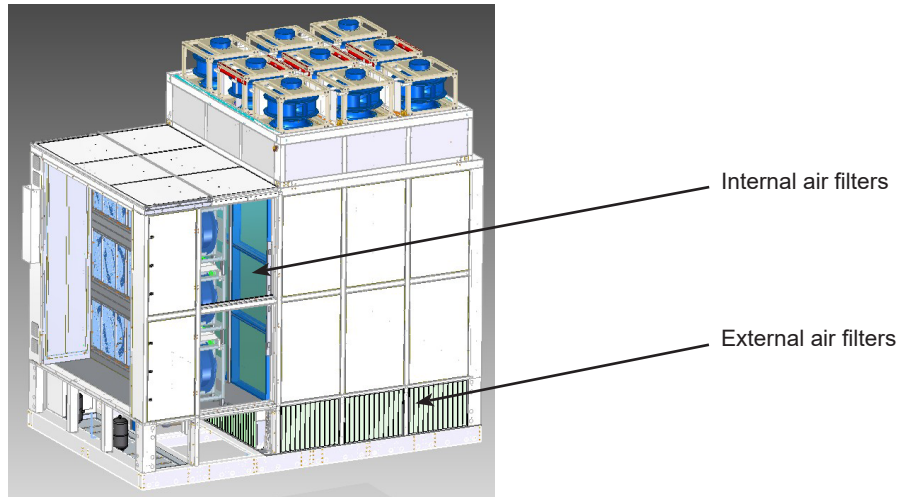
- Air filter life depends on ambient conditions in which they operate, it is important to check every 30 days for their status to ascertain chances to reach their standard maintenance

- schedules;
- Every 90 days cleaning or replacement of filters is necessary;
- When a differential pressostat is mounted, filters cells must be cleaned or replaced when pressure drop reaches the maximum value recommended by the filter manufacturer (usually 200 Pa for corrugated filters).



Warning: the lack of filter cleaning or replacement can cause a decrease in the unit/plant efficiency because:

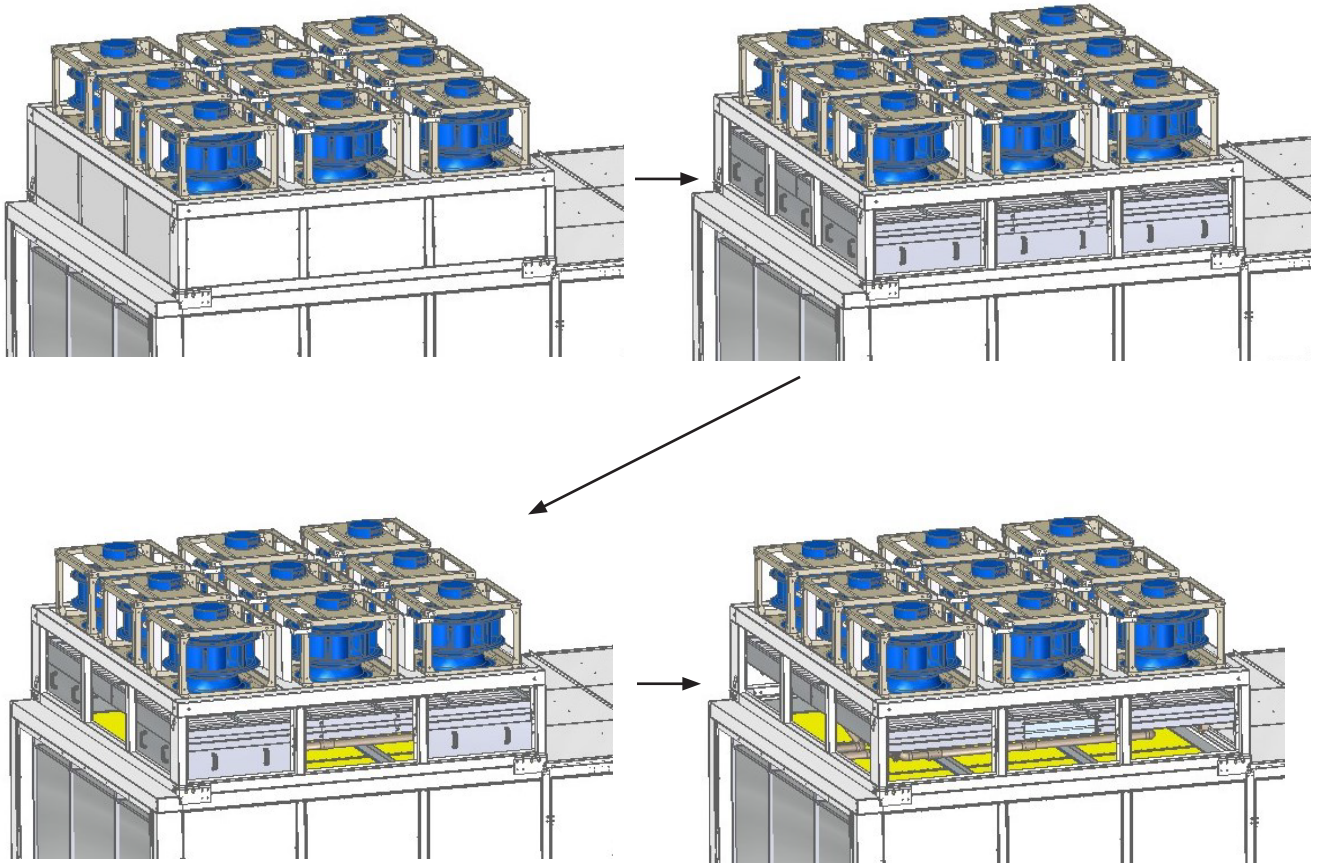
- Airflow rate will decrease due to air pressure drop increase;
- Unit total efficiency will decrease and consequently lower comfort will be obtained;
- Refrigeration system can be damaged in case of DX coil installation.



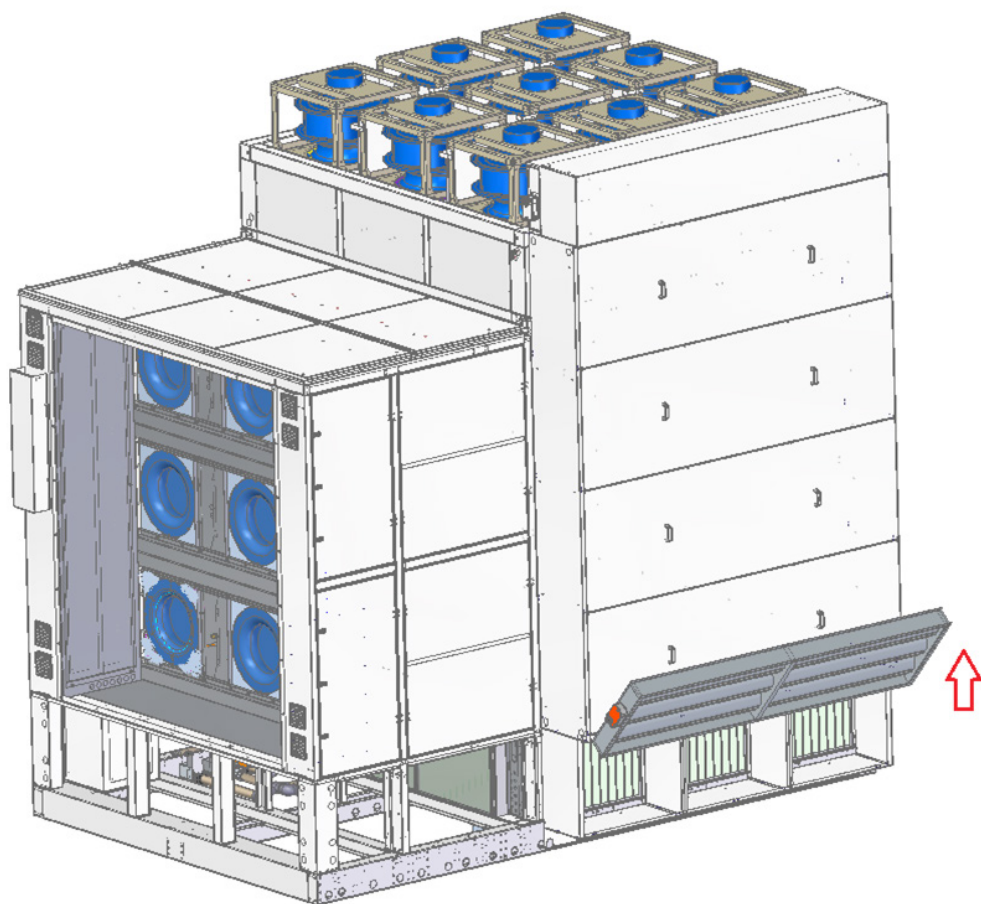
Components to clean/disinfect

Heat exchanger, access panels

Remove middle internal panel before. Attention not to damage the heat exchanger!



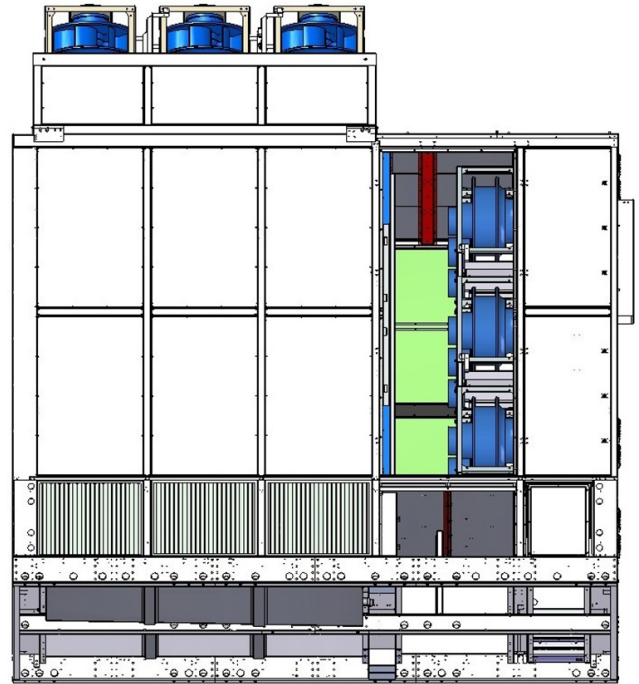
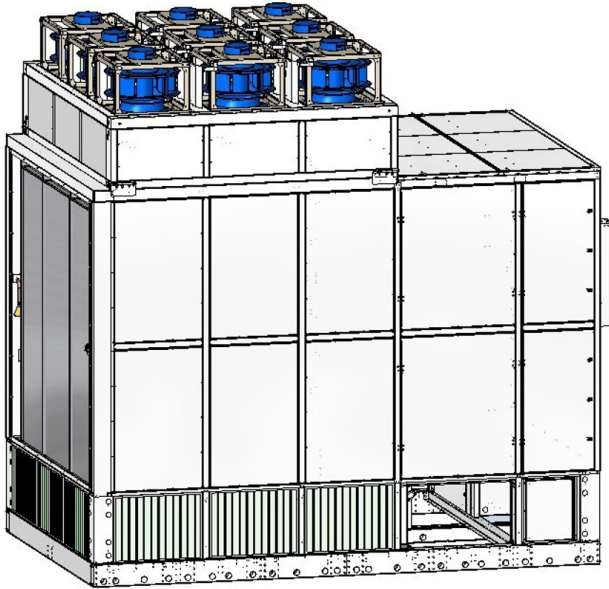
With Low Ambient Kit option, rotate the damper upwards to access to external air filters.



8.4 - Fans

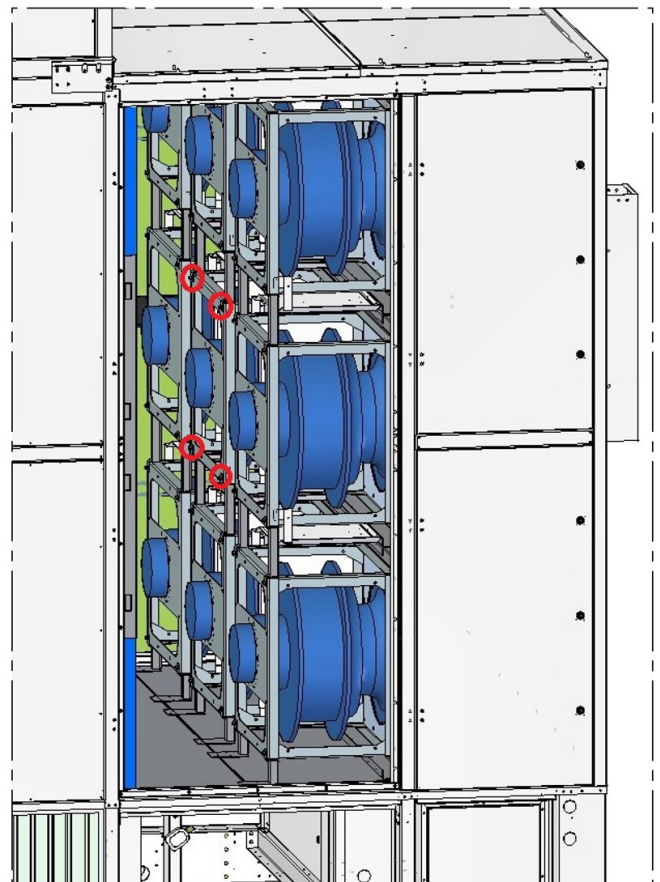
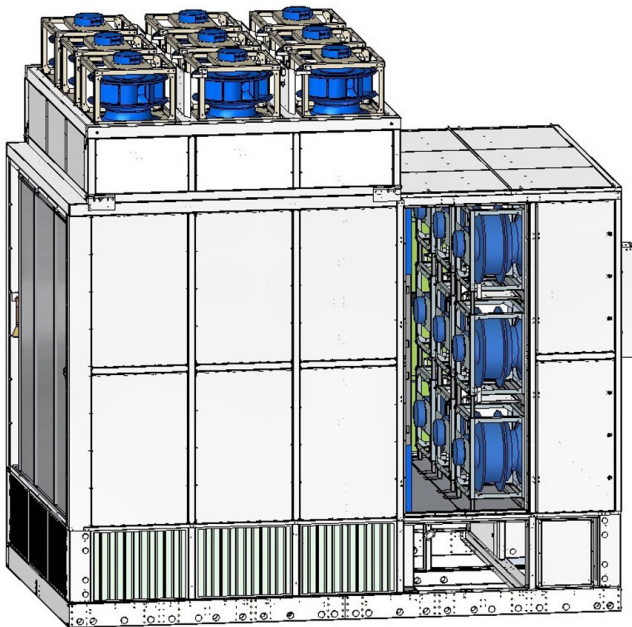
If maintenance or replacement of the data center side fans is necessary the operators must follow the next steps:

1 - Remove the side panels;



NOTE: Orange stiffener on unit top will be used to hold the fan by the eyebolt/belt.

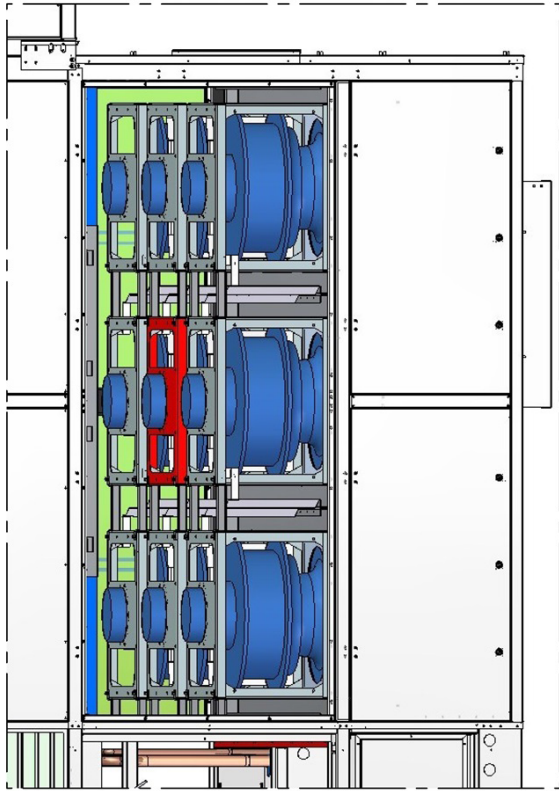
2 - Disconnect the electrical cables, unscrew fixing screws on the four corners;



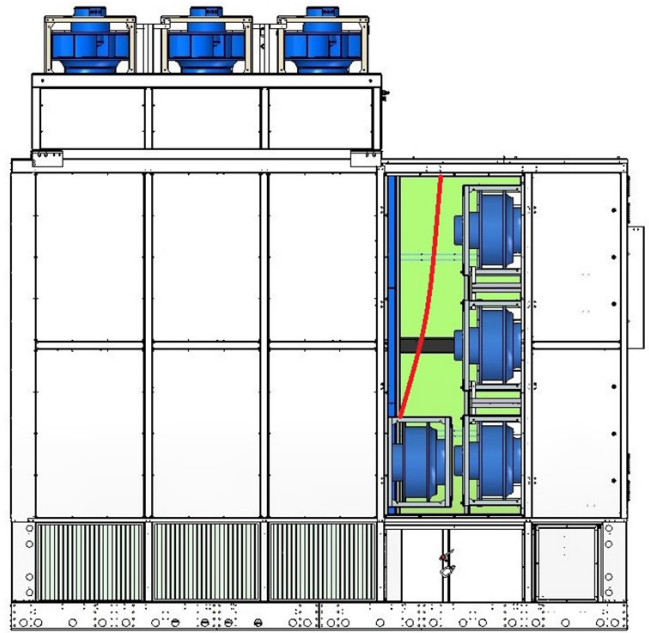
WARNING!

There is a risk of the fans and panel falling down thus causing an injury during the replacement operation. Due to the weight of the fans (approx. 35 kg) and the panel (up to 25 kg), two technicians are required to carry out fan replacement.

3 - Remove the back fan support and fan together handling them by the top stiffener + eyebolt + belt;

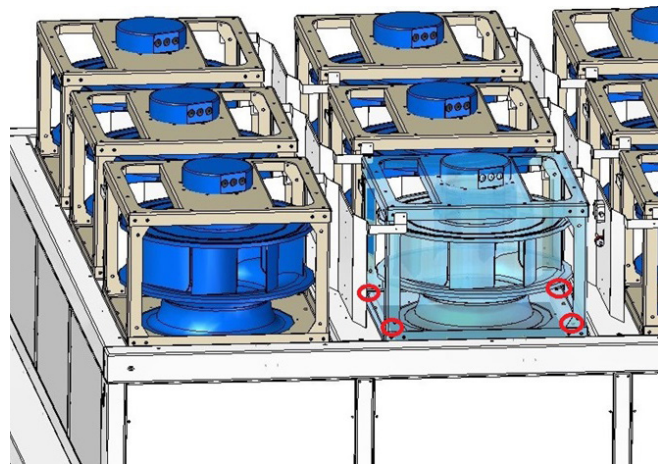
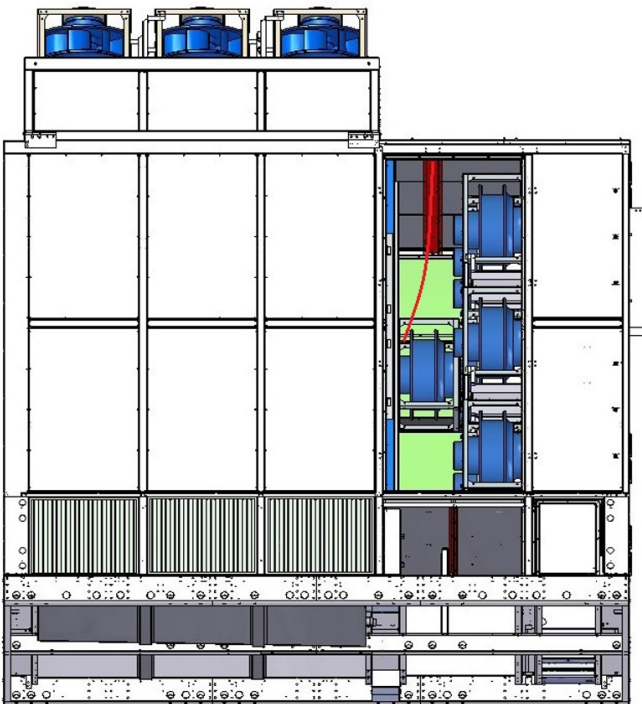


4 - Lower the fan on the unit bottom.

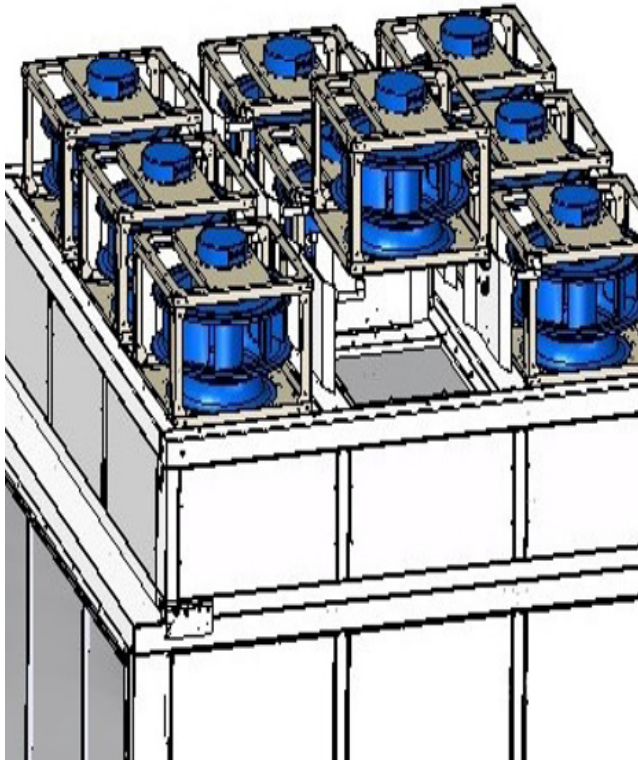


If maintenance or replacement of the process side fans is necessary, the operators must follow the next steps:

1 - Remove safety grids, disconnect the electrical cables, unscrew the 12 screws that fix the fan assembly with the unit;



2 - Remove the fan assembly from the unit.



8.5 - Dampers (if installed)

Every 6 months, check that dampers complete their full movement freely and without stops, particularly the motorized ones. For manually controlled dampers, check the holding device that keeps them in position.

8.6 - Refrigeration circuit



WARNING: The operators must wear gloves to avoid burns caused by hot parts of the compressor.

WHEN REPAIRING THE REFRIGERATION CIRCUIT, COLLECT ALL REFRIGERANT IN A CONTAINER: DO NOT ALLOW IT TO ESCAPE.

- When removing (for repairs) or charging refrigerant, it must always be done on both the high and low pressure sides of the compressor simultaneously.
- The compressor copper plated steel connections should be welded with a silfos material containing a minimum of 5% silver.

8.6.1. Oil Charge R410A

The additional oil charge is already charged in factory. Check the right oil level in sight glass during the commissioning (see 7.1). If the level is too low see 8.6.2.

The oil to be used when topping up (only if there are any leaks) is EMKARATE RL 32 - 3MAF or Mobil EAL Arctic 22CC (see Tab. 8.1 and Tab. 8.2).

Tab. 8.1 - EMKARATE RL 32 -3MAF oil

Viscosity at 40 °C	: 31.2 cSt
Viscosity at 100 °C	: 5.6 cSt
Viscosity index (ISO Grade)	: 32

Tab. 8.2 - Mobil Arctic EAL 22CC oil

Density (at 15 °C)	: 0.967 kg/l
Flash point (C.O.C.)	: 245 ° C
Pour point	: < - 54 ° C
Viscosity at 40 °C	: 23.6 cSt
Viscosity at 100 °C	: 4.7 cSt
Viscosity index (ASTM D2270)	: 130

These oils rapidly absorb humidity present in the air when they are exposed to the atmosphere. If the oil absorbs humidity, the ester molecules can break down, forming acidity.

We therefore recommend exposing the oil for as short time as possible (no more than a few minutes) and, in case of topping up, using exclusively the oil indicated on the refrigerating compressor.

Normally 1 or 2 - litre cans are available for this purpose; once they are opened, they must be completely used up.

They must not be used after a long period, as they absorb humidity. It is therefore obvious that the taps of the compressor must only be turned after the whole plant has been subjected to a vacuum and partial filling.

8.6.2. Oil topping-up of an installed circuit

If oil leakages occur, the topping - up operation is necessary. (Contact the local Service before intervention).

8.7 - Unit shutdown precautions

When unit is expected to be out of order for long periods, it is recommended to use the following simple precautions:

1. Disconnect power supply on the general electric panel and place a warning notice that the unit is out of order;
2. Shut off water supply;
3. Empty unit basins (the water discharge valve is normally opened, with spring return);
4. Shut off coil valves and drain coils;
5. Shut all dampers off;
6. Every 30 days have motors, fan and pumps to rotate for few seconds to avoid damages to bearing.

Every 6 months, check that dampers complete their full movement freely and without stops, particularly the motorized ones.

In case the unit could remain idle at ambient temperature below 0° C, it is particularly important to proceed to coil drainage as per point 4), furthermore it is necessary to empty all traps and replenish them with an antifreeze solution.

8.8 - Dismantling the unit

The machine has been designed and built to ensure continuous operation.

The working life of some of the main components, such as the fan, depends on the maintenance that they receive.



CAUTION: The unit contains substances and components hazardous for the environment (electronic components, lead gel battery, refrigerating gases and oils).

At the end of the useful life, when the unit is dismantled, the operation must be carried out by specialized refrigerating technicians. The unit must be delivered to suitable centers specialized for the collection and disposal of equipment containing hazardous substances.

The lead gel battery, refrigeration fluid and the lubricating oil inside the circuit must be recovered according to the laws in force in the relevant country.

8.9 - Regulation (EU) no. 517/2014 (F- gas)

8.9.1. Introduction

Stationary air conditioners placed into the European Community market and operating with fluorinated greenhouse gases (F- gas, such as R407C, R134a, R410A), have to comply with the F- gas Regulation (EU) No. 517/2014.

This Regulation is in force since Jan 1, 2015 and it replaces the Re. (EU) no. 342/2006.

This document summarizes the obligations for the operators that are responsible for the equipment during all its operative life until its disposal.

8.9.2. Normative References

F-gas	517/2014	Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006
Certified personnel and Companies	2015/2067	Commission Implementing Regulation (EU) 2015/2067 of 17 November 2015 establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases
Leak check air conditioning	1516/2007	Commission Regulation No 1516/2007 of 19 December 2007 establishing, pursuant to Regulation (EC) No 842/2006 of the European Parliament and of the Council, standard leakage checking requirements for stationary refrigeration, air conditioning and heat pump equipment containing certain fluorinated greenhouse gases
Leak check fire protection systems	1497/2007	Commission Regulation No 1497/2007 of 18 December 2007 establishing, pursuant to Regulation (EC) No 842/2006 of the European Parliament and of the Council, standard leakage checking requirements for stationary fire protection systems containing certain fluorinated greenhouse gases

From 01/01/2017 to be replaced by:
Commission Implementing Regulation (EU) 2015/2068 of 17 November 2015 establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, the format of labels for products and equipment containing fluorinated greenhouse gases

8.9.3. Fluorinated Greenhouse Gases

Following notes have to be considered when operating with the above mentioned equipments:

Fluorinated greenhouse gases are covered by the Kyoto Protocol.

The fluorinated greenhouse gases in this equipment should not be vented to the atmosphere.

Referring to the value noted in Annex I and Annex IV of Regulation (EU) No 517/2014 here below the global warming potential (GWP) of some major F- gases or mixtures:

R-134a GWP 1430

R-407C GWP 1774

R-410A GWP 2088

NOTE: the refrigerants as R22 are not F-gas and their relevant regulation is Reg. (EU) no. 1005/2009.

8.9.4. Operators

8.9.4.1. Definitions

Operator, according to Regulation 517/2014 Article 2, point 8, means the natural or legal person exercising actual power over the technical functioning of products and equipment covered by this Regulation.

The State may, in defined, specific situations, designate the owner as being responsible for the operator's obligations.

Where large installations are involved, service companies are contracted to carry out maintenance or servicing. In these cases the determination of the operator depends on the contractual and practical arrangements between the parties.

8.9.4.2. Obligations

Operators of stationary air conditioners, which contain fluorinated greenhouse gases, shall, using all measures which are technically feasible and do not entail disproportionate cost:

- a Prevent leakage of these gases and as soon as possible repair any detected leakage.
- b Ensure that they are checked for leakage by certified personnel.
- c Ensure for putting in place arrangements for the proper recovery by certified personnel.

- d According to Regulation 517/2014 the operators shall ensure that the equipment is checked for leaks as following:
 Case 1 - Non-sealed equipment contains less than 5 tonnes of CO₂ equivalent of fluorinated greenhouse gases.
 Leakage test not required
 Case 2 - Hermetically sealed equipment contains less than 10 tonnes of CO₂ equivalent of fluorinated greenhouse gases.
 Leakage test not required
 Case 3
Leakage test required: check the equipment for leaks with the minimum frequency given in the following table:

X = Tonnes of CO ₂ Equivalent	Y = equivalent amount of refrigerant [kg]			Minimum frequency for leak check	
	R134a	R410A	R407C	with leakage detection	without leakage detection
5 ≤ X < 50	3,5 ≤ Y < 35	2,4 ≤ Y < 24	2,8 ≤ Y < 28	12 Months	24 Months
50 ≤ X < 500	35 ≤ Y < 350	24 ≤ Y < 240	28 ≤ Y < 282	6 Months	12 Months
X ≥ 500	Y ≥ 350	Y ≥ 240	Y ≥ 282	3 Months	12 Months

- e Recovery for the purpose of recycling, reclamation or destruction of the fluorinated greenhouse gases, pursuant to Art. 8 of the Regulation 517/2014 shall take place before the final disposal of that equipment and, when appropriate, during its servicing and maintenance.

8.9.5. Leakage Detection

The manufacturer approves the following leakage check methods according to Reg. 1516/2007 and Reg. 1497/2007:

Method	Specifications
a Check of circuits and components representing a risk of leakage with gas detection devices adapted to the refrigerant in the system	Gas detection devices shall be checked every 12 months to ensure their proper functioning. The sensitivity of portable gas detection devices shall be at least five grams per year.
b Application of ultraviolet (UV) detection fluid or suitable dye in the circuit	The method shall only be undertaken by personnel certified to undertake activities which entail breaking into the refrigeration circuit containing fluorinated greenhouse gases.
c Proprietary bubble solutions/soapsuds	---

8.9.6. Labelling

The label applied on the unit (see *Onboard Label*) is designed to fill-in the relevant amounts of refrigerant according to Regulation 1494/2007 (2015/2068):

- a Where fluorinated greenhouse gas is foreseen to be added to the equipment outside of the manufacturing site at the point of installation, a dedicated label accommodates notation of both the quantity (kg) pre-charged in the manufacturing plant and of the quantity charged at the installation site as well as the resulting total quantity of F-gas as a combination of the above mentioned quantities, in a manner which conforms to the legibility and indelibility.
 Our split units are usually not pre-charged on factory, in this case the total quantity of refrigerant charged in the unit has to be written in the relevant label, during the commissioning operation at the installation site.
 All of the quantities of must be given both as mass of refrigerant [kg] and as Tonnes of CO₂ Equivalent.
 Use the following rule for computation:

$$\text{where: Tonnes of CO}_2 = \frac{\text{kg of refrigerant} \times \text{GWP of refrigerant}}{1000}$$

Refrigerant	GWP
R-134a	1430
R-407C	1774
R-410A	2088

- b Our packaged units (not split) operating with f - gas are usually full charged on factory and the total amount of refrigerant charge is already reported on the label. In this case, the label has no need of further written information.
- c In general, the above mentioned information has been located in the main nameplate of relevant unit.
- d For equipment with double refrigeration circuits, in regards to differentiates requirements on the basis of the quantity of F-gas contained, the required information about refrigerant charge quantities has to be listed separately for each individual circuit

-
- e For equipments with separate indoor and outdoor sections connected by refrigerant piping, the label information will be on that part of the equipment which is initially charged with the refrigerant. In case of a split system (separate indoor and outdoor sections) without a factory pre-charge of refrigerant, the mandatory label information will be on that part of the product or equipment which contains the most suitable service points for charging or recovering the fluorinated greenhouse gas(es).

NOTE: Safety data sheets of F-gases used in the products are available on demand.

8.9.7. Record Keeping





Operators of equipment which is required to be checked for leaks (see *12.5 Leakage Detection*), shall establish and maintain records for each piece of such equipment specifying the following information:

- a the quantity and type of fluorinated greenhouse gases installed
- b the quantities of fluorinated greenhouse gases added during installation, maintenance or servicing or due to leakage
- c whether the quantities of installed fluorinated greenhouse gases have been recycled or reclaimed, including the name and address of the recycling or reclamation facility and, where applicable, the certificate number
- d the quantity of fluorinated greenhouse gases recovered
- e the identity of the undertaking which installed, serviced, maintained and where applicable repaired or decommissioned the equipment, including, where applicable, the number of its certificate
- f the dates and results of the leak checks carried out (see *12.5 Leakage Detection*)
- g if the equipment was decommissioned, the measures taken to recover and dispose of the fluorinated greenhouse gases

Unless the records are stored in a database set up by the competent authorities of the Member States the following rules apply:

- a the operators shall keep the records for at least five years
- b undertakings carrying out activities for operators shall keep copies of the records for at least five years

Table 8.3 Periodical maintenance schedule

COMPONENT		MAINTENANCE PERIOD EVERY		
		3 Months	6 Months	1 Year
 WARNING: do not reach into the fan while the fan wheel is running.	Check for soiling, damage corrosion, and proper fixing.	X		
	Check bearings noise.	X		
	Measure the current and power consumption.		X	
	Cleaning to preserve the function.	X		
AIR FILTERS	Check for soiling, damage, corrosion.	X		
	Check state of filter.	X		
	Clean or replace if necessary.	X		
	Carry out controls more frequently in dusty environments.	X		
NEW AIR FILTER (if installed)	See air filter. Clean or replace.	X		
CONTROL SYSTEM	Check for proper and functionally correct installation and surrounding conditions.	X		
	Check the function of the LEDs of the display's control system and the alarms.	X		
	Check the connections for electrical and mechanical function.		X	
	Check the functional elements (e.g. operational controls and display devices).		X	
	Check the electrical/electronic input signals (e.g. sensors, remote controllers, command variable) for compliance with nominal values.		X	
	Check control function, control signals and safety chains.		X	
	Adjust control function and control signals.		X	
EVAPORATIVE SYSTEM	See Enclosure A.			
SWITCH CABINET POWER CIRCUITS  WARNING: electrical cables and electrical components of the air conditioner are under voltage. Before operating on the electrical connections, make sure there is no voltage through a voltmeter or a phase detector.  Wait at least 5 minutes to remove the electrical box panels and access to the parts under tension.	Check the power supply on all phases.		X	
	Check the connections for electrical and mechanical function.		X	
	Check the power supply at all terminals.		X	
	Measure power consumption at all connected consumers.		X	
	Set, adjust and tighten the functional elements (e.g. operational controls and display devices).		X	
	Check safety equipment, e.g. thermal switch.		X	
	Replace fuses (every 2 - 3 years)			X
	Check protective covers for completeness.			X
REFRIGERATION CIRCUIT  CAUTION: Fluoride refrigerants increase the green-house effect and are subject to restrictions and norms, according to the national and European regulations.	Measure the working pressures and temperatures (to be done by a refrigeration technician).		X	
	Check the power consumption, measure head temperature and check for possible abnormal operating sounds.		X	
	Make sure that there is no frost building up on the evaporator and compressor.	X		
	Check function of all regulating devices (power regulators, valves, etc.).	X		
	Check safety devices for function. If the quantity of the refrigerant is not enough, detect the leakage if any. Then reclaim, void, repair and charge.		X	
	If the quantity of refrigerant is not enough, it needs to be reclaimed and refilled with completely new refrigerant.			
	Check oil level at the sight glass (where sight glass is available).	X		
	Carry out a test to check humidity inside oil			X
	Check crankcase heater for function.		X	
	Check digital modulation - solenoid valve	X		

COMPONENT		MAINTENANCE PERIOD EVERY		
		3 Months	6 Months	1 Year
EXTERNAL CONDENSER	See appropriate manual.			
CHILLED WATER CIRCUIT	Make sure there is no loss of water.		X	
	Deaerate the cooling water circuit using the vent valve near unit hydraulic connections.		X	
	Check that the cold water supply is ensured.		X	
	Check the temperature and the pressure of the water on the inlet and outlet side using thermometers and manometers if installed		X	
	Check the proper function of the two- way valve.		X	
	Make sure that the system is filled with the prescribed amount of glycol and that there is no frost in the hydraulic circuit.		X	
	In case of water loss, it needs to be refilled. Make sure the glycol concentration is correct.		X	
	Check that the water circulation is in perfect order.		X	

9 - Anomalies and their probable causes

Tab. 9.1 - Research and resolution of common anomalies

Anomaly	Probable cause	Possible resolution
1) Active safety systems are out of order	Safety systems not connected	Execute electric connection
	Electric system failure	Call electric maintenance
	Electric components failure	Replace component
2) Actual airflow rate is lower than the expected one	Dirty filters	Clean or replace air filters
	Dirty fin pack	Clean coils
	Wrong fan rotation	Change electric motor connections
	Too much air pressure drop	Check system/plant design
		Adapt fan section
	Dampers shut off	Open and adjust dampers
	Wrong fan signal	Change fan signal
3) Actual airflow rate is higher than the expected one	Components (e.g. filters) missing	Install missing components (while unit is out)
	Inspection doors open	Close doors
	Not airtight panels	Check panel gaskets and restore if necessary
	Too little air pressure drop	Adjust dampers
		Check system/plant design
		Adapt drive
Wrong fan signal	Change fan signal	
4) Thermal capacity is lower than the expected one	Air underflow	See anomaly 2)
	Lack or insufficient supply to coils	Open shut off valves
		Check pump water flow rate and pressure
		Check pump electric connections
	Coil connections inverted	Invert inlet/outlet connections
	Fin pack dirty or damaged	Clean and comb fin pack
	Air bubbles in circuit	Purge coils
	Internal fluid temperature not at design value	Adjust thermostats on thermal sources
Evaporative system problem	See anomaly 5)	
5) Evaporative system	Water supply insufficient or shut off	Open supply valve
		Check pump electric connections
		Clean water strainers
		Check and adjust water ball-cock
		Check water switch level
Clogged nozzles / filters	Clean nozzles / filters	
6) Droplets carryover is noticed	Air overflow	See anomaly 3)
	Water overflow	Adjust water flow by supply valve
7) Unit sound level is too high and/or vibrations are transmitted toward the plant	Fan isolators inadequate	Call Technical Department
	Rotating parts out of balance	Call Technical Department
	Foreign matters in rotating parts	Clean internal part (while unit is out)
	Air overflow	See anomaly 3)

Enclosure A - Evaporative cooling system

A1. Evaporative cooling system

A1.1 - System description

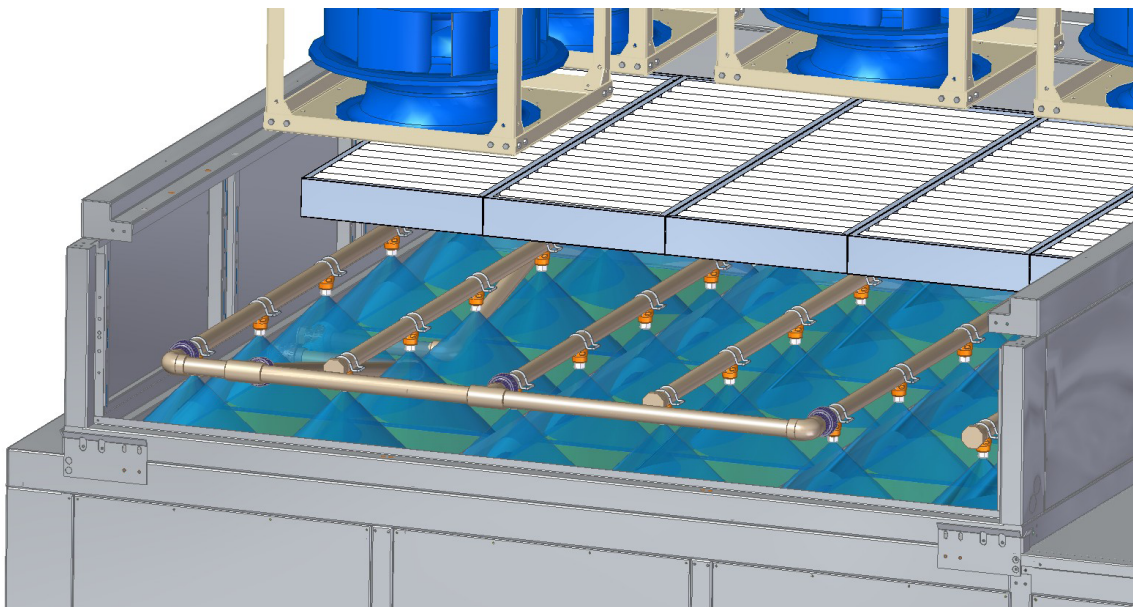
Liebert® EFC is equipped with two racks with several nozzles, placed at the exit of the heat exchanger, on the process air side. These racks spray water on the surface of the heat exchanger creating a thin water film which maximizes the cooling effect by evaporation.

A1.2 - Components of the systems

The evaporative cooling system is comprised of (see enclosure D):

- Submersible pumps, are able to provide water to the racks at a maximum pressure of 3 bar;
- One or two racks with several nozzles used to spray water on the surface of the heat exchanger;
- Droplet separator;
- Water filters, to prevent nozzle clogging;
- Flow switches;
- Calibration valve;
- Level switch to control water level;
- Conductivity sensor, to measure water conductivity;
- Feeding valve;
- Discharge valve;
- Flow meter (if installed).

Fig. A.5 - Nozzles spray water on the surface of the heat exchanger



A2. Maintenance and water quality



WARNING: The operators must wear gloves, mask and eye protection to avoid coming into contact with bacteria, fungi, mud, etc which may appear in the evaporative system if correct maintenance is not performed.

A2.1 - Maintenance procedures

- Before the warm season, when the evaporative system could be activated, the unit must be disinfected;
- If the heat exchanger and drain panels show hard limescale deposition, the descaling procedure is necessary;
- In compliance with local regulations relating to the worker's health, verify the need and frequency of legionella monitoring, we recommend to make quarterly analysis to verify the presence of legionella in the system. If contamination is detected, contact local certified and authorized water treatment companies and local authorities where required by legislation;
- Any activity should be carried out by qualified and trained technicians.

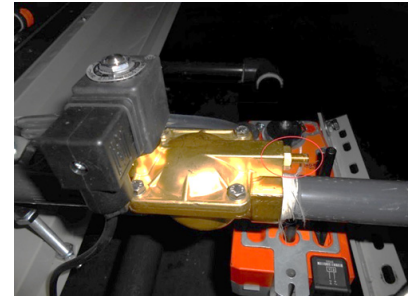
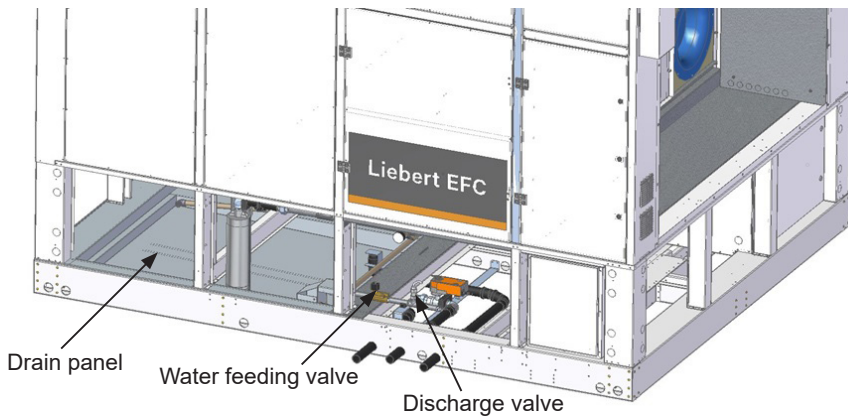
The interval depends on the water quality: the more salts or impurities in the water, the more frequently the inspections must be performed.

- Check the condition of the nozzles; clean or replace if necessary.
- Check the tightness of the connections whether threaded or compression-based
- Check the drain panel by removing air filters (figure A.6). clean and remove any dust or foreign bodies to keep the unit cleaned and to avoid pump premature failure.

Enclosure A - Evaporative cooling system

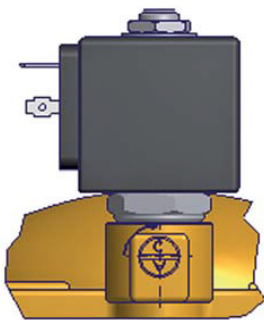
- Clean water filters (figure A.7);
- Clean level switch and conductivity sensor (figure A.8);
- Check conductivity sensor calibration using the solution supplied within the unit;
- Clean droplet separator (figure A.9);
- Clean nozzles (Figure A.10);
- Check and clean water discharge valve (Figure A.6).

Figure A.6 - Drain panel and water discharge valve



Water feeding valve speed set: Close the screw fully and then open ¼ turn to limit water hammering

Water feeding valve manual control



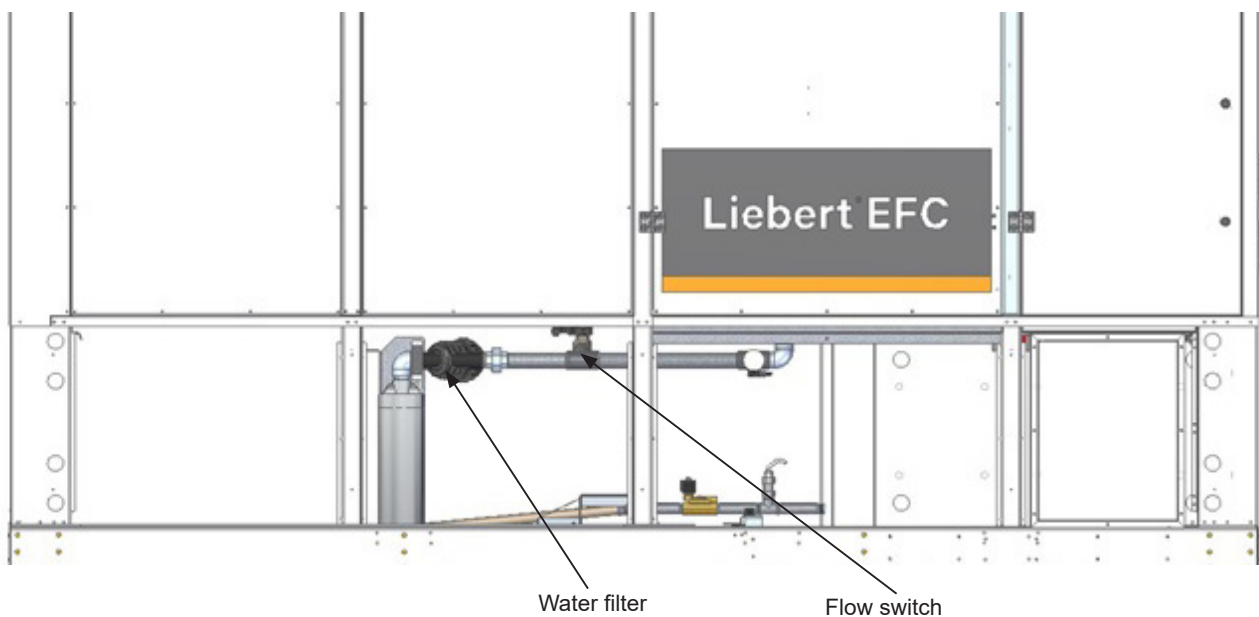
Closed



Open

Note: Closed (valve operates normally when coil is energised/de-energised):
The letter "C" is in the upper position of the screw head
Open: The letter "A" is in the upper position of the screw head

Figure A.7 - Water filters



Enclosure A - Evaporative cooling system

Figure A.8 - Level switch and conductivity sensor

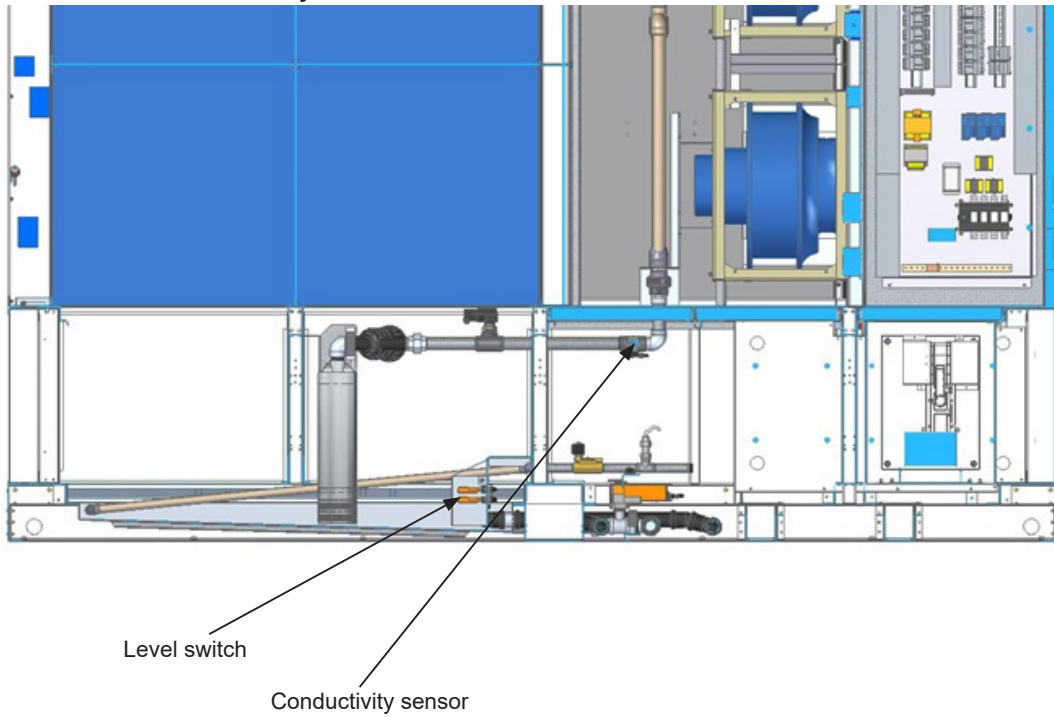
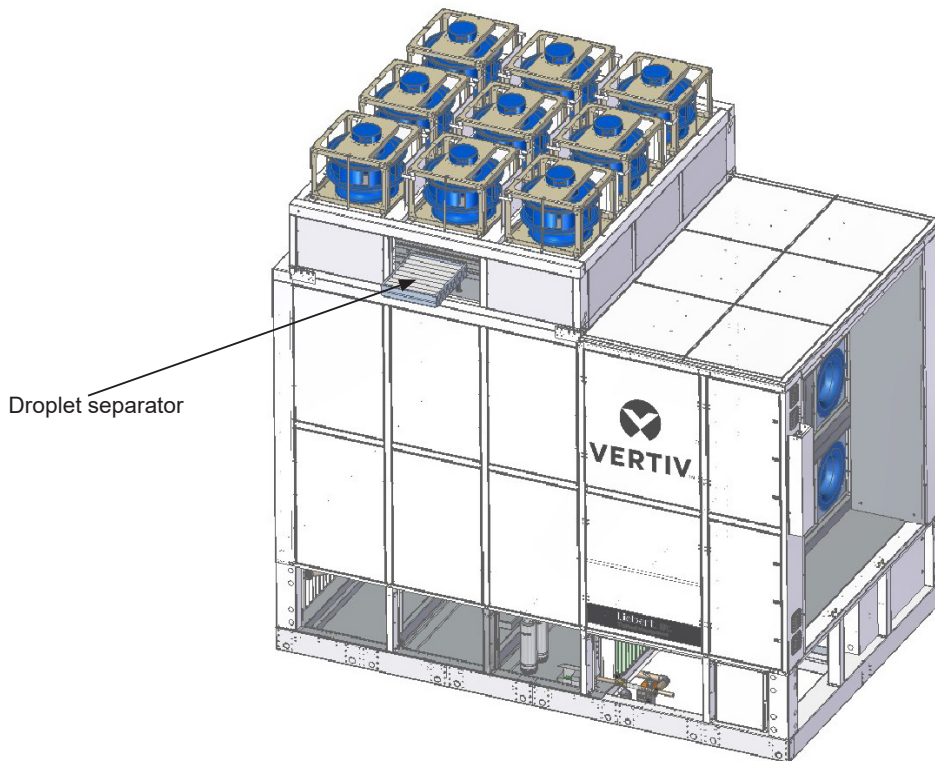


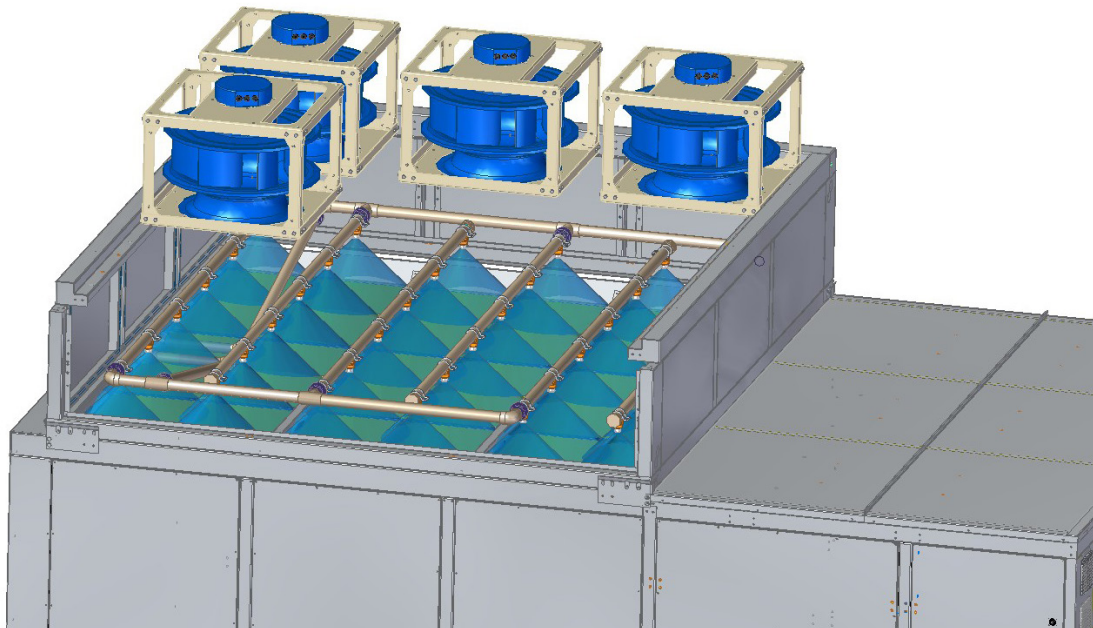
Figure A.9 - Droplet separator



Note: Here shown the single unit left, on the single unit right the level switch and conductivity sensor are on the opposite side

Enclosure A - Evaporative cooling system

Figure A.10 - Evaporative system nozzles



A2.2 - Water quality

Water quality

The unit must be supplied with drinking water as indicated on Directive 98/83/EC, filtered with a filtration grade not less than 89 micron, having the following characteristics:

- $6.5 < \text{pH} < 8$
- Electrical conductivity $< 400 \mu\text{S}/\text{cm}$
- TDS $< 260 \text{ mg}/\text{l}$ @ $180 \text{ }^\circ\text{C}$
- Total hardness $< 10^\circ\text{f}^*$
- Total alkalinity $< 50 \text{ mg}/\text{l CaCO}_3$
- Chlorides $< 20 \text{ mg}/\text{l}$
- Silica $< 5 \text{ mg}/\text{l}$
- Organic matter $< 3 \text{ mg}/\text{l}$

Note:

If softened water is used consider 3°f as minimum value for total hardness.

Note:

It is highly recommended to dose the antiscalant in the feeding water to avoid scaling on the system.



Ensure a pressure between 2 and 4 bar on the evaporative system water inlet.

Enclosure B - Technical data table

Tab. B.1a - Electrical data

Configuration	Model	Power supply	Electrical Data			min/max Cu cable size mm ²
			FLA	LRA	RESIDUAL-CURRENT CIRCUIT BREAKERS I _{Δn} =0.3A (400V)*	
			[A]	[A]		
Evaporative Cooling Fans + Pump	EFC220	400 V / 3 Ph + N / 50 Hz + earth	81.2	81.2	100	25
Evaporative Cooling + DX Fans + Pump + Compressor(s)	EFC220	400 V / 3 Ph + N / 50 Hz + earth	115.2 (149.2)**	255.2 (289.2)**	150	50
Evaporative Cooling Fans + Pump	EFC300	400 V / 3 Ph + N / 50 Hz + earth	178.2	178.2	200	50
Evaporative Cooling DX Fans + Pump + Compressor(s)	EFC300	400 V / 3 Ph + N / 50 Hz + earth	212.2 (246.2)**	352.2 (386.2)**	250	70
Evaporative Cooling Fans + Pump	EFC320	400 V / 3 Ph + N / 50 Hz + earth	147	147	200	50
Evaporative Cooling DX Fans + Pump + Compressor(s)	EFC320	400 V / 3 Ph + N / 50 Hz + earth	181 (215)**	321 (355)**	200 (250)	50 (70)
Evaporative Cooling Fans + Pump	EFC400	400 V / 3 Ph + N / 50 Hz + earth	150	150	200	50
Evaporative Cooling DX Fans + Pump + Compressor(s)	EFC400	400 V / 3 Ph + N / 50 Hz + earth	(218)** ((250))***	(358)** ((343))***	(250)** ((300))***	(70)** ((95))***

* ATTENTION Only universal (type B, B+) RCD protective devices are permitted

** value in brackets is for tandem compressors

***value in dual brackets is for dual tandem compressors

NOTES:

- The cables have to be sized in compliance with local standards and according to the type and characteristics (e.g. Ampere) of installation.
- The data in the tables do not consider the absorbed current for other options not explicitly described.
- The specific energy allowed to flow from the circuit breakers, installed by the user, must be lower than 300.000A² x s.
- Prescriptions on the differential relay required to the user:
 - For special places (healthcare facilities, etc...) comply with the local regulations;
 - For ordinary places, a low sensitivity is suggested (300mA) coordinated with the value of the ground heater (IEC 364): Ra ≤ 50/Ia (Art.413.1.4.1, CEI 64-8 or IEC60364-4-45);
 - In case of frequent over-voltages with mains impulse, it is advisable to install a selective differential and to evaluate the need for adopting other devices;

Tab. B.1b - Electrical data

Component	Model	Quantity	FLA	LRA	Power input	cosφ
		no.	[A]	[A]	[kW]	
Fans primary	EFC220	4	9.4	0.1	6	0.9
Fans process		4	9.4	0.1	6	0.9
Compressor		1 or 2	34	174	17.2	0.79
Recirculating pumps		1	6	18	1.2	0.9
Fans primary	EFC300	9	9.4	0.1	6	0.9
Fans process		9	9.4	0.1	6	0.9
Compressor		1 or 2	34	174	17.2	0.79
Recirculating pumps		1	9	27	1.9	0.9
Fans primary	EFC320	9	9.4	0.1	6	0.9
Fans process		6	9.4	0.1	6	0.9
Compressor		1 or 2	34	174	17.2	0.79
Recirculating pumps		1	6	18	1.2	0.9
Fans primary	EFC400	9	9.4	0.1	6	0.9
Fans process		6	9.4	0.1	6	0.9
Compressor		2 or 4	34	174	17.2	0.79
Recirculating pumps		1	9	27	1.9	0.9

NOTE: The fans power factor cos φ decrease when the fans run at low speed: this should be considered in case of UPS system installation.

Enclosure B - Technical data table

Tab. B.2 - Refrigerant and oil charge for units with built-in condenser

Model	R410A REFRIGERANT CHARGE [kg]	INITIAL OIL CHARGE (*) [l]	ADDITIONAL OIL CHARGE ALREADY ADDED IN FACTORY (*) [l]
EFC22060PX	23	3.25	1.5
EFC22060PT	27.5	2x3.25	1.0
EFC30050PX	29	3.25	2.0
EFC30050PT	37	2x3.25	2.0
EFC32050PX	29	3.25	2.0
EFC32050PT	37	2x3.25	2.0
EFC40050PT	38	2x3.25	2.0
EFC40050PD	26+26	4x3.25	1.5+1.5

(*) The recommended oil for units with R410A refrigerant is EMKARATE RL 32-3MAF

Tab. B.3 - Refrigerant and oil charge for units with remote condenser

MODEL	BASE REFRIGERANT CHARGE (2) [kg - each circuit] Microchannel Coil Condenser	BASE REFRIGERANT CHARGE (2) [kg - each circuit] Fins and Tubes Coil Condenser	BASE OIL CHARGE (1) [l]		Max System Refrigerant Charge before oil addition (4) [kg – each circuit]	Oil to be added over the Max System Refrigerant Charge (4) [l – each circuit]
			oil within compressor (Data in brackets refer to Digital Scroll Compressor Cooling System, when the data differs)			
			Initial oil charge	Max topping up		
EFC22060PX			3.25	3.14	13	a
EFC22060PT			2x3.25	2x.3.14	13	a
EFC30050PX			3.25	3.14	13	a
EFC30050PT			2x3.25	2x3.14	13	a
EFC32050PX			3.25	3.14	13	a
EFC32050PT			2x3,25	2x3,14	13	a
EFC40050PT			2x3,25	2x3,14	13	a
EFC40050PD			2x3,25	2x3,14	13	a

$a = 0.025 \times \text{total refrigerant charge for each circuit [kg]} + 0.09$



NOTE: Check oil level inside the compressor, where compressor's oil level sight glass is available, after 30 min. of compressor running at maximum capacity: oil level must be between 1/2 and 3/4 of sight glass. In tandem compressors, the oil level must be checked with both compressors running at maximum capacity (note: when only one compressor is running, the oil level inside the compressor that is not currently running could be at the minimum and the compressor, that is running, at the maximum capacity; when one compressor is running at maximum capacity and one compressor is running in modulating capacity, the oil level in the latter one could be between 1/2 and the minimum).

Enclosure B - Technical data table

Tab. B.3a - Refrigerant pipe charge

EXTERNAL PIPE DIAMETER (mm)	Gas [kg/m]	liquid at different condensing temperatures ⁽³⁾ R410A [kg/m]		
		35.0°C	46.0°C	57.0°C
10 x 1	0.0048	0.0507	0.0470	0.0426
12 x 1	0.0075	0.0793	0.0734	0.0665
14 x 1	0.0108	0.1142	0.1056	0.0958
16 x 1	0.0147	0.1554	0.1438	0.1304
18 x 1	0.0192	0.2030	0.1878	0.1703
22 x 1.5	0.0271	0.2862	0.2648	0.2402
28 x 1.5	0.0469	0.4956	0.4585	0.4158

(1) The recommended oil for units with R410A refrigerant is EMKARATE RL 32-3MAF.

(2) Unit coupled with remote condenser suggested for ambient temperature up to 35°C. With **Smart Aisle™** application increase refrigerant charge up to 10%. The final charge must be precisely defined in field.

(3) For distance D see Fig. 1.

(4) Topping up is requested for short pipeline too, due to the extra-charge of refrigerant.

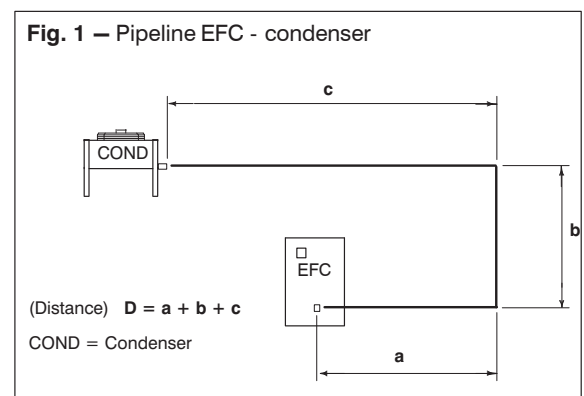


NOTICE: Check oil level inside the compressor, where compressor's oil level sight glass is available, after 30 min. of compressor running at maximum capacity: oil level must be between 1/2 and 3/4 of sight glass.

In tandem compressors the oil level must be checked with both compressors running at maximum capacity (note: when only one compressor is running, the oil level inside the compressor that is not currently running could be at the minimum and the compressor, that is running, at the maximum capacity; when one compressor is running at maximum capacity and one compressor is running in modulating capacity, the oil level in the latter one could be between 1/2 and the minimum).





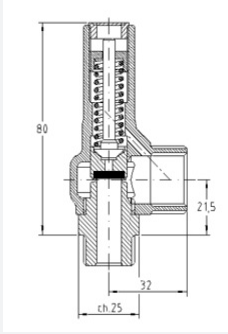
Note: The refrigeration circuit is supplied pressurized with helium at 2 bar.

Fig.1 - Pipeline Liebert® EFC - Condenser



Enclosure B - Technical data table

Tab. B.4 – Calibration of electrical components

COMPONENT	SETTING	NOTES	Contact
High Pressure Transducer (HP)	Range 0-45 barg Output 0-5 V		
Low Pressure Transducer (LP)	Range 0-17.3 barg Output 0-5 V		
High Pressure Switch (HP)	STOP 42.0 ± 1 barg START 33.0 ± 1.5 barg (fixed setting - manual reset)	 <p>Reset</p>	Normally closed
Clogged Filter Differential Pressure Switch (CF)	Filter F5 = 3 mbar	 <p>Setting ring</p>	Normally closed
Safety Valve	Setting Pressure 45 bar		

Enclosure B - Technical data table

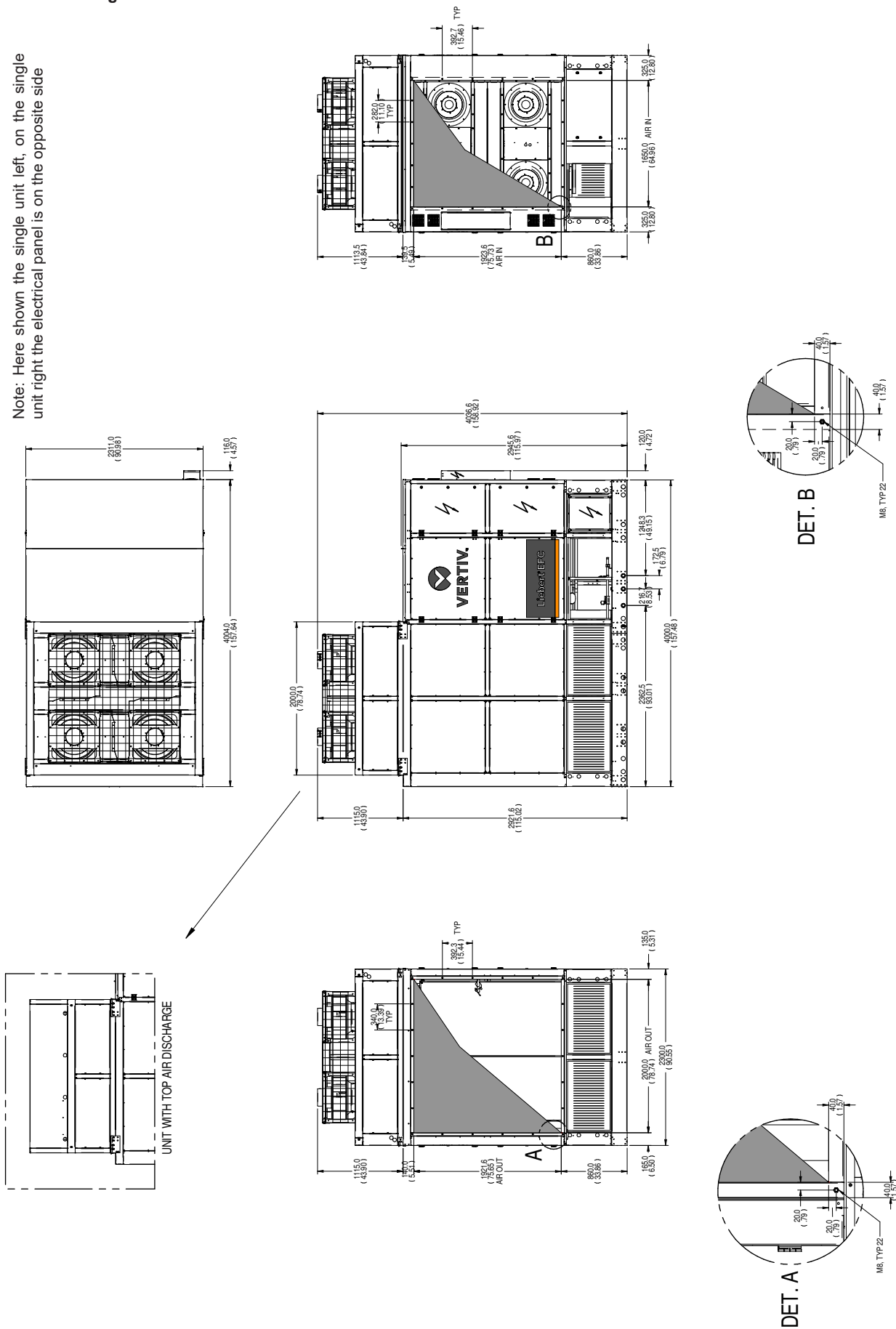
Tab. B.5 - Adjustments and calibrations of valves (see Enclosed D - Refrigeration circuits)

Component	Calibration & Operating	Application	Model	Drawing
Servomotor for chilled water valve	Modulating action	All Versions	Controlli MVB46	
2 - way chilled water valve	Modulating action	All Versions	Controlli VMB8A	
3 - way chilled water valve	Modulating action	All Versions	Controlli VMB8A	
Thermostatic expansion valve	Superheating control 6 8K	All Versions	Sporlan BBIZE / OZE	

Enclosure C - Dimensional Data/Connections

Liebert EFC220 Single Unit Left

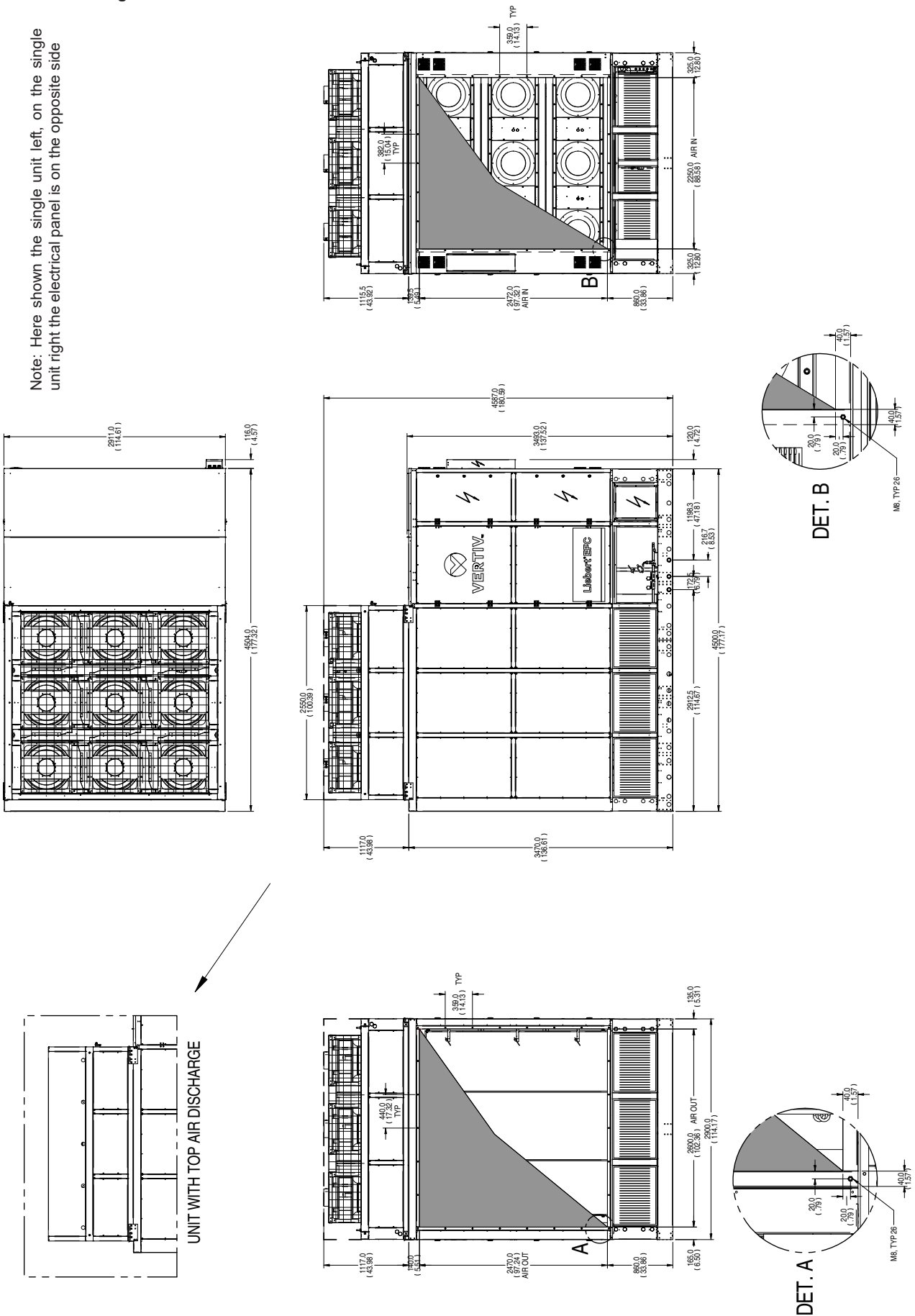
Note: Here shown the single unit left, on the single unit right the electrical panel is on the opposite side



Enclosure C - Dimensional Data/Connections

Liebert EFC300 Single Unit Left

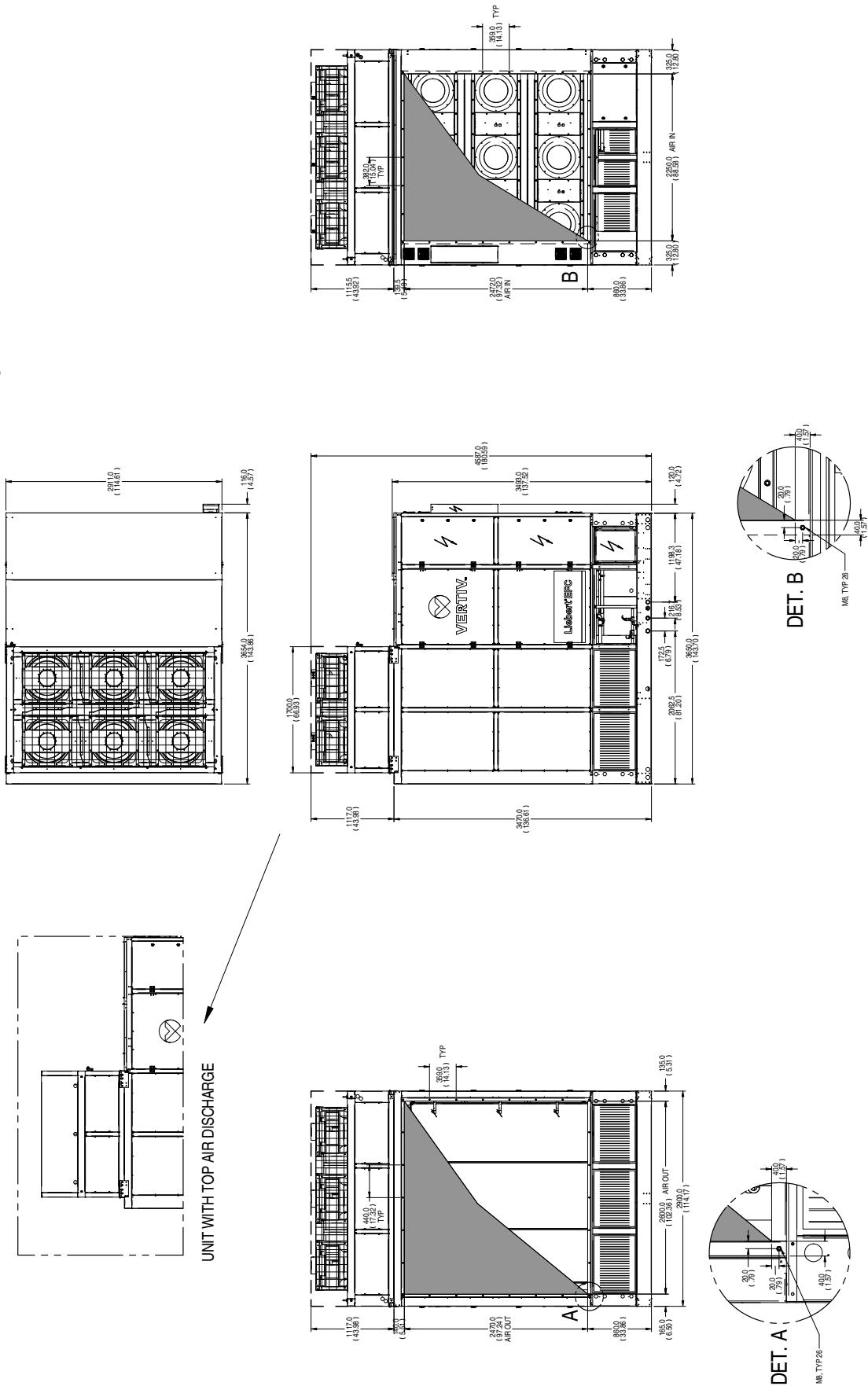
Note: Here shown the single unit left, on the single unit right the electrical panel is on the opposite side



Enclosure C - Dimensional Data/Connections

Liebert EFC320

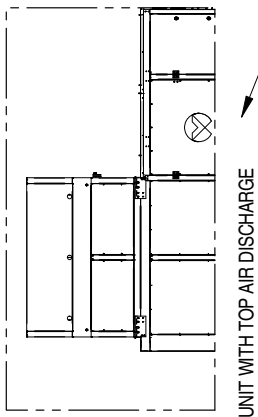
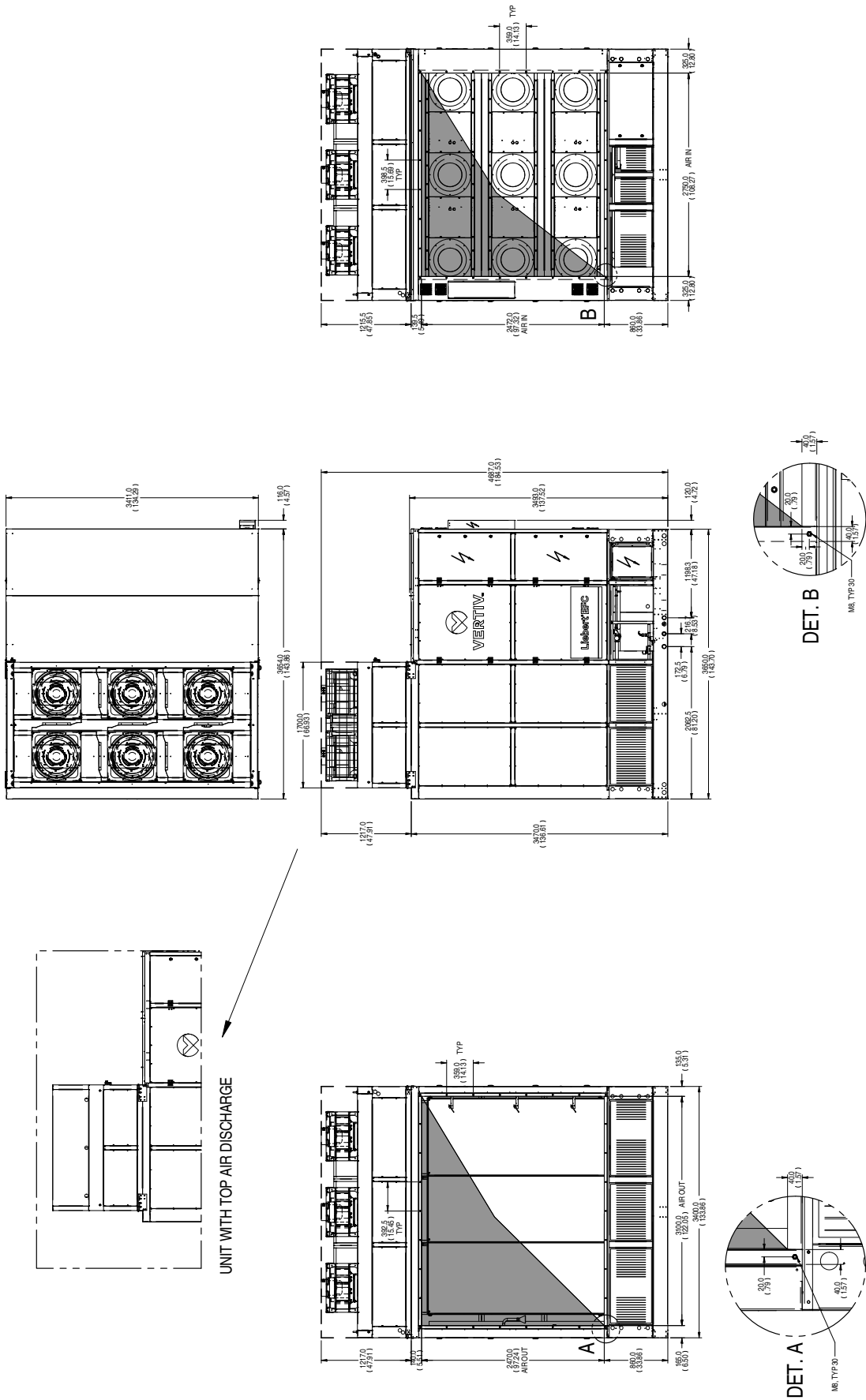
Note: Here shown the single unit left, on the single unit right the electrical panel is on the opposite side



Enclosure C - Dimensional Data/Connections

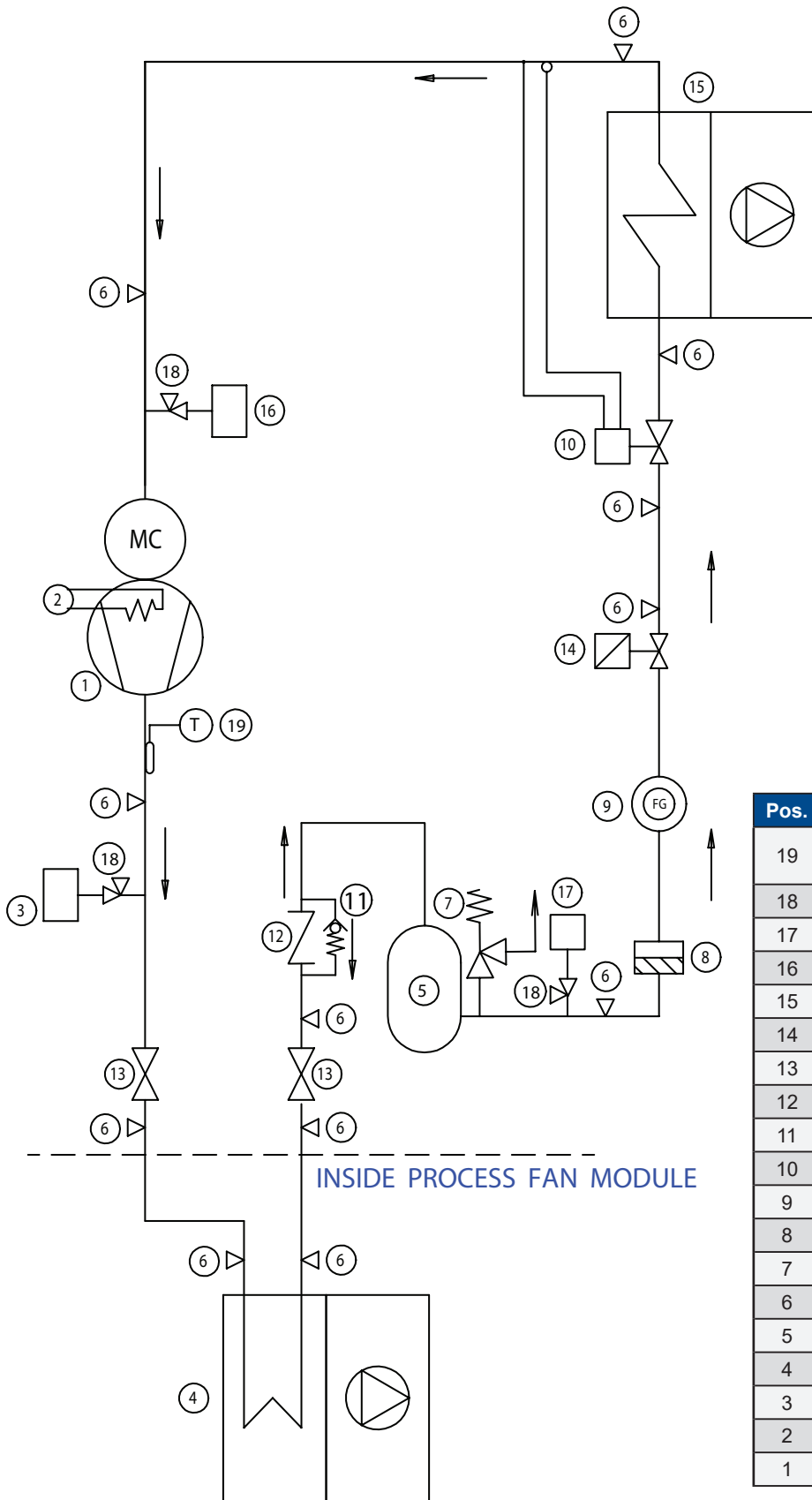
Liebert EFC400

Note: Here shown the single unit left, on the single unit right the electrical panel is on the opposite side



Enclosure D - Refrigerant, Hydraulic and Electrical Connections

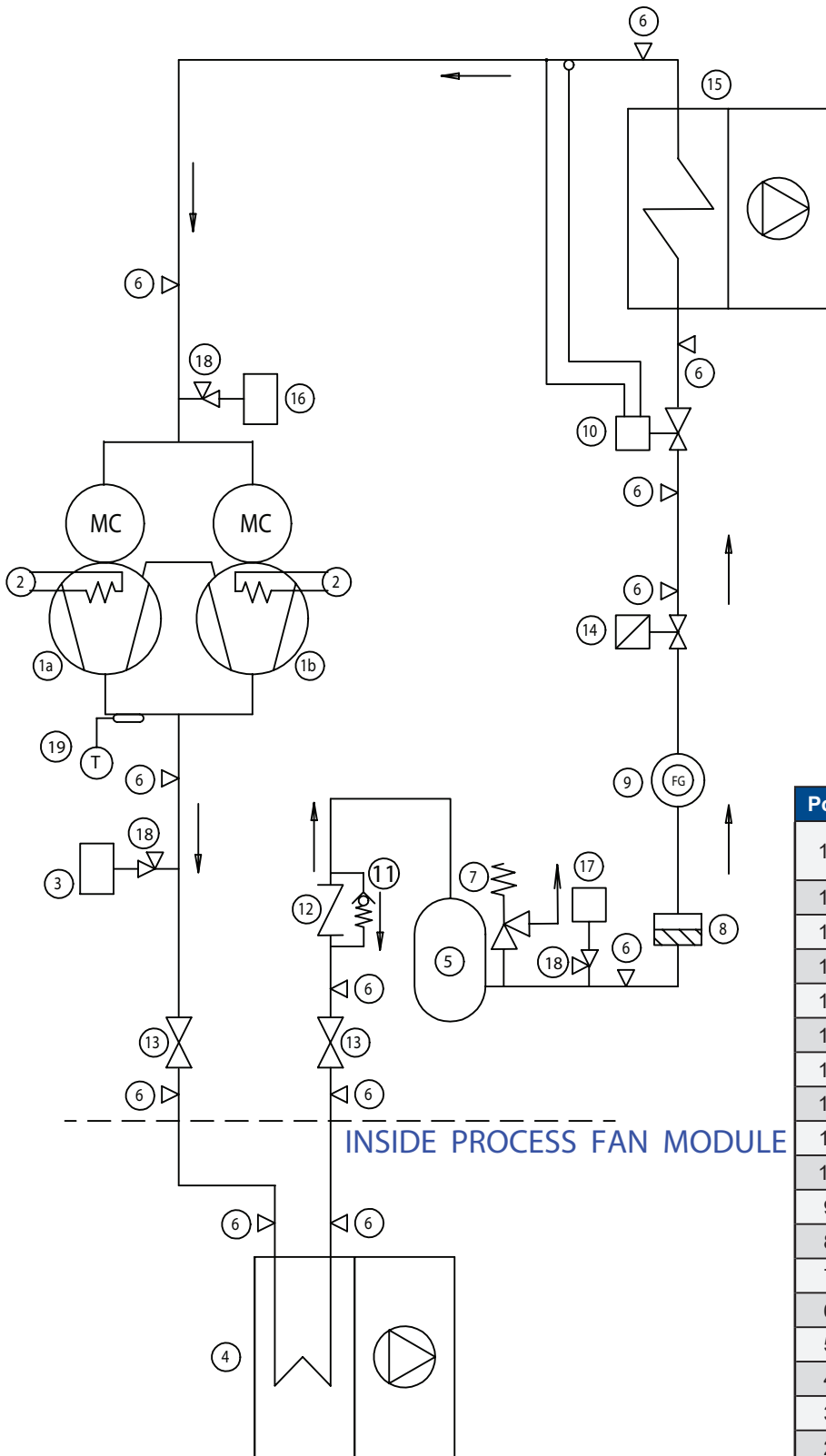
Fig. D.1 - DX system refrigerant circuit - Single DIGITAL SCROLL compressor - TXV



Pos.	DESCRIPTION
19	NTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRASDUCER
15	EVAPORATOR
14	SHUT OFF SOLENOID VALVE
13	SHUT-OFF VALVE
12	CHECK VALVE
11	CHECK VALVE 10 bar
10	THERMOSTATIC EXPANSION VALVE
9	SIGHT GLASS
8	FILTER DRYER
7	SAFETY VALVE
6	ACCESS VALVE 5/16 SAE
5	LIQUID RECEIVER
4	AIR COOLED CONDENSER
3	HIGH PRESSURE SWITCH
2	CRANKCASE HEATER
1	DIGITAL SCROLL COMPRESSOR

Enclosure D - Refrigerant, Hydraulic and Electrical Connections

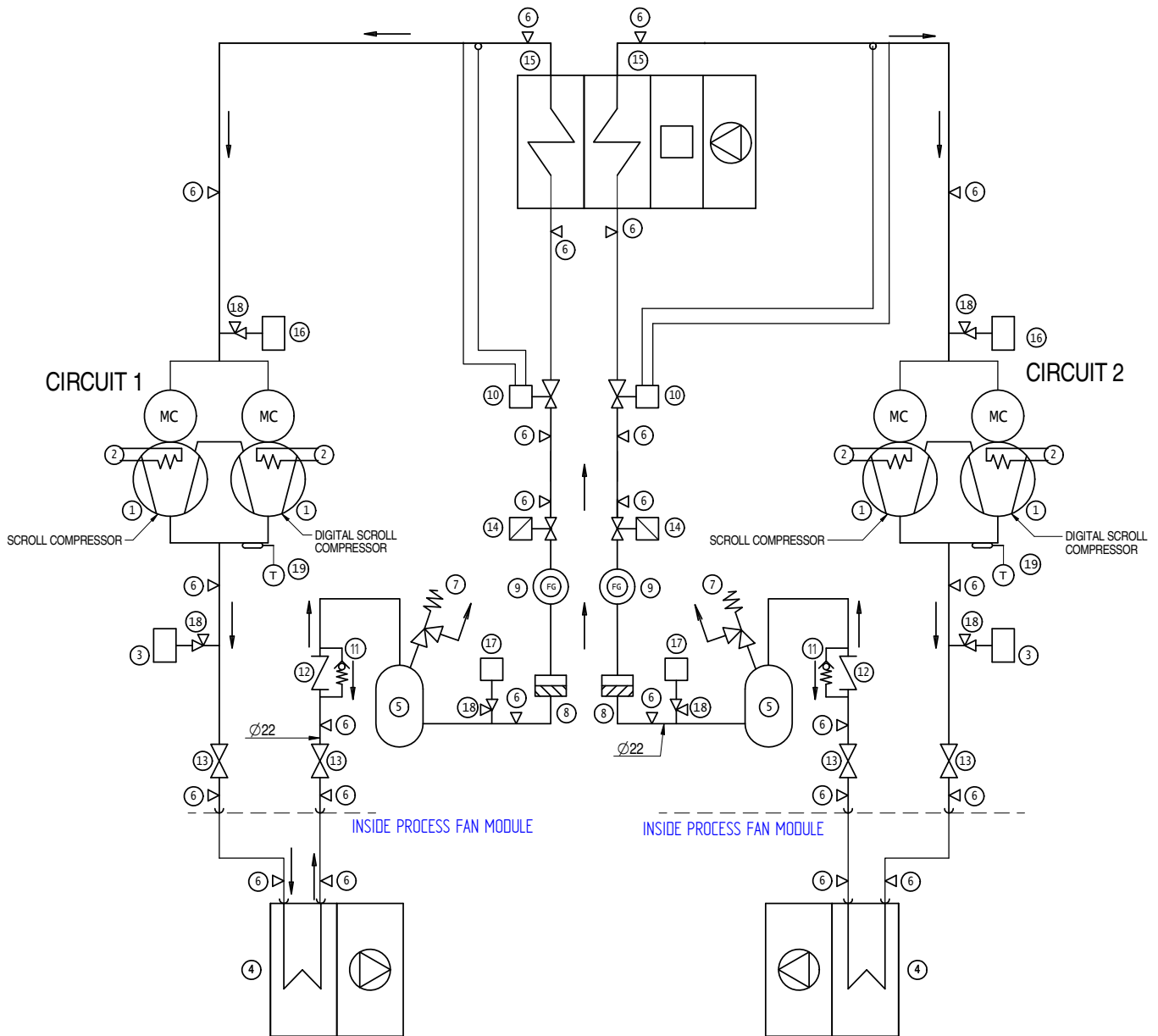
Fig. D.2 - DX system refrigerant circuit - Tandem DIGITAL SCROLL compressor - TXV



Pos.	DESCRIPTION
19	NTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRASDUCER
15	EVAPORATOR
14	SHUT OFF SOLENOID VALVE
13	SHUT-OFF VALVE
12	CHECK VALVE
11	CHECK VALVE 10 bar
10	THERMOSTATIC EXPANSION VALVE
9	SIGHT GLASS
8	FILTER DRYER
7	SAFETY VALVE
6	ACCESS VALVE 5/16 SAE
5	LIQUID RECEIVER
4	AIR COOLED CONDENSER
3	HIGH PRESSURE SWITCH
2	CRANKCASE HEATER
1b	SCROLL COMPRESSOR
1a	DIGITAL SCROLL COMPRESSOR

Enclosure D - Refrigerant, Hydraulic and Electrical Connections

Fig. D.3 - DX system refrigerant circuit - Dual Tandem DIGITAL SCROLL compressor - TXV

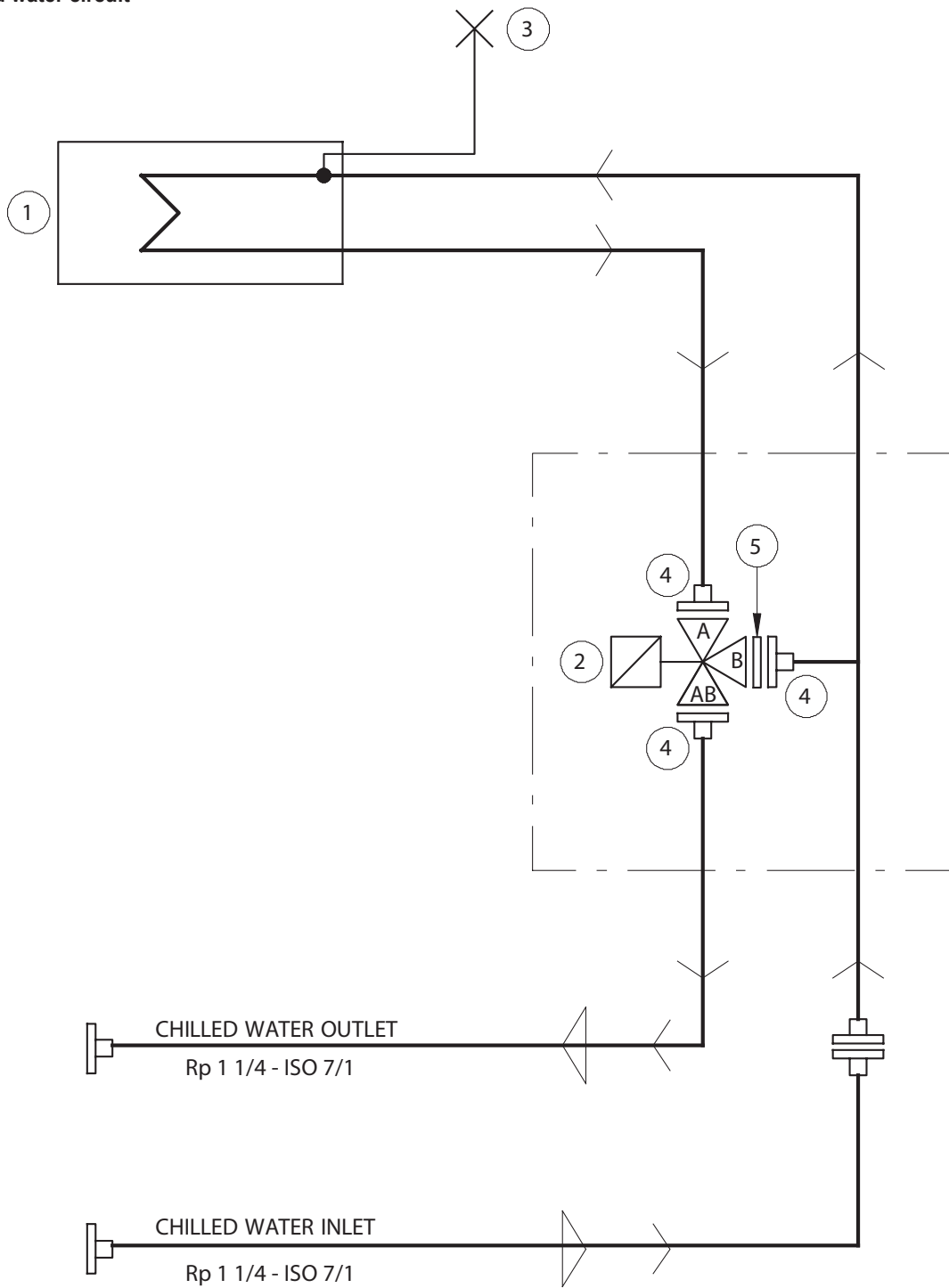


Pos.	DESCRIPTION
19	PTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRASDUCER
15	EVAPORATOR
14	SHUT OFF SOLENOID VALVE
13	SHUT-OFF VALVE
12	CHECK VALVE
11	CHECK VALVE 10 bar

Pos.	DESCRIPTION
10	THERMOSTATIC EXPANSION VALVE
9	SIGHT GLASS
8	FILTER DRYER
7	SAFETY VALVE
6	ACCESS VALVE 5/16 SAE
5	LIQUID RECEIVER
4	AIR COOLED CONDENSER
3	HIGH PRESSURE SWITCH
2	CRANKCASE HEATER
1	COMPRESSOR

Enclosure D - Refrigerant, Hydraulic and Electrical Connections

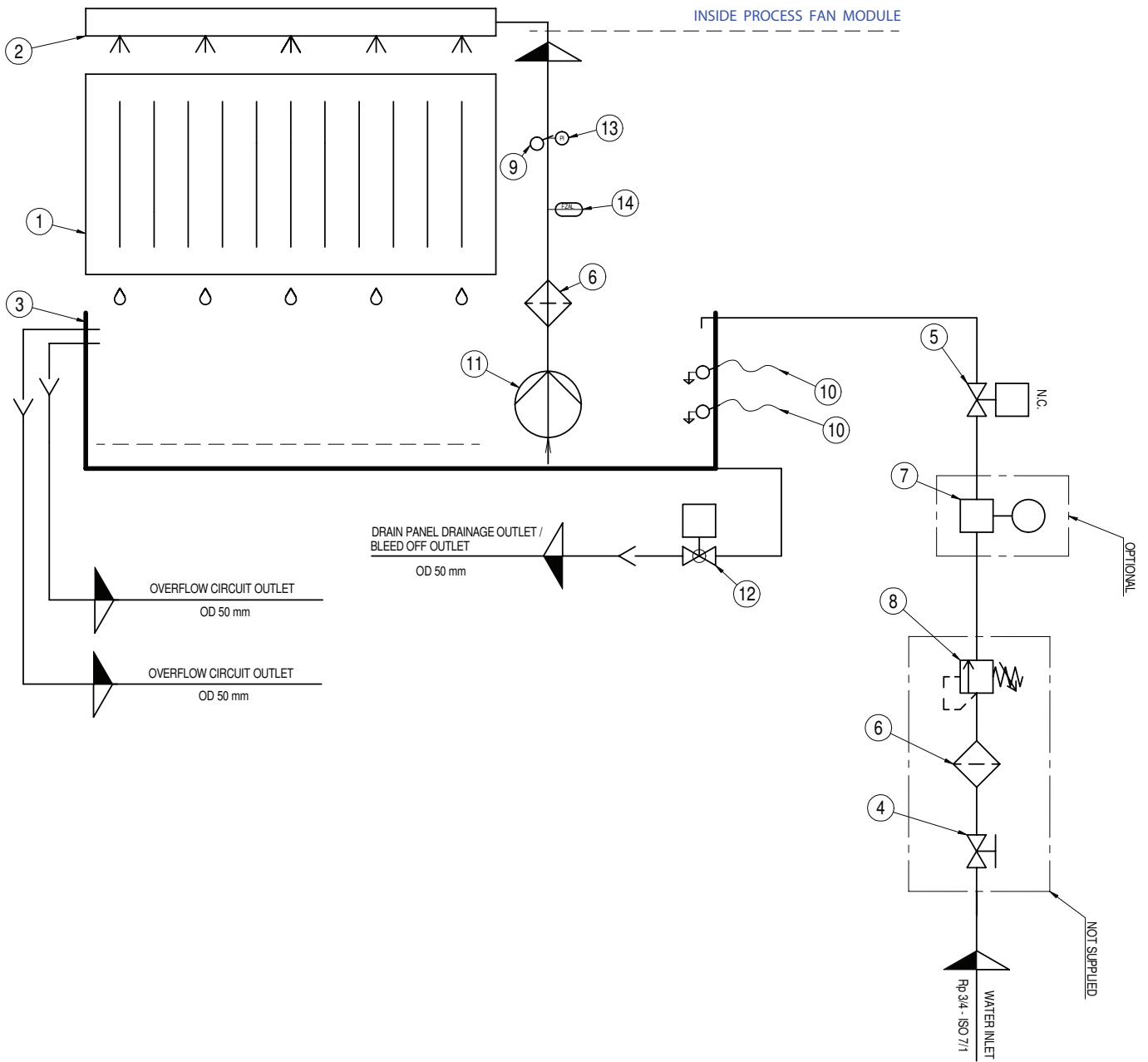
Fig. D.4 - Chilled water circuit



POS.	DESCRIPTION
1	Chilled water coil
2	Chilled water 3 - way valve
3	Manual bleed valve
4	Valve fittings
5	Blind disk

Enclosure D - Refrigerant, Hydraulic and Electrical Connections

Fig. D.5 - Hydraulic circuit Evaporative System(for one pump)



Pos.	DESCRIPTION
14	FLOW SWITCH
13	MANOMETER
12	MOTORIZED BALL VALVE
11	PUMP
10	LEVEL SWITCH
9	CONDUCTIVIMETER
8	PRESSURE REGULATOR

Pos.	DESCRIPTION
7	FLOW METER
6	FILTER
5	SOLENOID VALVE
4	VALVE
3	DRAIN PANEL
2	SPRINKLERS
1	PLATE HEAT EXCHANGER



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