Liebert® EFC

The Highly Efficient Indirect Evaporative Freecooling Unit

Unit configuration 3.5 (Composite heat exchanger)

User Manual

English, 10040805MAN_ENG, rev. G - 30.03.2023

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

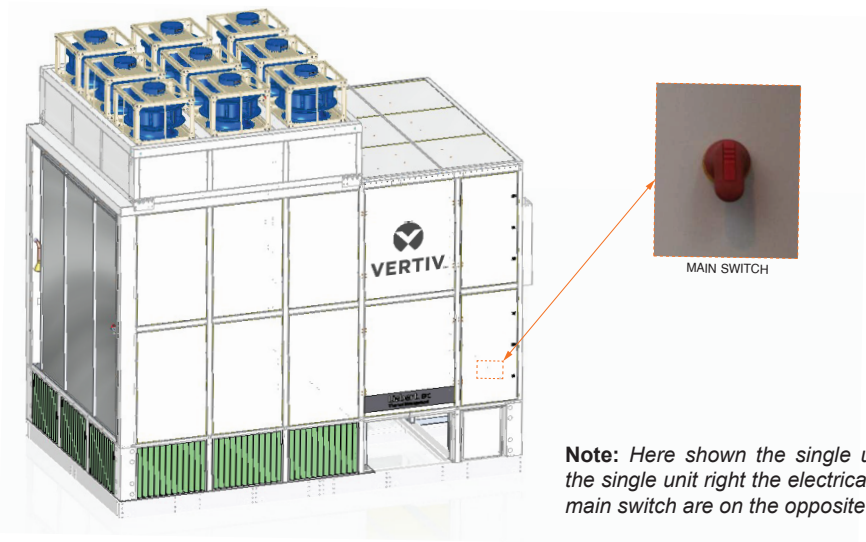
Before proceeding with installation, read all instructions, verify that all parts are included and check the nameplate to make sure the voltage matches available utility power.
For identification of the unit (model and serial no.) in case of the necessity for assistance or spare parts, locate the identification 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.
Follow all local regulations to prevent risk of legionella disease and other microbiological risks (risk assessment, prevention, control, maintenance, health surveillance)

NOTICE

Water Quality Requirements: make sure the water supplied to the unit and the water into the recirculation system are in line with the water specification as per *Chapter 3.2*.

VERTIV™

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

CE

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

COMPRESSOR
FLA (37) LRA (2) QT. (3)
COMPRESSOR
FLA (1) LRA (2) QT. (3)
FAN MOTOR INT.
FLA (1) LRA (5) QT. (6)
FAN MOTOR EXT.
FLA (4) LRA (8) QT. (9)
PUMP MOTOR
FLA (7) LRA (11) QT.
TOTAL FLA AC (10) A
TOTAL FLA DC (14) A
Ipk (15) KA (12)
Icw (16) KA

REFRIGERANT TYPE
GWP (13)
CIRCUIT 1 REFRIGERANT CHARGE (17)
ON FACTORY (18) Kg
ON SITE (19) .....Kg
CIRCUIT 2 (38) REFRIGERANT CHARGE
ON FACTORY (20) Kg
ON SITE (21) .....Kg

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

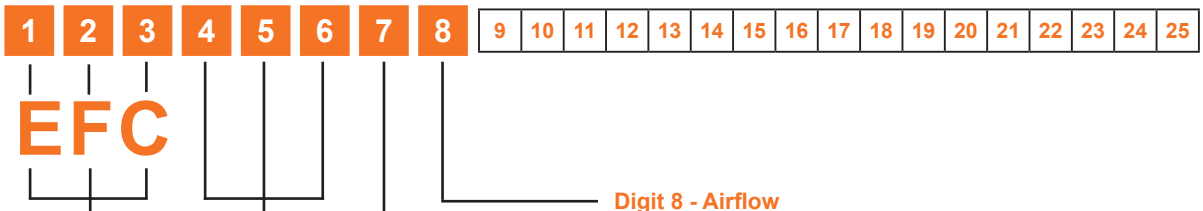
Onboard Label

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 1 - 3
Liebert® EFC

Digit 4 - 6
Unit Model
250 EFC 250 model
300 EFC 300 model
320 EFC 320 model
400 EFC 400 model
440 EFC 440 model

Digit 8 - Airflow
0 std EC FAN

Digit 7 - Unit size
5 2900 (width) x 4587 (height)
7 3400 (width) x 4687 (height)
8 3400 (width) x 4587 (height)
9 2500 (width) x 4587 (height)

Digit 9 - Cooling system
P Evaporative, recirculating pumps (Please refer to dedicated user manual)
C Evaporative, recirculating pumps – Composite heat exchanger

Digit 10 - Backup
0 None
X DX Backup (1 single digital)
W CW Backup
T DX Backup (1 tandem digital)
D DX 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 + Coarse 40% (G2) + Clogged Filter
2 Coarse 40% (G2) + Clogged Filter

Digit 16 - Internal filters
1 Coarse 60% (G4) + Clogged Filter
2 ePM10 50% (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 + PE
1 400 / 3 / 50 + N + PE + ATS
2 400 / 3 / 50 + N + PE + ATS + UltraCap
3 400 / 3 / 50 + N + PE + UltraCap

Digit 19 - Display and Switch
A Small Display
B Small Display + Network Switch
D Small Display + Network switch 5P
E Small Display + Network switch 8P
F Small Display + Network switch 8P fiber

Digit 20 - Monitoring
0 None
1 Modbus 485 monitoring
2 Modbus IP monitoring
3 Bacnet MSTP monitoring
4 Bacnet IP monitoring
5 SNMP monitoring

Digit 21 - Sensors
2 Water Meter
3 Energy Meter + Water Meter

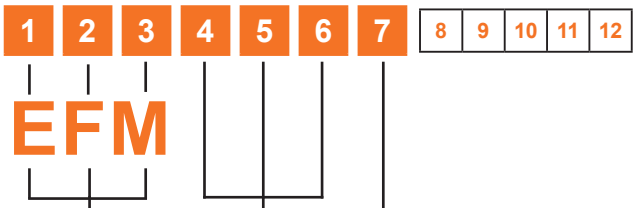
Digit 22 - Packing
P Standard
S Seaworthy + skid for flat rack

Digit 23 to 24 - Free
000 Standard Unit

Digit 25 - Special Requirements
0 None
X SFA

Digit Nomenclature (Fan Module)

The unit is fully defined by twelve digits.



Digit 1 - 3
Fans modules

Digit 4 - 6
Fans modules type

Digit 7 - Fan Type
(Identical unit digit 8)
0 Std EC FAN

Digit 8 - Backup
(Identical to unit digit 10)

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

Digit 9 - External Air Discharge
(Identical to unit digit 13)

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

Digit 10 - Packing
(Identical to unit digit 22)

P Standard
S Seaworthy + skid for flat rack

Digit 11 - Used to match unit power supply
0 400 / 3 / 50 + N

Digit 12 - Special Requirements
0 None
X SFA

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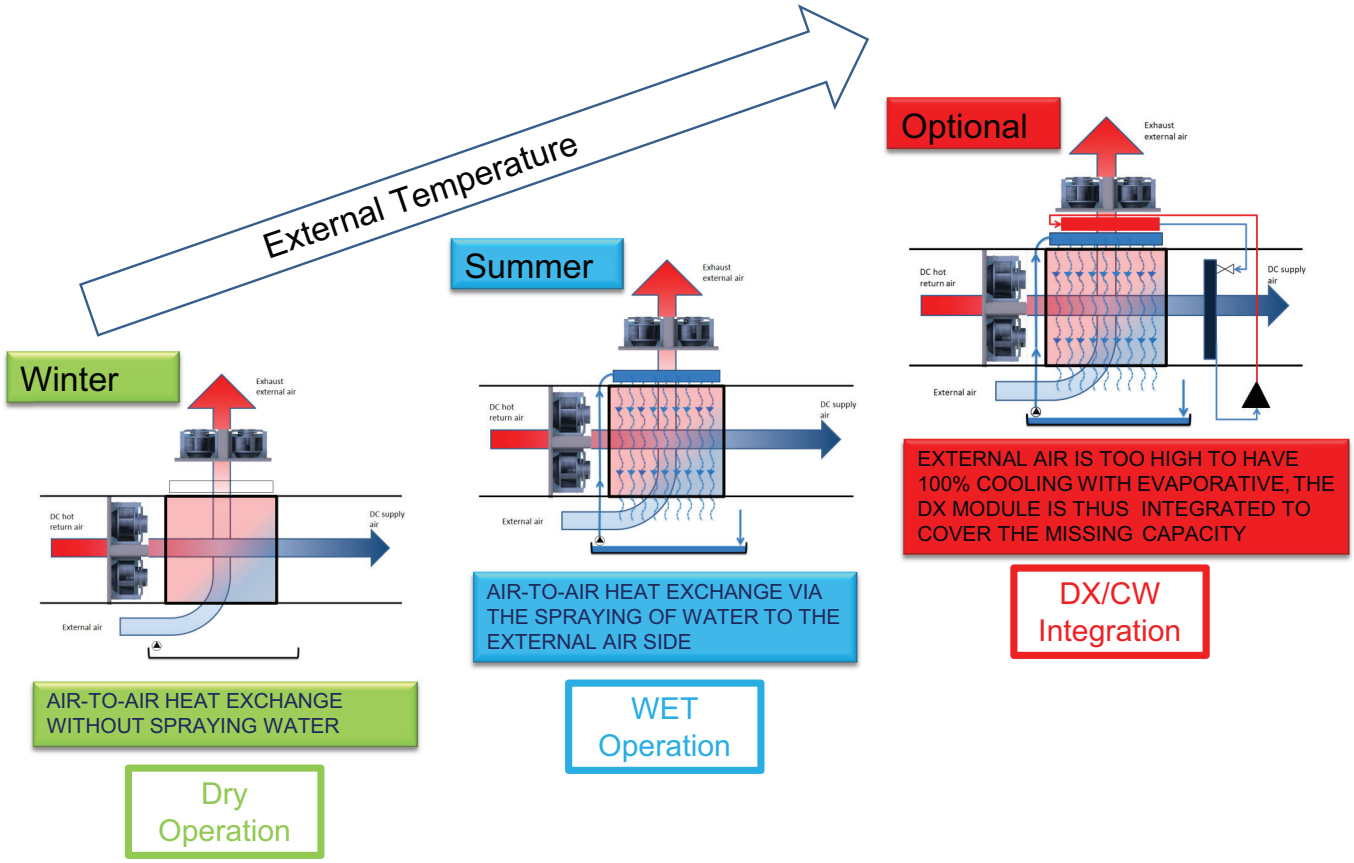
1 - General Description

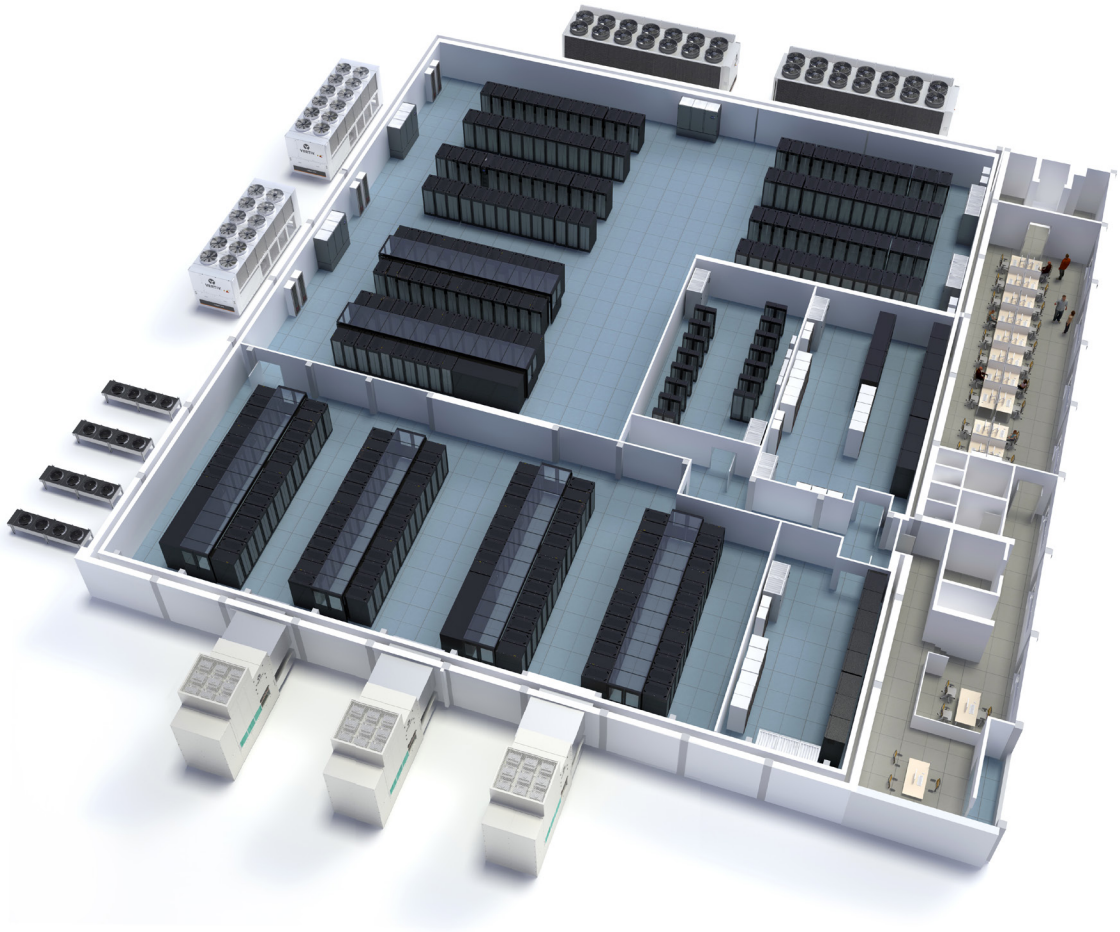
Liebert® EFC is Vertiv™ answer to the latest and future Data Center needs.
The Data Center environment is growing constantly in terms of cooling needs consequently asking for cooling solutions that provide exactly what the servers need without wasting energy overcooling as well as avoiding hot spots. **Liebert® EFC** as a result of EC fans and air-to-air composite 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 cooling capacity is controlled by external air flow modulation;
- 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.





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 provide PRECISE TEMPERATURE and AIRFLOW CONTROL

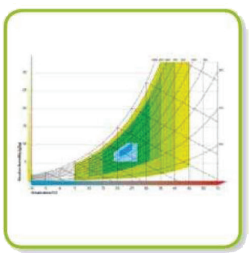
The iCOM™ control logic optimizes internal air volumes and temperatures matching exactly the servers' airflow and cooling needs, ensuring that not even a single Watt is wasted in moving or cooling unrequired air.

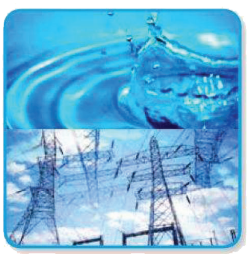
To guarantee ASHRAE RECOMMENDED guidelines

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 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.





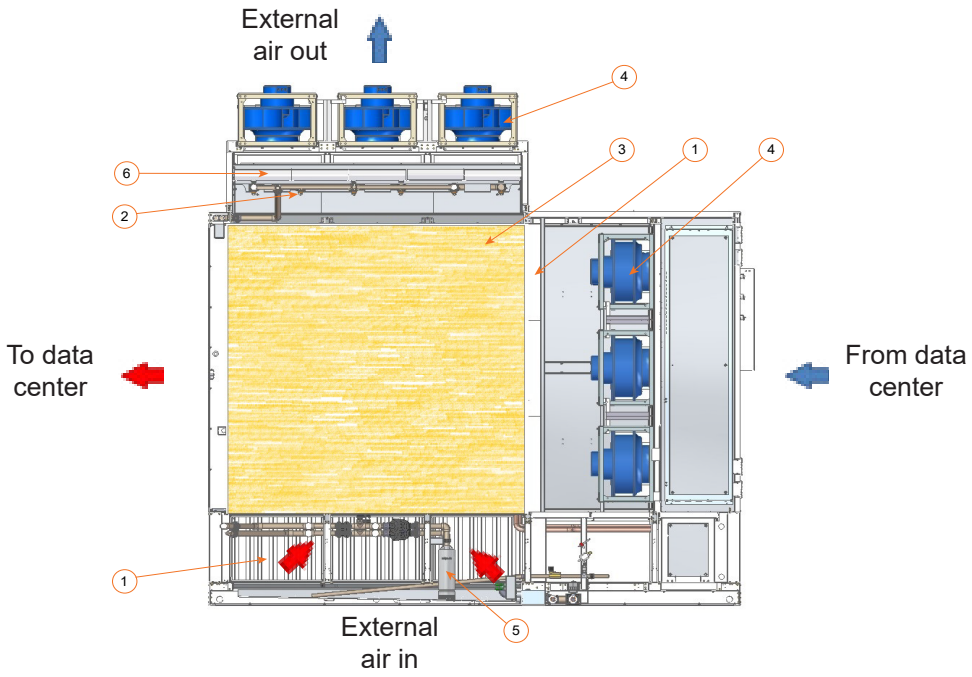
Utmost Efficiency Even at the Data Center System Level

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 Ethernet 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

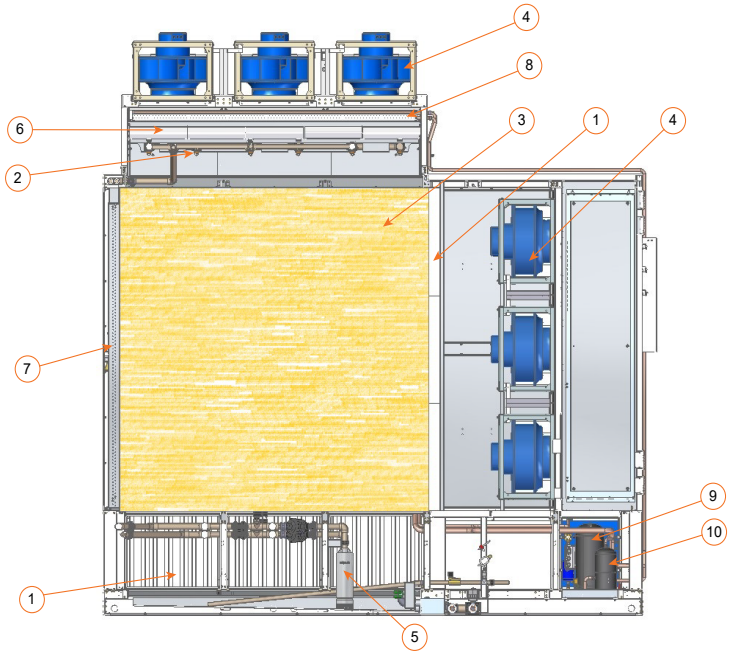
The **Liebert® EFC** standard unit is provided with EC fans (**4**) that push the data center air and pull the outdoor air through an air-to-air composite heat exchanger (**3**), where the outdoor air absorbs heat from the data center air. The Data Center air passes through the air filters (**1**) and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

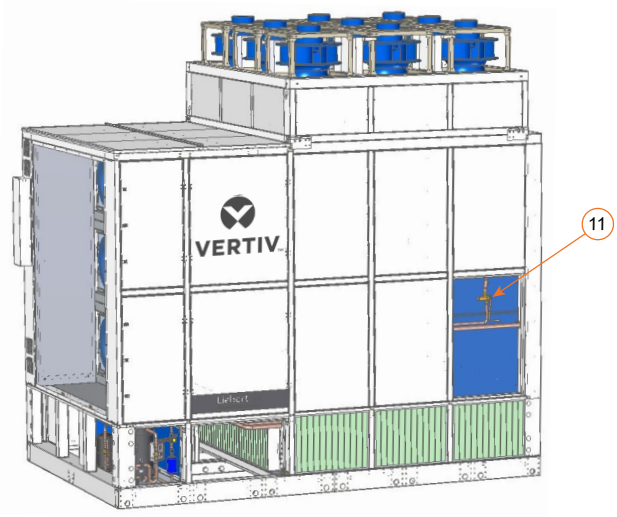


In climates featuring high levels of humidity the unit requires the integration of a **Direct Expansion** (**DX**) System or the installation of a **Chilled Water** (**CW**) Coil.

Evaporative Cooling and DX Cooling Working Mode

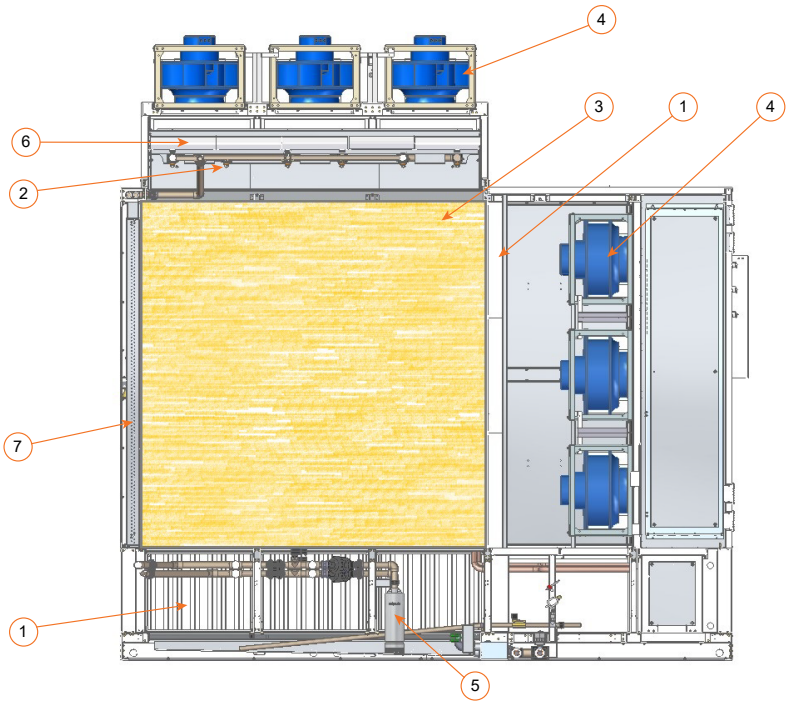
When the unit is equipped with a **DX** backup system the Data Center air passes, after it exits the air-to-air heat exchanger (**3**), through an evaporator (**7**) which cools down the air to the desired temperature. The other main components of the **DX** system are: the condenser (**8**) mounted 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

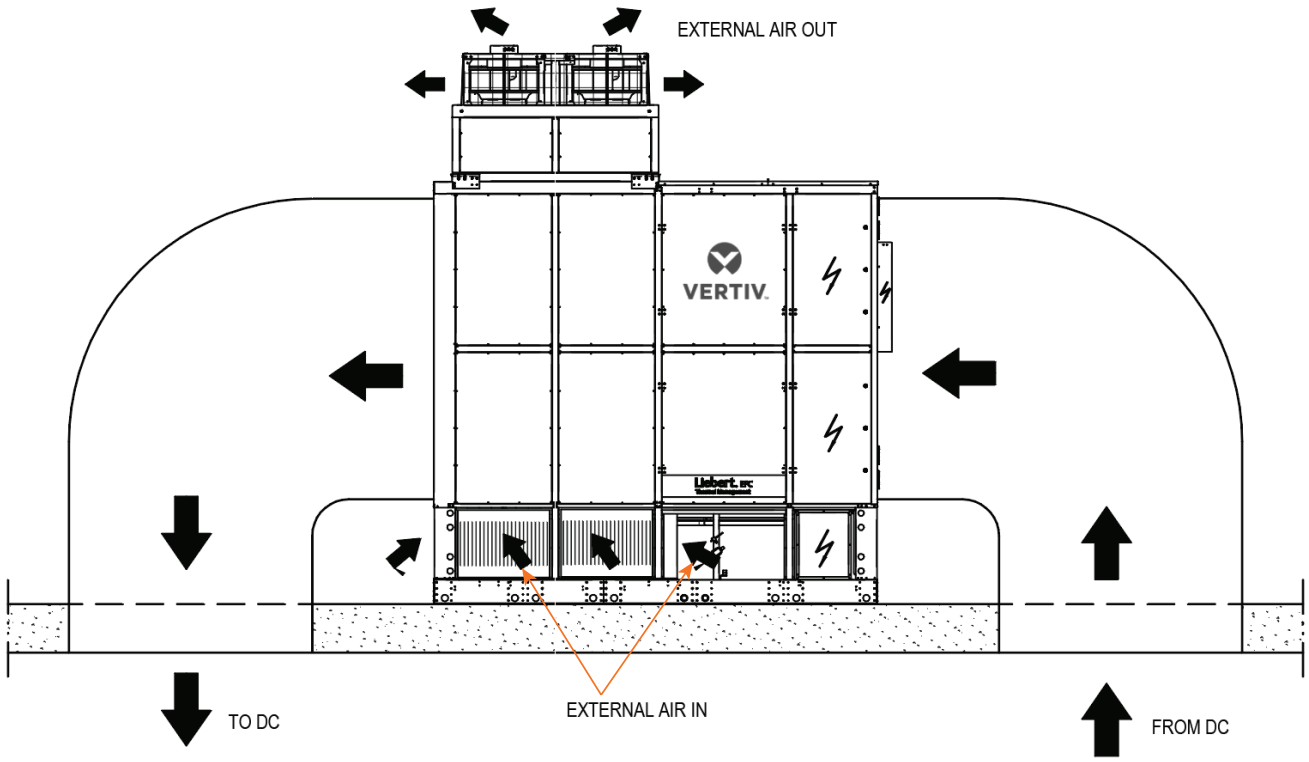
When the unit is equipped with a **CW** backup system the Data Center air passes, after it exits the air-to-air heat exchanger (**3**), through a **CW** coil (**7**) which cools down the air to the desired temperature. The waterflow through the chilled water coil is adjusted with a two-way or three-way valve.



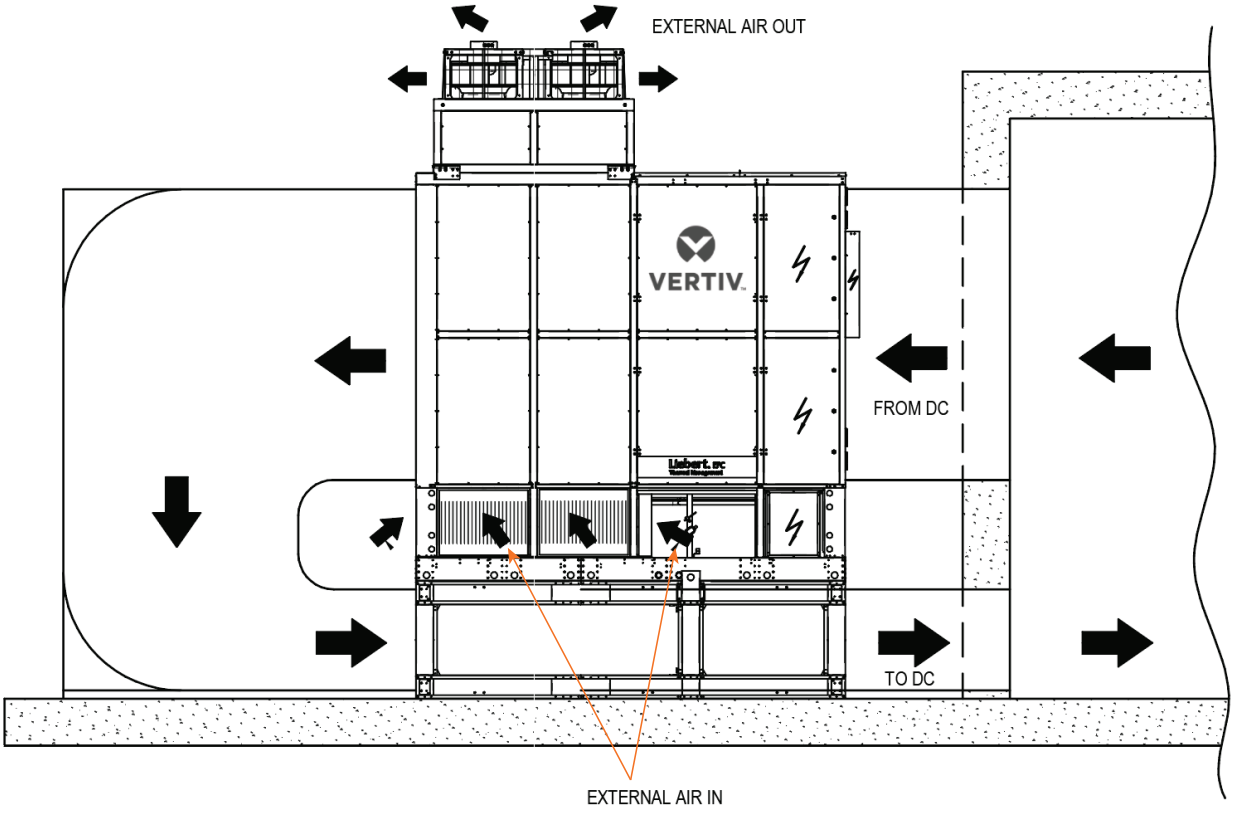
Air discharge version (digit 12, 13 & 14)

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).

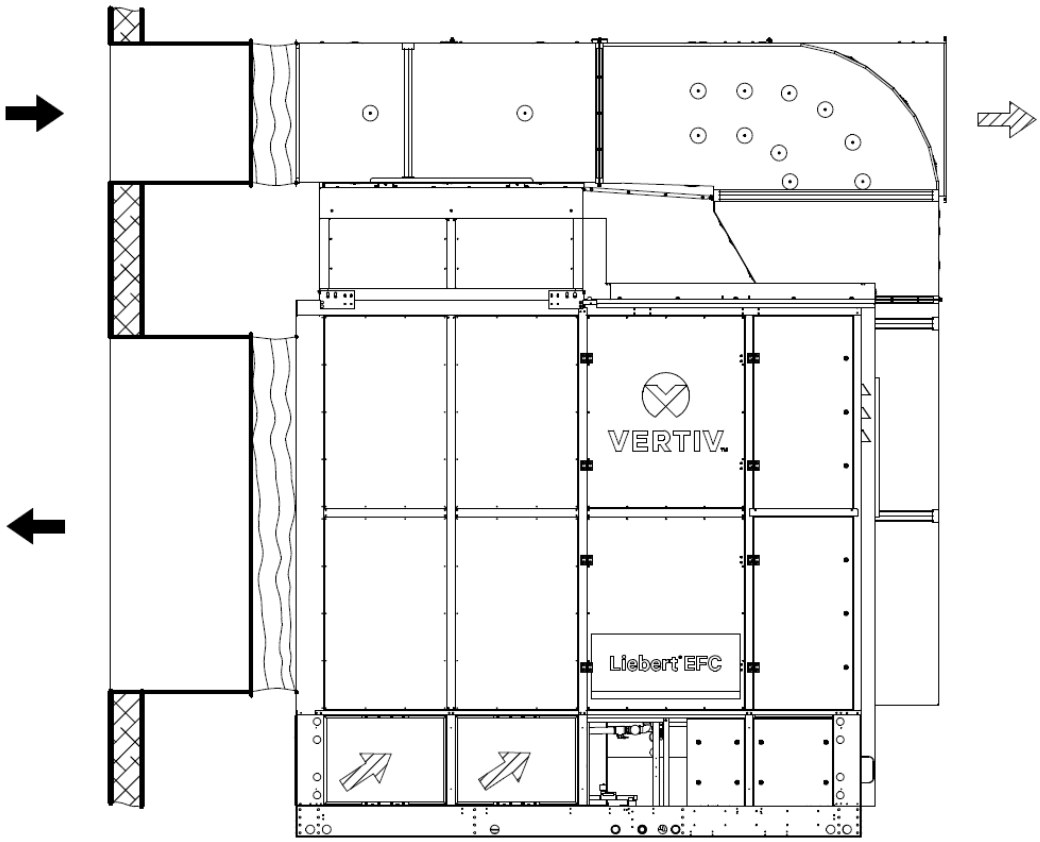
Roof Configuration



Perimeter Configuration



Top Suction 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. 1 - Operating limits

For all units		
Room air conditions Temperature:		from 20°C to 50°C
Storage conditions/ambient running condition *with evaporative cooling working	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.
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*

Relative position room unit vs. remote condenser	
From unit to condenser, max distance	up to 60m equivalent length
From unit to condenser, max geodetic height (1) (2)	from 20m to 3m
Requirements	
Pipe diameter	see *Tab. 5.1*
Oil traps on vertical upward line of refrigerant gas	every 6m, max
Extra oil charge	see *Tab. A.3*
Condenser	design
Additional non return valve on delivery line, at 2 m from compressor	recommended
Insulation external liquid pipe line	allowed

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

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} (kPa)**	**Δp_{ms} (kPa)**
EFC250, EFC300, EFC320, EFC400, EFC440 (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].

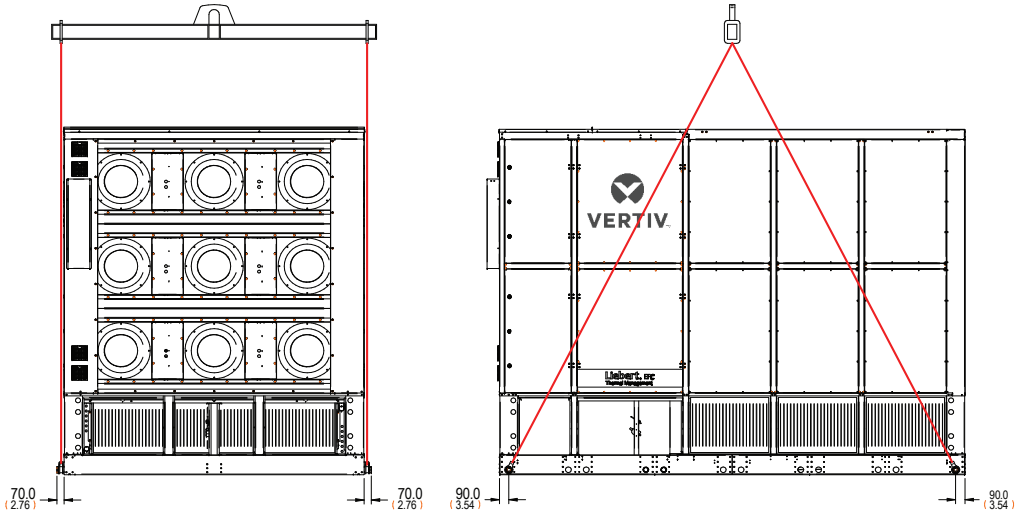
WARNING!

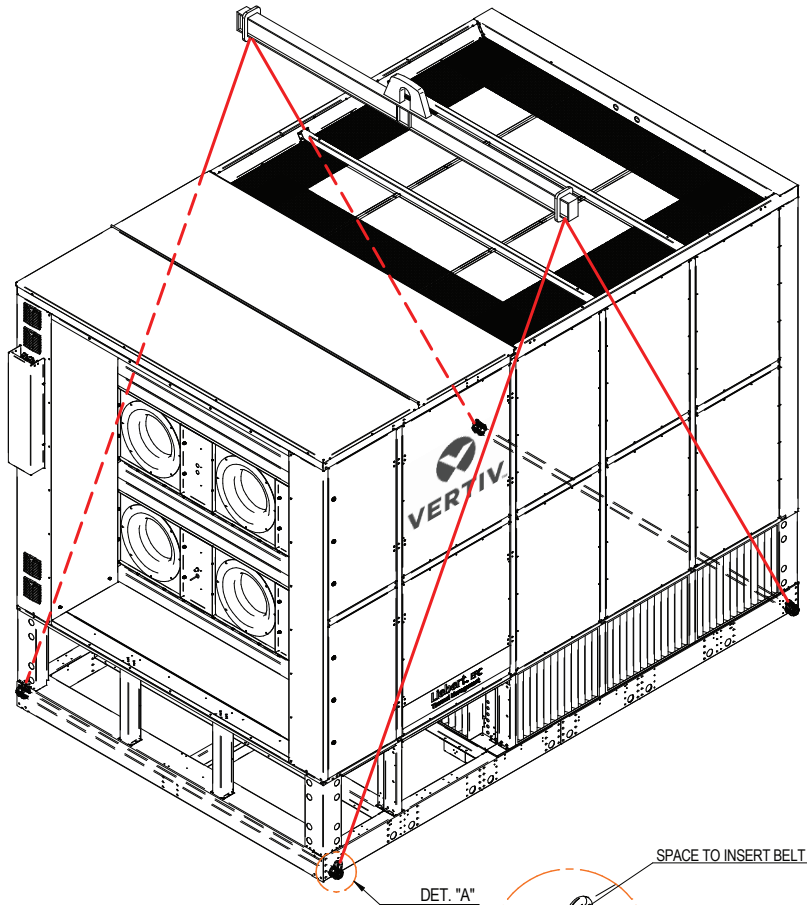
Do not lift the entire unit using eyebolts placed on fan module top.

WARNING!

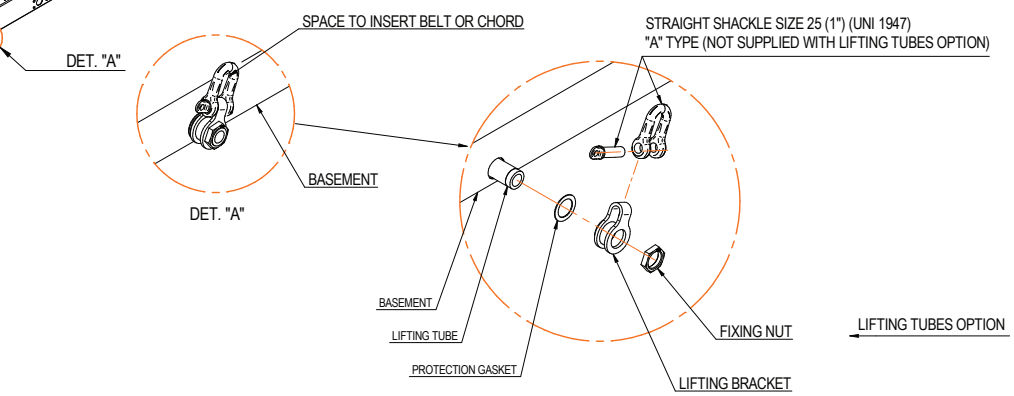
Risk of heat exchanger damage due to UV exposure: Before assembling the fan module, and during all the transport and storage operations, it is mandatory to keep the composite heat exchanger protected from direct and continuous solar radiation, as the UV rays could affect the heat exchanger material.

Heat exchanger module recommended handling

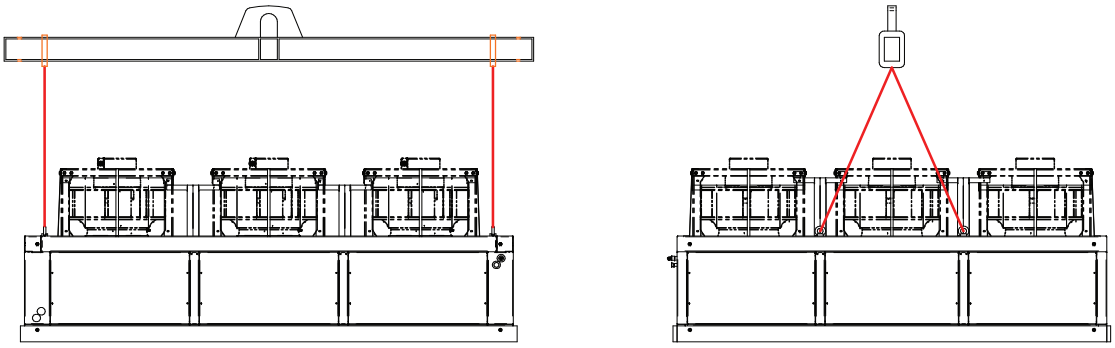




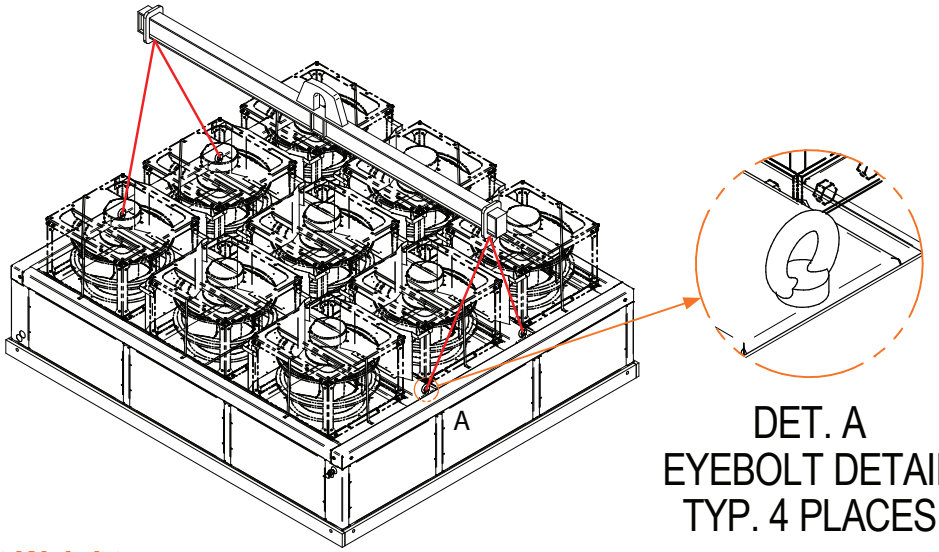
WARNING!
Risk of heat exchanger damage due to UV exposure: Before assembling the fan module, and during all the transport and storage operations, it is mandatory to keep the composite heat exchanger protected from direct and continuous solar radiation, as the UV rays could affect the heat exchanger material.



Fan module recommended handling



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



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 and with empty basin. Refer to Tab. 2.6 for basin volume data.*

Tab. 2.1
EFC250 Unit Weight

Unit	Weight [kg]
EFC250_ _ _0	3588
EFC250_ _ _X	3838
EFC250_ _ _T	3958
EFM250_ 0	903
EFM250_ X	1006
EFM250_ T	1045

Tab. 2.2
EFC300 Unit Weight

Unit	Weight [kg]
EFC300_ _ _0	4800
EFC300_ _ _X	5050
EFC300_ _ _T	5170
EFM300_ 0	1280
EFM300_ X	1380
EFM300_ T	1480

Tab. 2.3
EFC320 Unit Weight

Unit	Weight [kg]
EFC320_ _ _0	4100
EFC320_ _ _X	4350
EFC320_ _ _T	4470
EFM320_ 0	1055
EFM320_ X	1160
EFM320_ T	1200

Tab. 2.4
EFC400 Unit Weight

Unit	Weight [kg]
EFC400_ _ _0	5330
EFC400_ _ _T	5600
EFC400_ _ _D	5680
EFM400_ 0	1240
EFM400_ T	1380
EFM400_ D	1390

Tab. 2.5
EFC440 Unit Weight

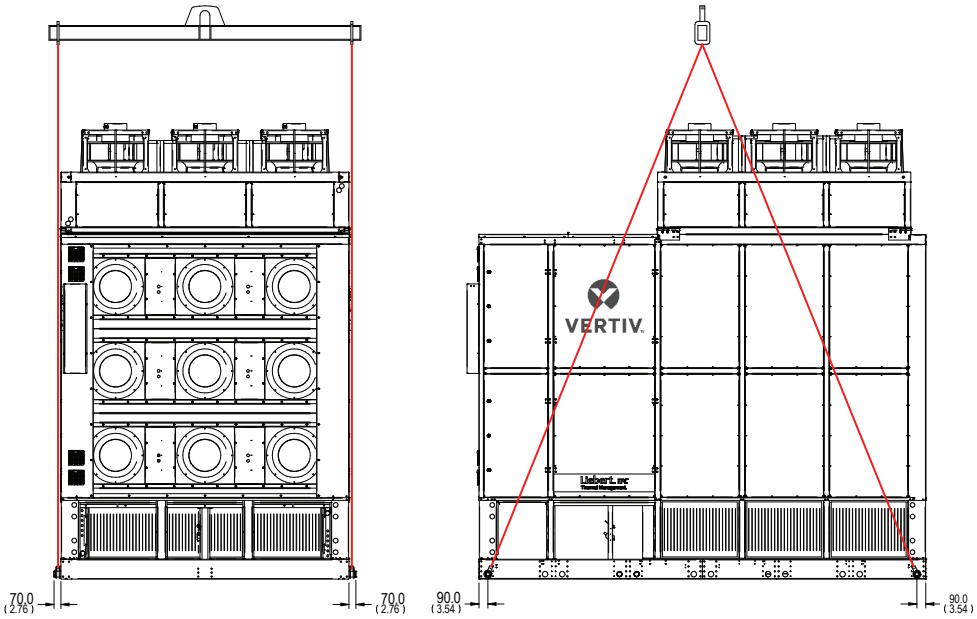
Unit	Weight [kg]
EFC440_ _ _0	4800
EFC440_ _ _T	5150
EFC440_ _ _D	5360
EFM440_ 0	1250
EFM440_ T	1400
EFM440_ D	1460

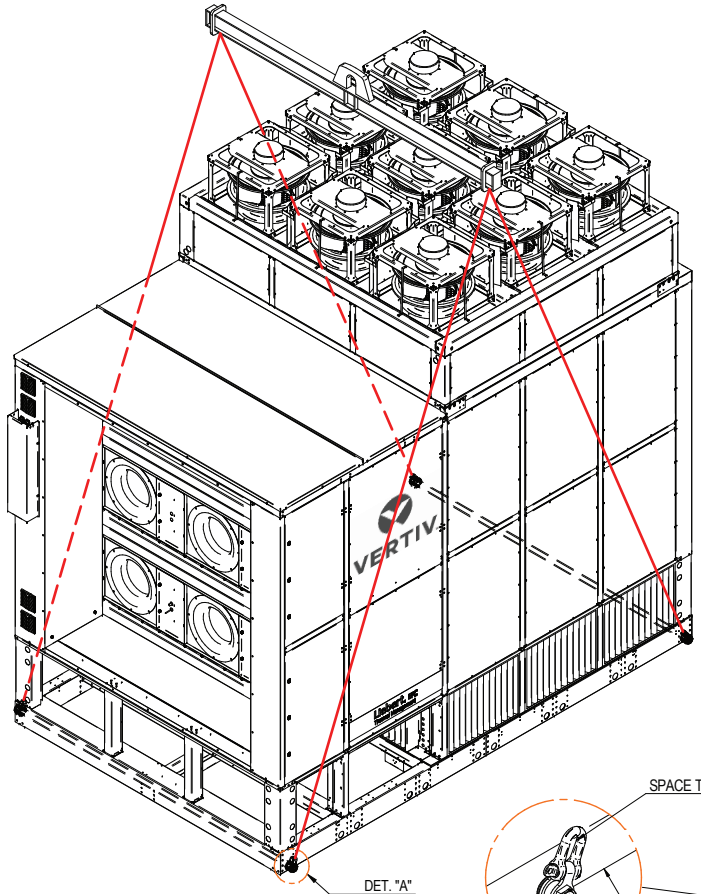
Tab. 2.6
Basin Volume

Unit		
EFC250	310	[l]
EFC300	574	[l]
EFC320	357	[l]
EFC400	425	[l]
EFC440	720	[l]

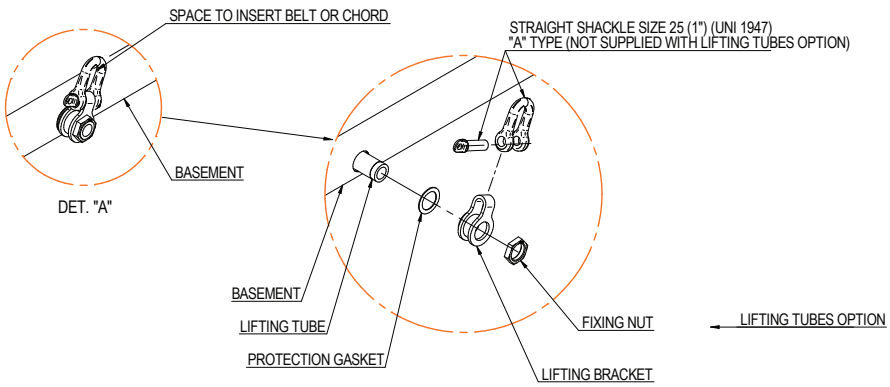
Configuration	
	0 - None
	X - DX Backup (1 single digital)
	T - DX Backup (1 tandem digital)
	D - DX Backup (2 tandem digital)

Assembled unit recommended handling





WARNING!
Do not lift the entire unit using eyebolts placed on fan module top.
Remove lifting tubes after unit instalation.



3 – Water system and water quality requirements

3.1 Evaporative cooling system

3.1.1 - System description

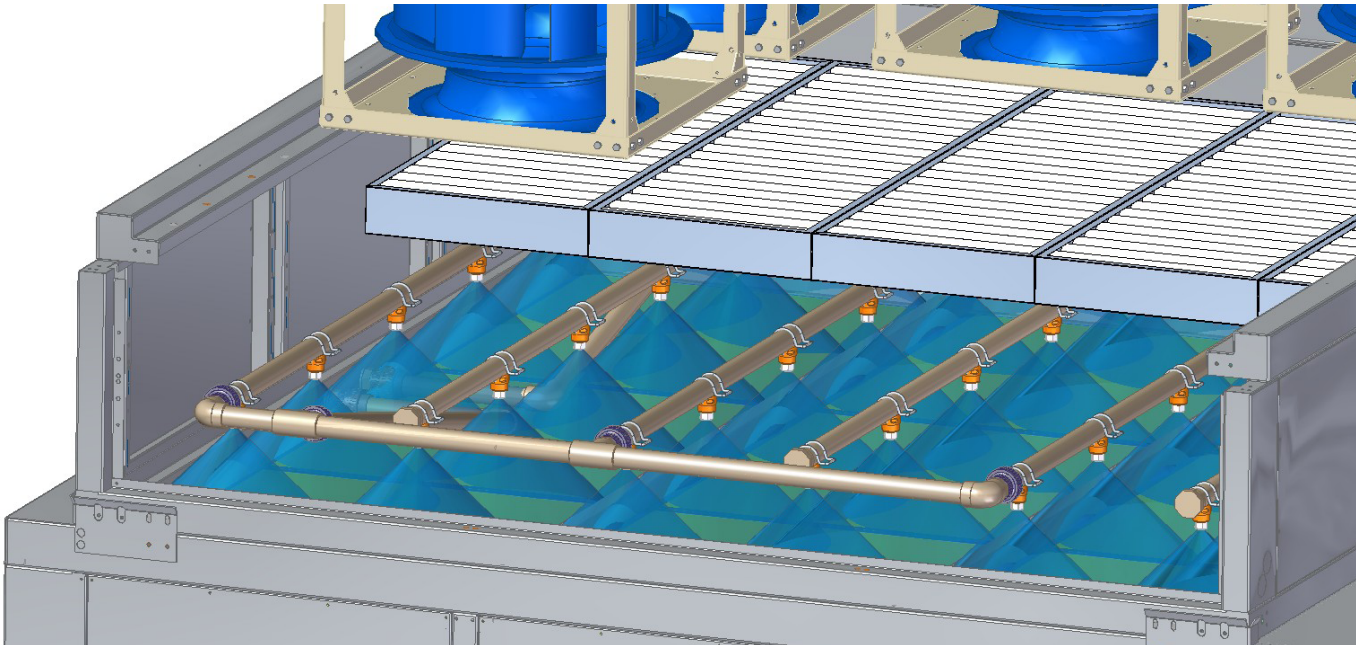
Liebert® EFC is equipped with a rack with several nozzles, placed at the exit of the heat exchanger, on the process air side. These racks spray water on the surface of the heat exchanger creating a thin water film which maximizes the cooling effect by evaporation. Water not evaporated is collected on the unit basin and then recirculated: considering during water recirculation the minerals concentration increase, there is a limit on maximum number of recirculation cycles (see *table 3.2*) and the conductivity value is used as indicator of potential scaling deposition. When the specific conductivity reach the set point value, the water with high mineral concentration is discharged and new water is feed into the unit. This is to avoid scaling grow up, that would means heat exchanger clogging and environment of bacterial proliferation, and pH increase, that would be dangerous for heat exchanger corrosion risk.

3.1.2 - Components of the systems

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

- Submersible pump, that is able to provide water to the rack at a maximum pressure of 3 bar;
- One rack with several nozzles used to spray water on the surface of the heat exchanger;
- Droplet separator;
- Water filters, to prevent nozzle clogging;
- Flow switches;
- Level switch to control water level;
- Conductivity sensor, to measure water conductivity;
- Feeding ball valve;
- Discharge ball valve;
- External air filters: to prevent water from splashing out the sump and filter external air.
- Flow meter;

Fig. 3.1 - Nozzles spray water on the surface of the heat exchange



3.2. Water Quality

To grant proper equipment operation, water treatment might be required and it is recommended to contact a local water treatment expert.

For proper operation of **Liebert® EFC**, the below specifications shall be followed at all times and any deviation shall be agreed in writing with Vertiv™ factory.

SPECIFICATIONS

FEED WATER AND MAKE-UP WATER: Feed water and make-up water should be compliant with specifications listed in *table 3.1* to grant a recirculating water quality as per *table 3.2*. Feed water and make-up water are intended to be the water at the unit water ingress.

The preferred water origin for **EFC** feed water and make-up water is municipal water main supply. If deep wells, river, lake and raining water is used, apply adequate treatments to bring physical-chemical parameters within specifications set in *table 3.1* and grant a recirculating water quality as per *table 3.2* and to control microbiological growth to avoid risks for health and safety. If reclaimed water is used, in addition to previous treatments need, specific water analysis should be made to ensure there are not constituent that could damage the unit. Sea water is not permitted. Feed water shall be free from any type of organic solvent, detergent and surfactant.

Table 3.1 - Feed water and make-up water quality (suggested limits)

FEED WATER SPECIFICATION		
Constituent	**Limit**	**Units**
pH	6 - 8.5	dimensionless
Specific conductivity	100-1000	microS/cm
Filtration rating	<150	µm
Total hardness, as $CaCO_3$	50-250	mg/l
Chloride	<200	mg/l
Sulphate	<200	mg/l
Chlorine	<1	mg/l
Silica	<25	mg/l
Microbiological profile	Water shall not represent a health and/or safety risk in compliance with local requirements/legislation	

Ensure an instant refill waterflow to the evaporative system of at least 3000 l/h. This requirement must be guarantee also in critical ambient conditions when multiple units may require simultaneous refill.

An adequate water treatment program on feed water and make-up water should be evaluated and eventually implemented, considering to use only chemicals approved from Vertiv™. Based on a case-by-case risk assessment, a specific water treatment program to control microbiological growth must be evaluated and eventually implemented to avoid any additional risk for health and safety in compliance with local requirements/legislation. In case value of Puckorius Scaling Index (PSI) calculated for recirculating water (see *Table 3.2*) is lower than 6, dosage of an anti-scalant is strongly recommended to avoid excessive scaling. In case value of Puckorius Scaling Index (PSI) calculated for recirculating water (see *Table 3.2*) is higher than 6.5, dosage of an anti-corrosive is strongly recommended to avoid metal corrosion.

NOTE: *water treatment for corrosion should consider anticorrosives approved from Vertiv™. Wetted materials list includes:*

- PVC
- copper pipe (water might fall on the finned coil and get in contact with copper tubes)
- AISI304 stainless steel
- painted galvalume and painted aluzinc
- galvanized mild steel

If softened water or reverse osmosis is used, consider 5°f (50 mg/l $CaCO_3$; 50 ppm $CaCO_3$) as minimum value for total hardness. When a reverse osmosis is used, water becomes aggressive. Partial mixing with raw water is highly recommended to ensure a minimum water conductivity of 100 microS/cm and a minimum water hardness of 50 mg/l $CaCO_3$. Because of this, pipes or components made from copper or copper alloys (brass, bronze, etc) must not be used on the feed water line due to the increased risk of corrosion.

RECIRCULATING WATER: during unit operation the recirculating water must have all characteristics listed in the below *table 3.2*.

Table 3.2 - Recirculating water quality required (mandatory requirement)

RECIRCULATING WATER SPECIFICATION (mandatory periodical check)		
Constituent	**Limit**	**Units**
pH	6 - 9.5	dimensionless
Specific conductivity	<3000	microS/cm
Total hardness, as $CaCO_3$	50-500	mg/l
Chloride	<400	mg/l
Sulphate	<400	mg/l
Silica	<100	mg/l
Cycles of concentration	<7*	dimensionless
Puckorius index	5.5 - 8**	dimensionless
Microbiological profile	Water shall not represent a health and/or safety risk in compliance with local requirements/legislation	

NOTE: *These values are dependent on regular blow down during operation and regular sump purge.*

(*) Note that the cycles of concentration is not an independent variable and its value strictly dependent on the ratio between feed water and recirculating water (total hardness, conductivity, chloride, sulphate, silica). This ratio is managed by blow down operation defined through the "Conductivity threshold" and "Delta" (Hysteresis) settings. During the evaporation, the water constituents concentration and the water conductivity increase, once it reaches the threshold, bleed off starts and fresh water is reclaimed with consequent reduction of the water constituents and conductivity.

(**) Mandatory requirement if dosage of anti-scalant or anti-corrosive to manage Puckorius Scaling Index (PSI) has not been performed, instead, if a dosage has been performed, Puckorius Scaling Index (PSI) is not required to be inside that limits.

WARNING: Avoid the contact of any part of the EFC with any type of organic solvent and aggressive detergent even if present in aqueous and/or diluted solution. Use only approved chemicals for descaling, anticorrosion, disinfection and cleaning: not approved substances could damage the unit components and invalidate the warranty. Contact Vertiv™ Service for approved chemical specifications.

It is recommended to check the feeding water quality, and it is mandatory to check the recirculated water quality to ensure the values match with the requirement listed on *table 3.1 / 3.2* and record the values in accordance with the frequency in *table 3.3*, differently the warranty will become void. All records of such analysis results shall be available in case of a warranty claim.

Recirculating water sample must be taken reasonably far from the feed water inlet and reasonably close to bleed off activation (with conductivity reaching the threshold). If the water treatment provider recommends to analyze the water more frequently, this recommendation becomes the minimum requirement.

Any Vertiv™ warranty on **Liebert® EFC** will be void in case of product working condition are outside the specifications stated herein.
If analysis shows water quality has fallen out of the above specification and/or local specification, the records must show on subsequent analysis the issue has been addressed through treatment increase or modification. In this situation the analysis frequency become monthly at least.

Table 3.3 – Water Sample frequency

WHEN / FREQUENCY	MAKE UP WATER SAMPLES (Suggested)	RECIRCULATORY WATER SAMPLES (Mandatory)
At Commissioning	No. 1 Sample from each main feeding line	-
First month after Commissioning / Every **15** days	No. 1 Sample from each main feeding line	• <20 units / Samples from every 4 units equally distributed among the working groups, minimum 2 units • >20 / Every 5 units equally distributed among the working groups
Thereafter / Every **three** months	No. 1 Sample from each main feeding line	
Group: Units working in Teamwork / same loop, servicing the same portion of data room.		

At Unit start up / Commissioning, Feed Water characteristics are required to properly define the first attempt specific conductivity set point of the recirculating water (set on the unit control). Make sure the feed water analyses are available at least few days before the start up or at the commissioning date. Once defined with the procedure described below, it must be set on the unit control and progressively refined after the analyses of the recirculated water are available: if necessary, it must be reduced to keep chloride or other contents inside the maximum admitted values as shown in *table 3.2*.

First attempt specific conductivity set point calculation

Define max cycle of concentration for each single constituent among Chloride, Sulphate, and Silica by the ratio between the limits in *3.2* and the concentration on feed water analysis. The Cycle of Concentration (CoC) to be considered is the minimum between the calculated ones and 7 (maximum value for CoC as per *table 3.2*)

First attempt specific conductivity set point = (Feed water specific conductivity)*(CoC*(1-10%))

10% is the margin considered as the conductivity is slightly less than proportional to the cycles of concentration.

Example: if feeding water specific conductivity is 300 microS/cm, and chloride content is 130 mg/l, (Sulphate 15 mg/l and Silica 10 mg/l), the critical constituent is Chloride: 400/130= 3 CoC, which is less than the limit of CoC. New specific conductivity set point will be: 300*3*(1-10%)= 810 microS/cm.

Local Service Team is available to support Customers in identifying the most proper first attempt specific conductivity set point during commissioning phase.

NOTE: *if the recirculating water specific conductivity set on unit control has been changed, set the conductivity delta value as specific conductivity set value / 4.*

Vertiv™ reserves the right to change the above instructions and parameters if necessary, promptly informing the customer.

Hirating Software

EFC unit performances can be calculated by using Hirating Software. Water consumptions shown in the calculations are referred to steady conditions with Cycles of Concentration as per calculation input.

3.3. Maintenance

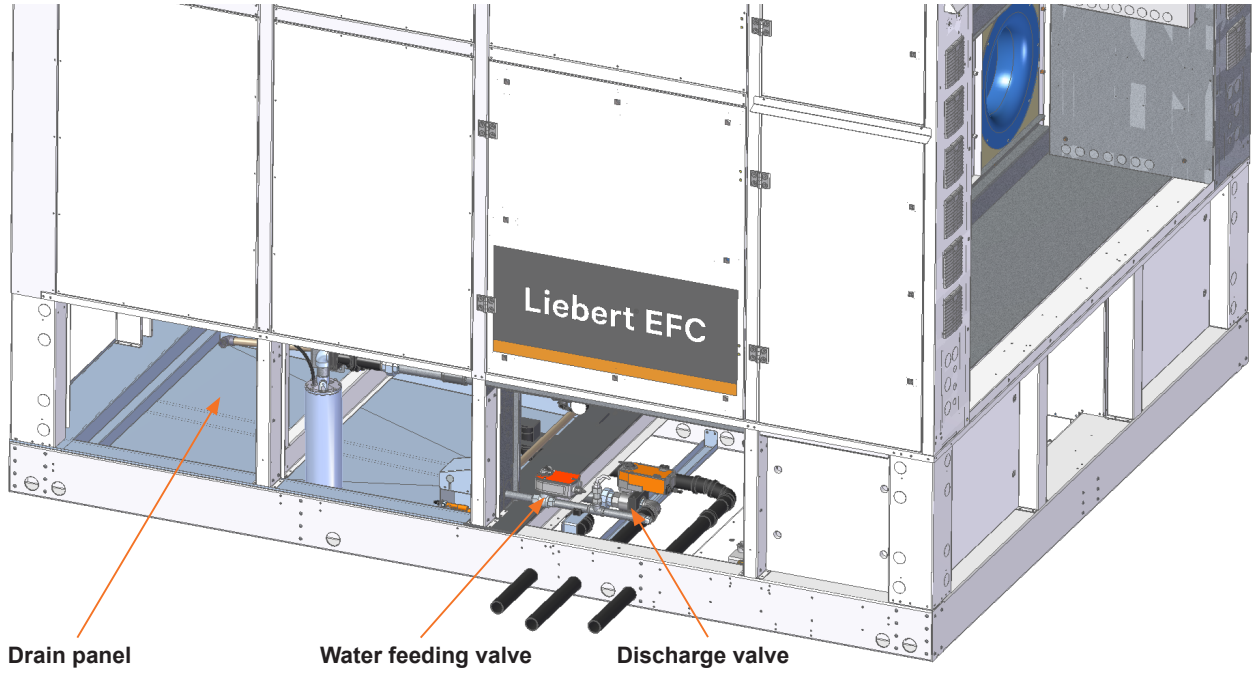
WARNING: The operators must wear gloves, mask and eye protection to avoid coming into contact with bacteria, fungi, mud, etc. which may appear in the evaporative system if correct maintenance is not performed.

3.3.1 - Maintenance procedures

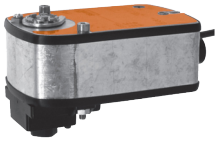
Any activity should be carried out by qualified and trained technicians. See the activities summarized in the table below.

EFC MAINTENANCE FOR EVAPORATIVE COOLING SYSTEM						
	ACTION	FREQUENCY				
		1 Month	3 Months	6 Months	1 Year	
Overall System	**Overall unit disinfection:** before the warm season, when the evaporative system could be activated, the unit must be disinfected;	**Once per year** (at least)				
	Descaling procedure: if the heat exchanger and drain panels show hard limescale deposition (thus not removable with fingers) proceed with descaling procedure. Contact Vertiv™ Service to ensure the right chemical product and procedure to be used.	In case of hard limescale deposition (limescale not removable with fingers)				
	Legionella monitoring 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. If contamination is detected, contact local certified and authorized water treatment companies and local authorities where required by legislation.	In compliance with local regulations				
The interval depends on the water quality: the more salts or impurities in the water, the more frequently the inspections must be performed.						
Equipment status	Check the drain panel by removing air filters (*figure 3.2*). clean and remove any dust or foreign bodies to keep the unit cleaned and to avoid pump premature failure.		X			
	Check status of external air filters (for soiling, damage, scaling, mold) Clean or replace if necessary.		X			
	Check and clean water discharge valve (*figure 3.2*);		X			
	Clean water filters (*figure 3.3*)		X			
	Clean level switch and conductivity sensor (*figure 3.4*);		X			
	Check conductivity sensor calibration using the solution supplied within the unit;		X			
	ACTION	FREQUENCY				
		1 Month	3 Months	1 year	2 years	
	Clean droplet separator (*figure 3.5*); **NOTE:** *in case of high solid deposit or in case of droplet separator surface damage, replace with new one*		X			
	Replace droplet separator (*figure 3.5*)			X		
	Check the condition of the nozzles; clean or replace if necessary (*Figure 3.6*);		X			
	Check the tightness of the connections whether threaded or compression-based;				X	
Water Check	Check *par. 3.2* - Water quality and record water parameters analysis, both feeding and recirculating;	X				

Figure 3.2 - Drain panel and water discharge valve



Water feeding valve manual control



Ball valve

The ball valve can be manually operated and fixed in any position using a hand crank. Unlocking is manual or automatic by applying the operating voltage.

Please note: *The hand crank may only be operated when the actuator is deenergised.*

Figure 3.3 - Water filters

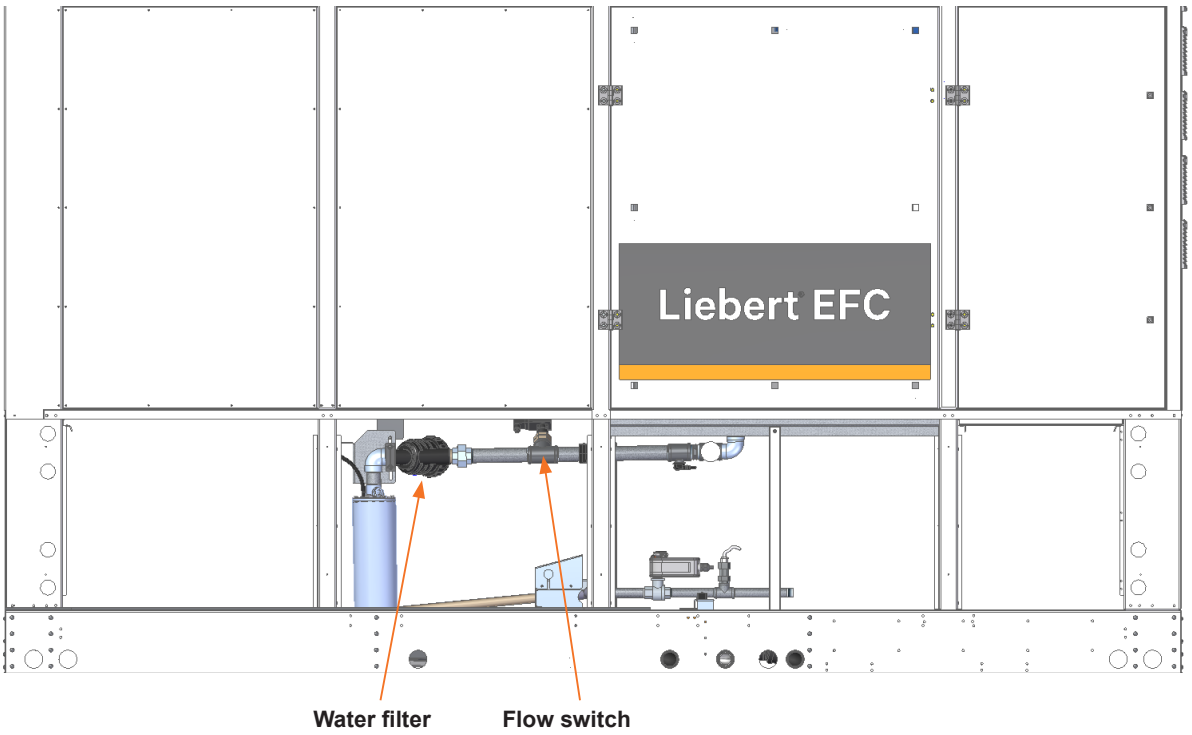


Figure 3.4 - Level switch and conductivity sensor

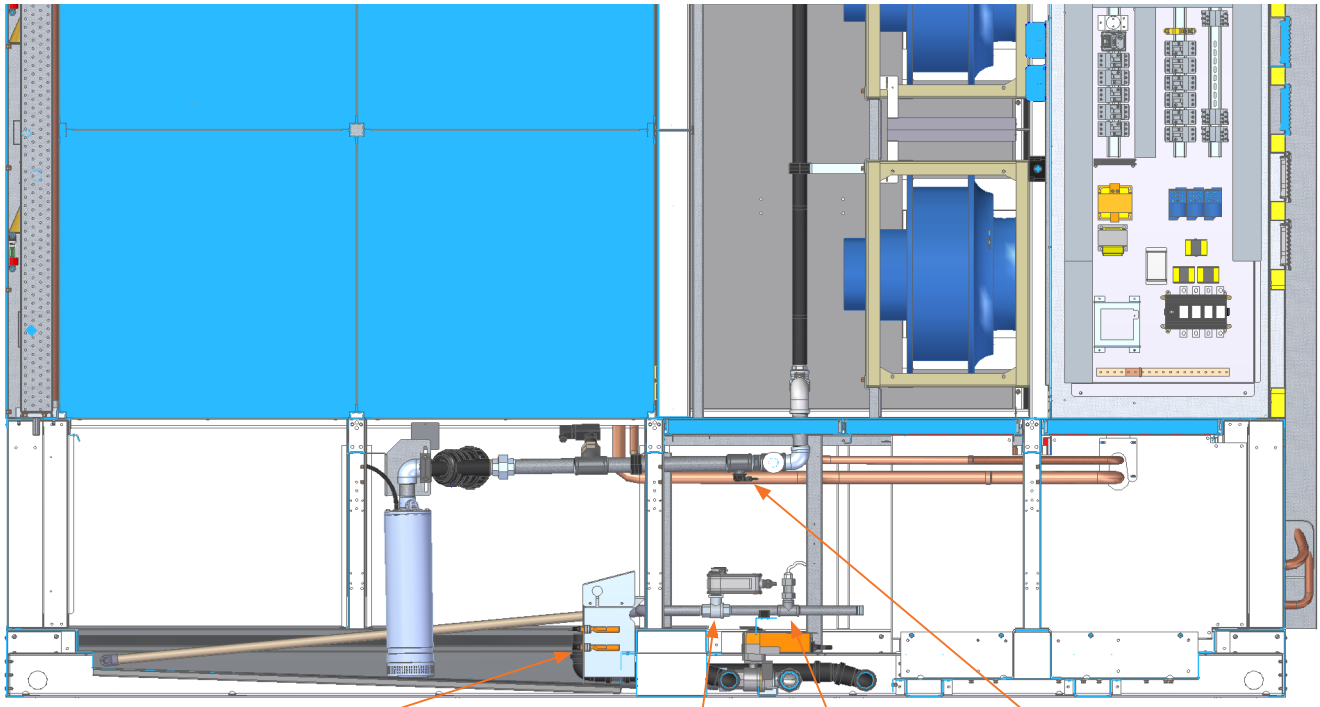
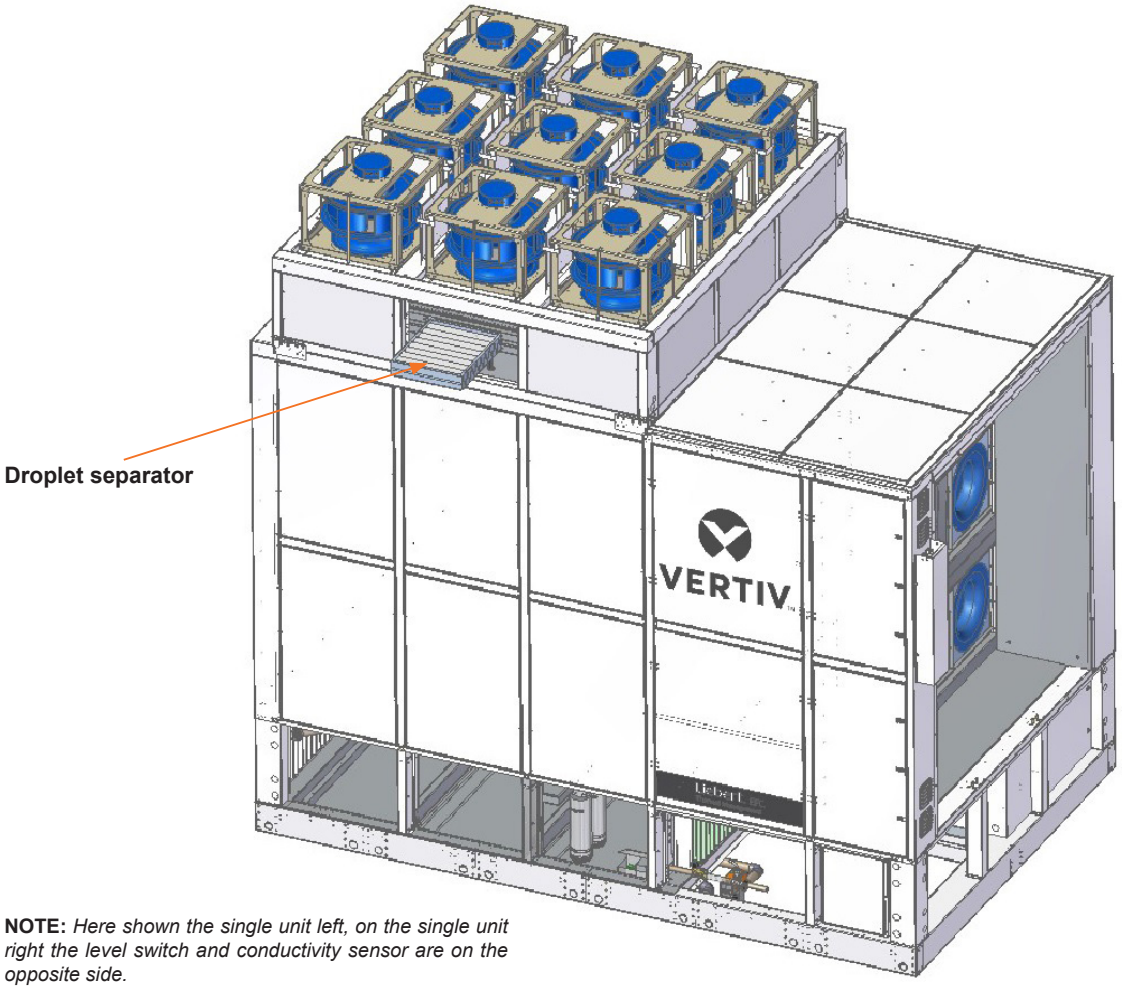
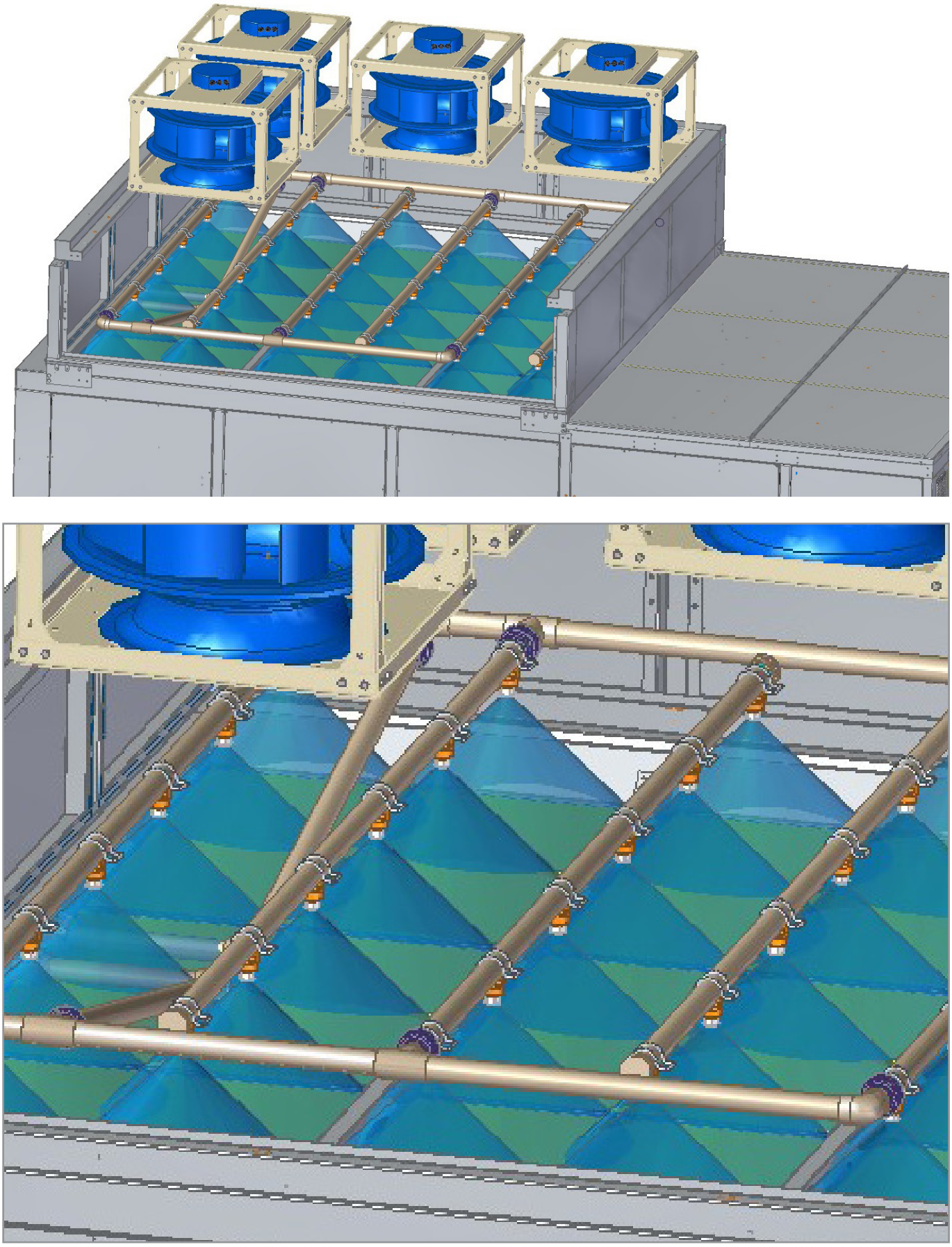


Figure 3.5 - Droplet separator



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

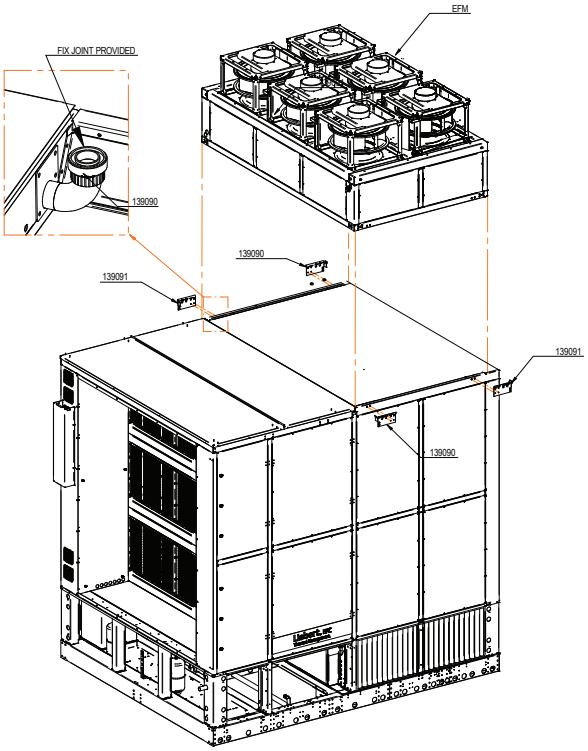
Figure 3.6 - Evaporative system nozzles



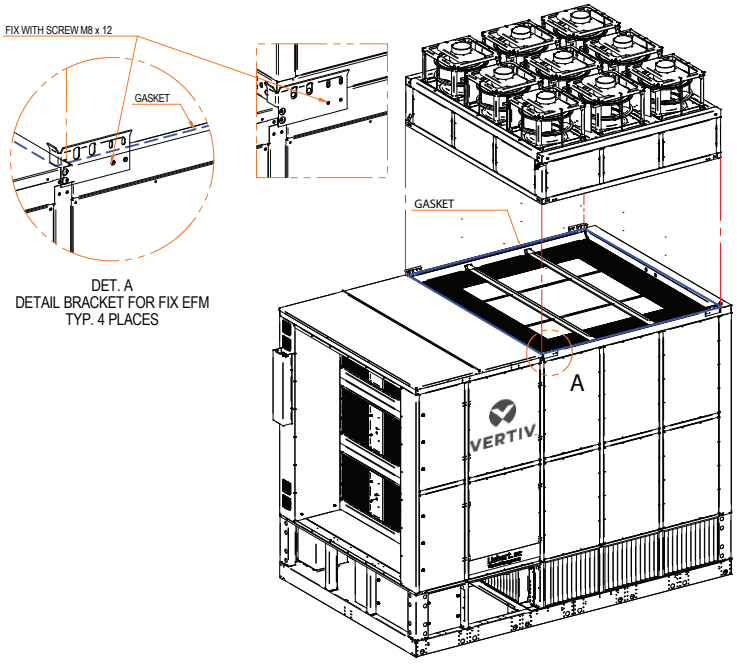
4 - Assembly

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 6 - 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.

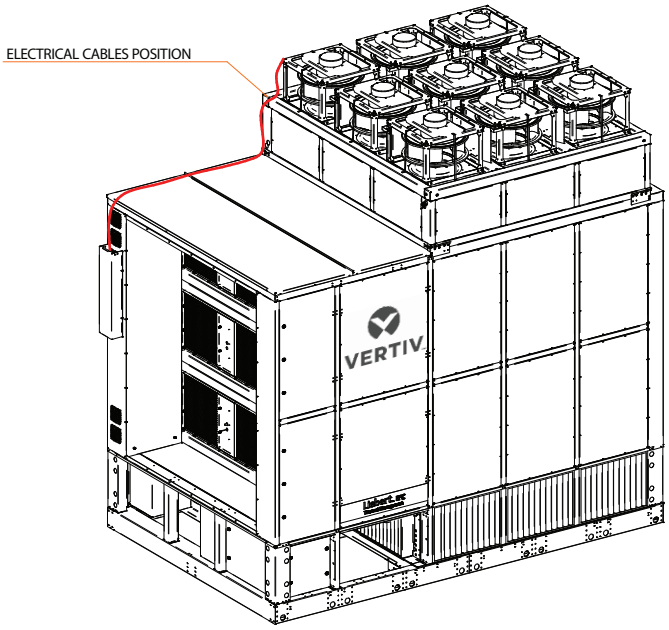


2. Put the gasket on the heat exchanger module, fix the four brackets on heat exchanger module.

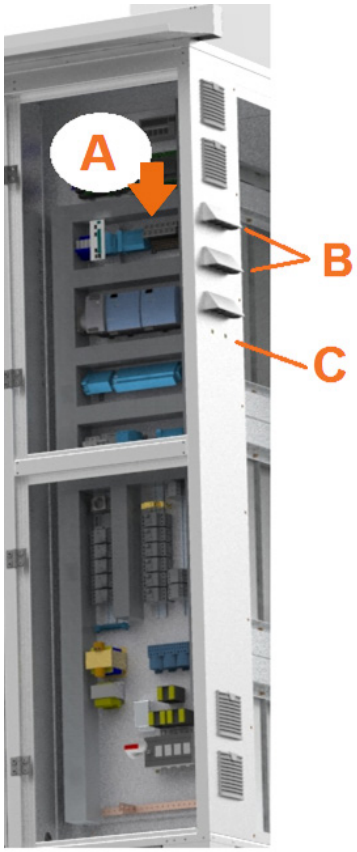


Fix the joint provided, see picture above.

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.



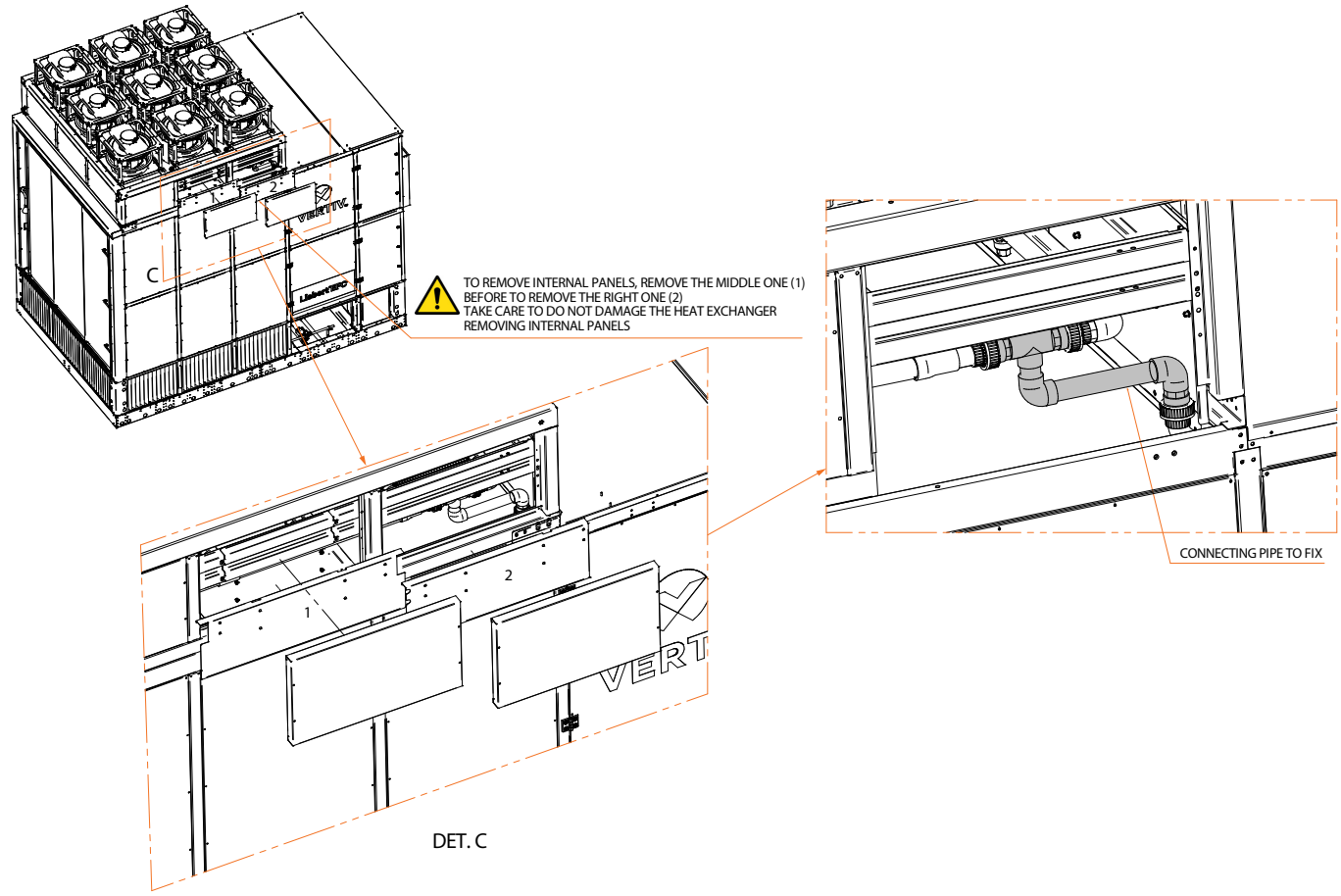
5. Connect the pipes to the evaporative system racks.

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 250, EFC 300, EFC 320, EFC 400



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 5 - 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.

5 - Refrigeration connections

5.1 - Refrigeration pipeline connections

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

CAUTION: The discharge operation of the heat exchanger module unit pressurized with nitrogen (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.

5.1.1 - 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. 5.1*. 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-damping clamps (which include rubber gaskets). Place these every 1.5 - 2 m.

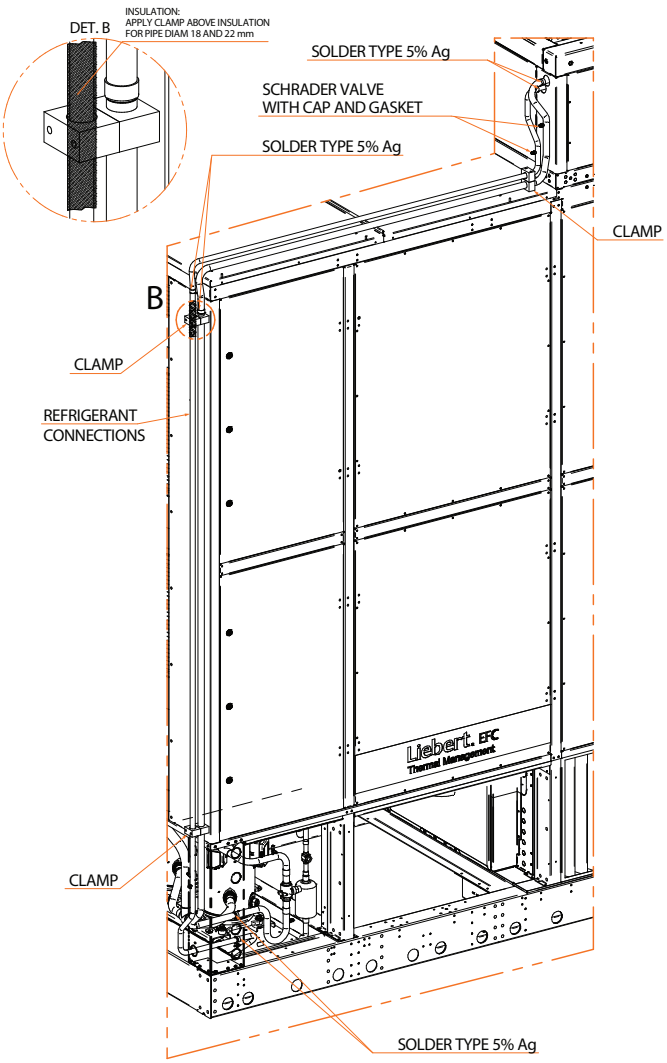
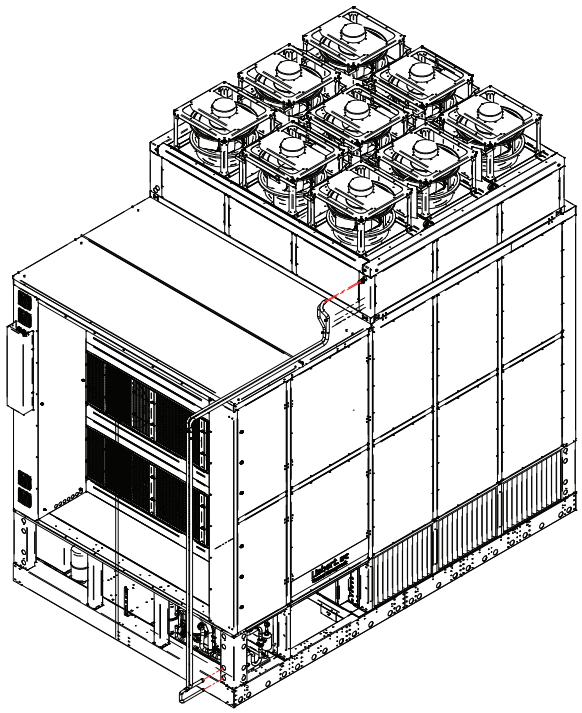
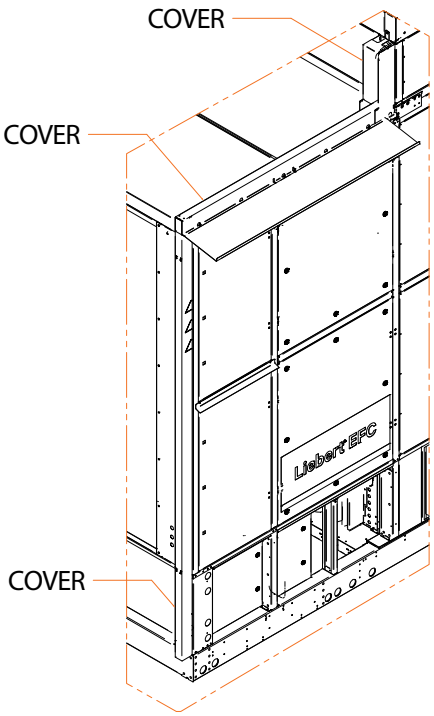
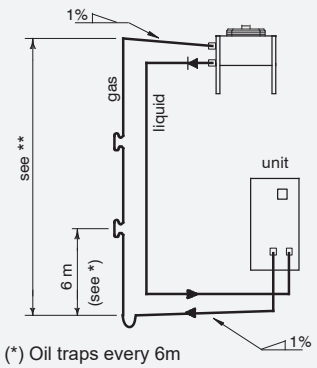
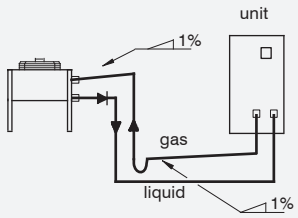
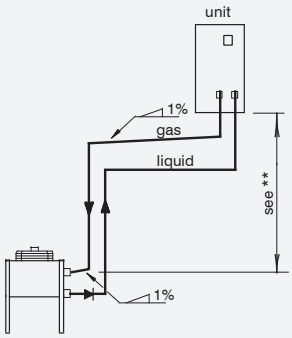


Fig. 5.1 - Recommended pipe layout





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 6m of vertical piping		

5.1.2 - 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. 5.1* 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.5.1 Standard pipes diameters

STANDARD PIPE DIAMETERS (Valid for equivalent lengths up to 60 m)		
MOD.	copper tube external diametre x thickness [mm] R410A	
	Gas	Liquid
EFC250_ _ _X	28 x 1.5	22 x 1.5
EFC250_ _ _T	35 x 1.5	28 x 1.5
EFC300_ _ _X	28 x 1.5	22 x 1.5
EFC300_ _ _T	35 x 1.5	28 x 1.5
EFC320_ _ _X	28 x 1.5	22 x 1.5
EFC320_ _ _T	35 x 1.5	28 x 1.5
EFC400_ _ _T	35 x 1.5	28 x 1.5
EFC400_ _ _D	35 x 1.5	28 x 1.5
EFC440_ _ _T	35 x 1.5	28 x 1.5
EFC440_ _ _D	35 x 1.5	28 x 1.5

5.1.3 - Installing pipelines

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

CAUTION: The discharge operation of the refrigerant circuit pressurized with nitrogen (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.

1. 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.
2. 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).
3. Wash out the pipelines as follows:
   a. Plug up the free ends of the pipes.
   b. Connect the nitrogen cylinder, fitted with a reducer (max. pressure 10 bar), to the ¼" SAE Schrader valve of the condenser.
   c. Pressurize the pipes with helium or nitrogen.
   d. Unplug the pipes instantaneously.
   e. Repeat a. - d. several times.

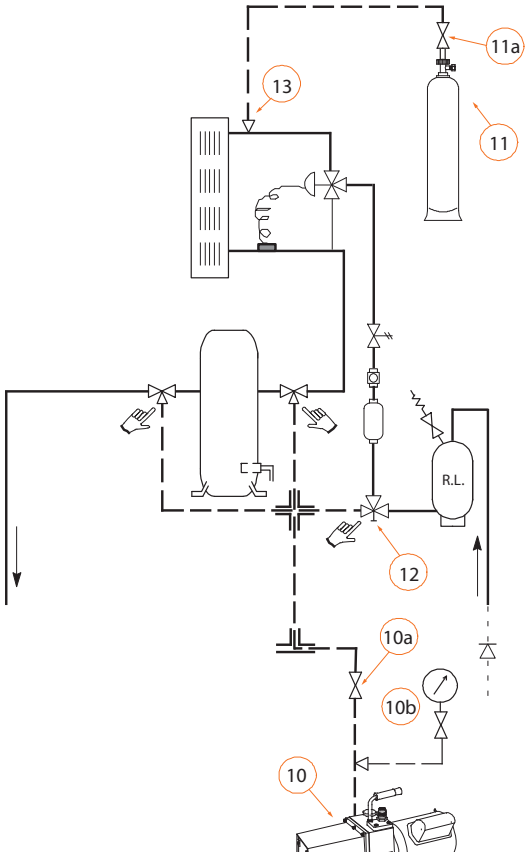
THIS OPERATION IS IMPORTANT TO AVOID REFRIGERANT FILTER CLOGGING, ESPECIALLY WHEN HARD COPPER PIPING IS USED.

4. Open the heat exchanger module unit shut-off valve.
5. Discharge the heat exchanger module unit pressurized with nitrogen (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).
6. Unbraze the bottoms from the connections of the heat exchanger module unit.
7. Fix (weld) the pipes.

5.2 - 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. 5.2 - Vacuum Pump and refrigerant charging cylinder connections for vacuum creation and refrigerant charge



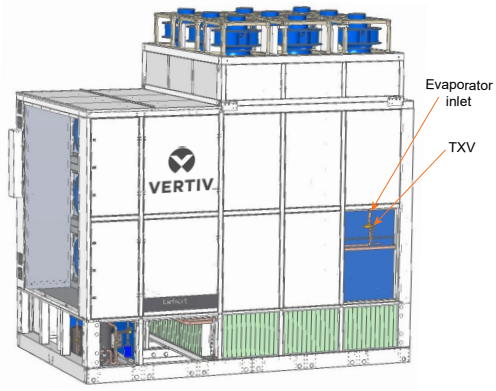
5.2.1 - R410A precharge

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 *8.1*). If the level is too low see *9.6.2*.

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.

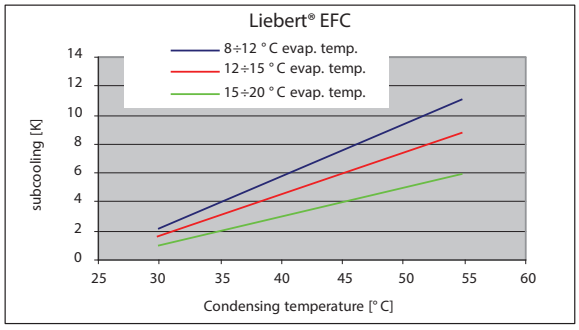


Note: *With low ambient kit, remove low ambient kit external panel to reach the TXV.*

   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.

5.2.2 - 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. Higher charge increases the subcooling value.
8. Verify the absence of bubble on sight glass.



5.3. Refrigerant circuits

The refrigerant circuits are presented in *Enclosure C*.

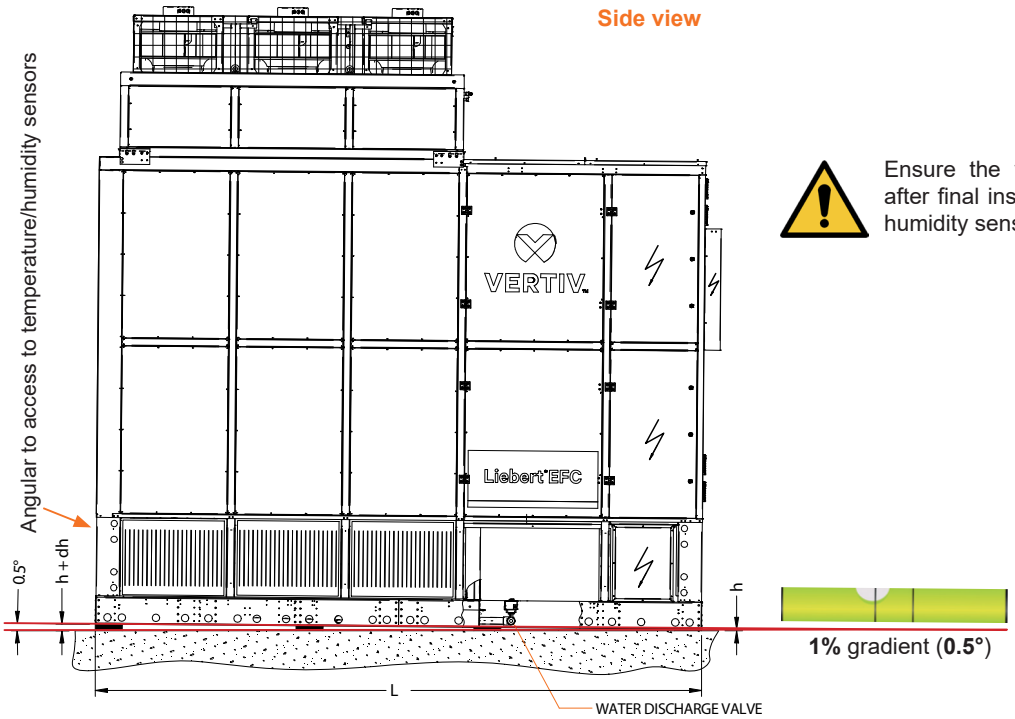
6 - Positioning

6.1 - 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;
- Make sure to handle properly the unit to avoid damage during positioning (specially on roof installation)
- 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;
- When **Liebert® EFC** are positioned during building construction, it is important that in this phase they are kept protected with the original package; most sensitive parts are external fan module (process fans) and heat exchanger, subject to potential damages caused by chips and small stones;
- At the same way water tank must be protected to avoid sands and stones falling in, that could damage water pumps;

Side view

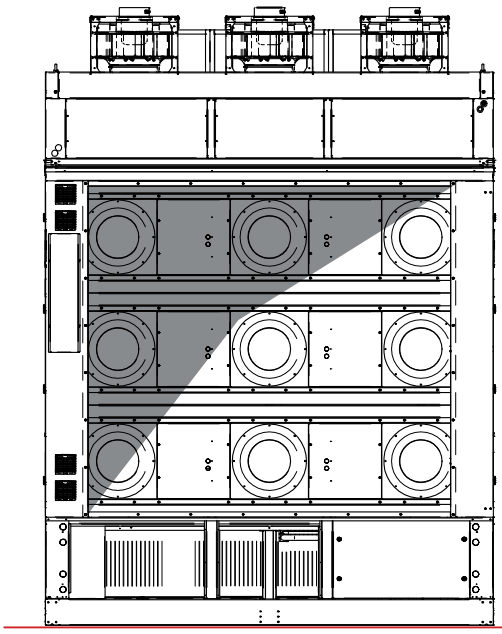


Ensure the vertical angular can be removed after final installation to access to temperature/ humidity sensors.

1% gradient (**0.5°**)

Allow a 1% gradient (0.5°) towards the water discharge valve (see drawing above) to facilitate good drainage.
Example calculation: dh = L/100. Make sure the unit is perfectly leveled on the other direction.

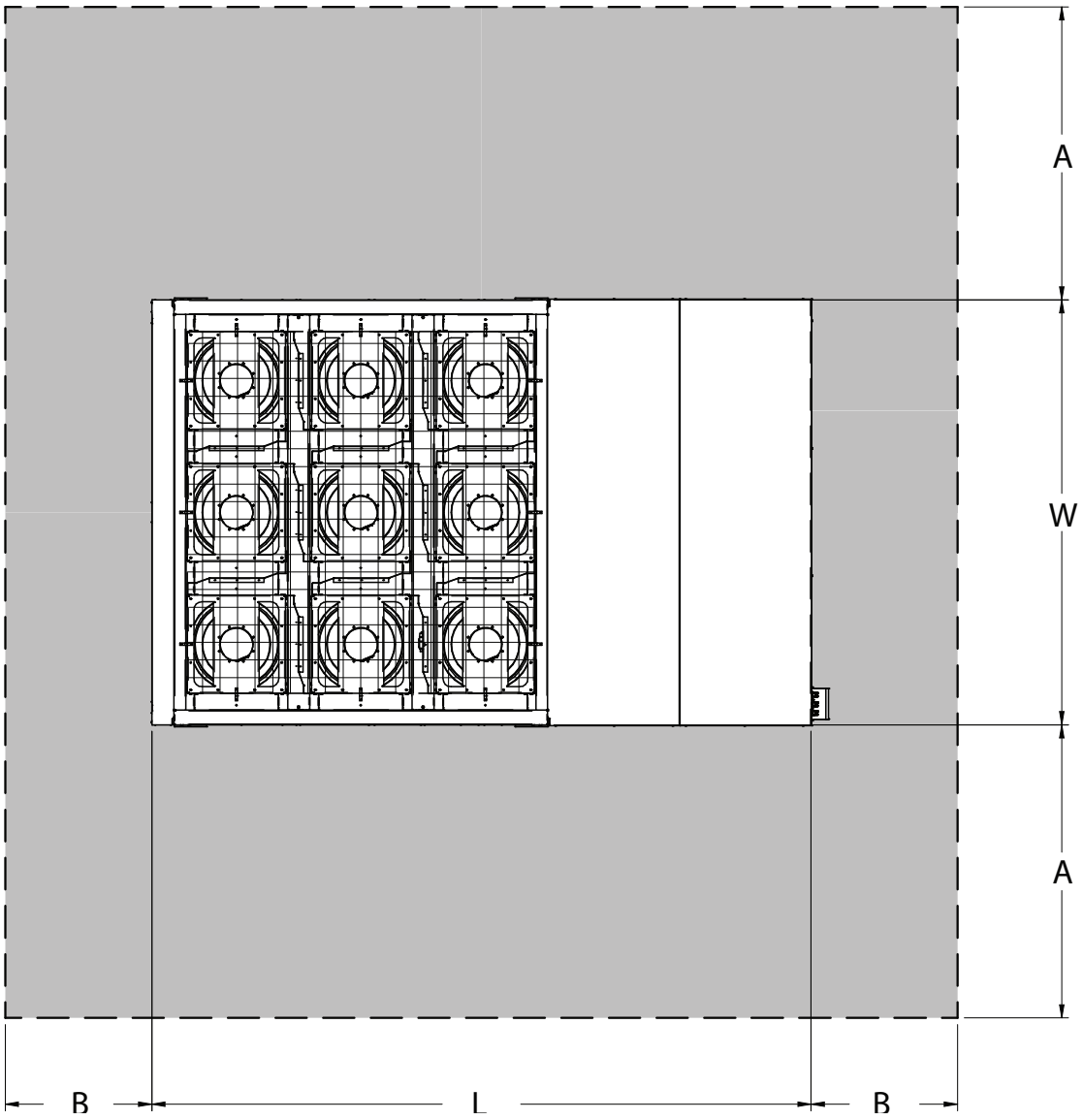
Frontal view



0% gradient (**0.0°**)

6.2 - 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.

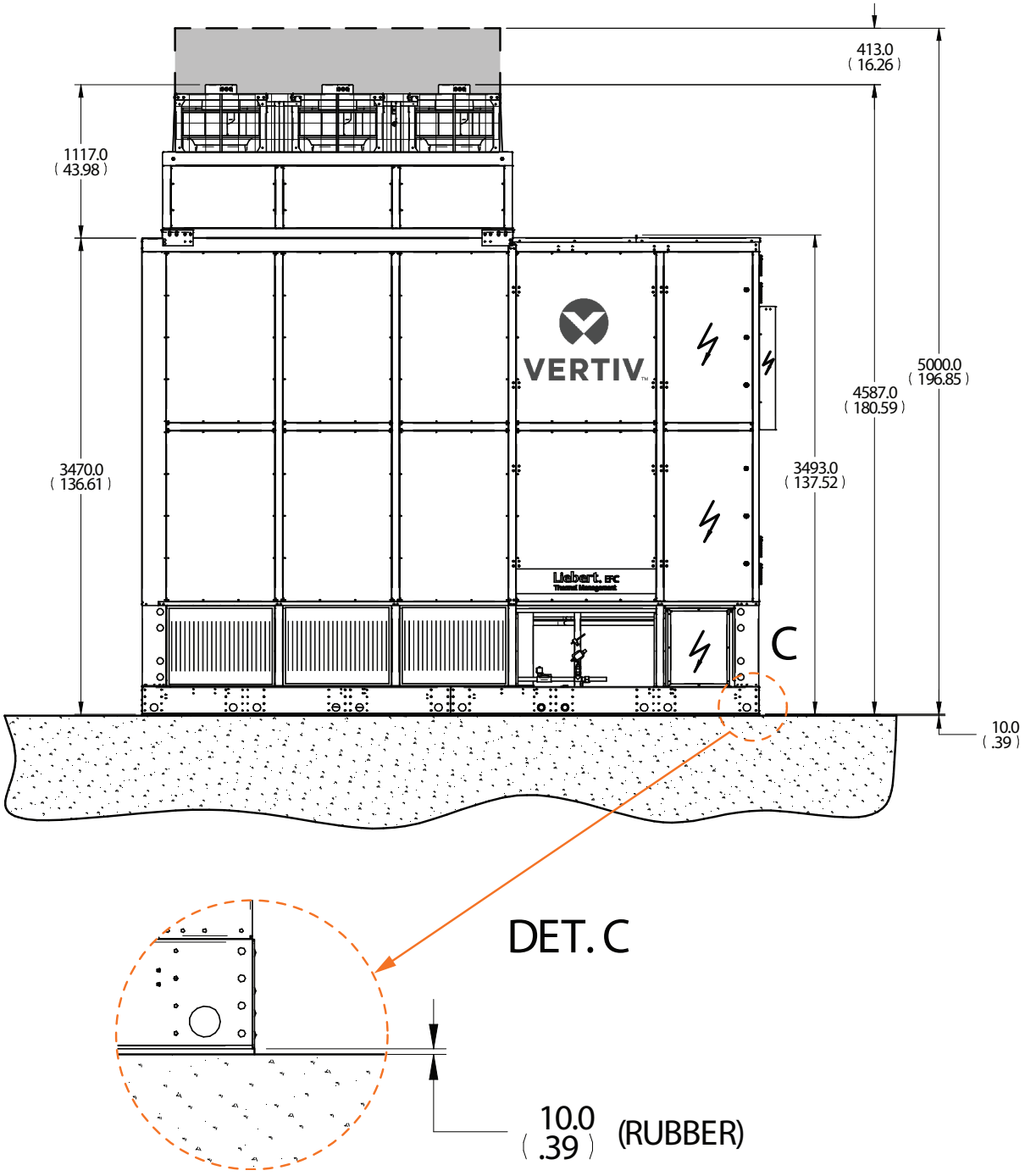


Tab 6.1 Dimensions

Unit	Dimensions			
	L (mm)	W (mm)	A (mm)	B (mm)
EFC250	3650	2500 (3500 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
EFC440	4500	3400 (4400 with Low Ambient Kit)	2000	1000

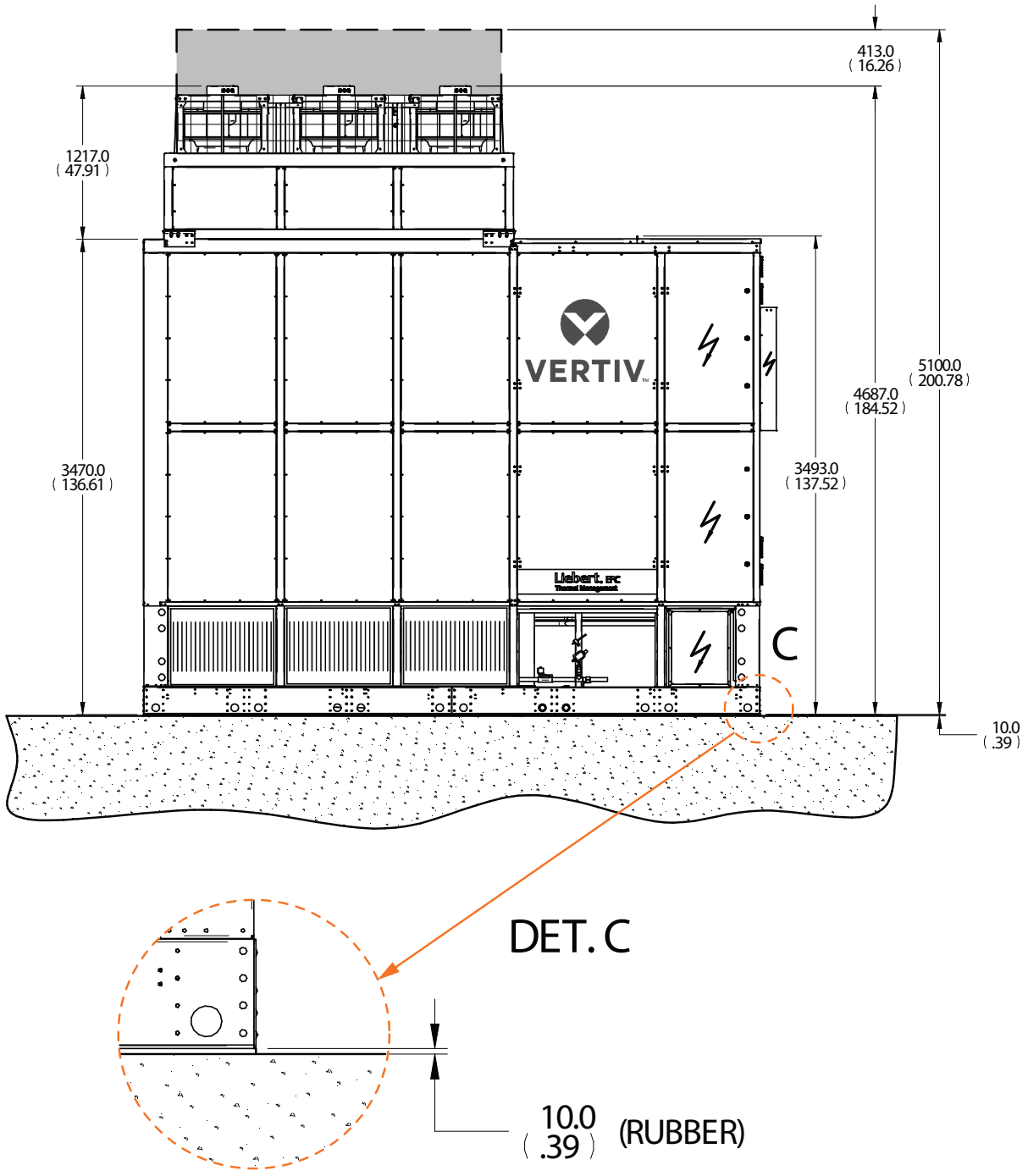
NOTE:
(1) space for ordinary maintenance: for extraordinary maintenance (heat exchanger, finned coils and fan module removal) the unit wide dimension space is required

Overall unit dimensions EFC250, EFC300, EFC320



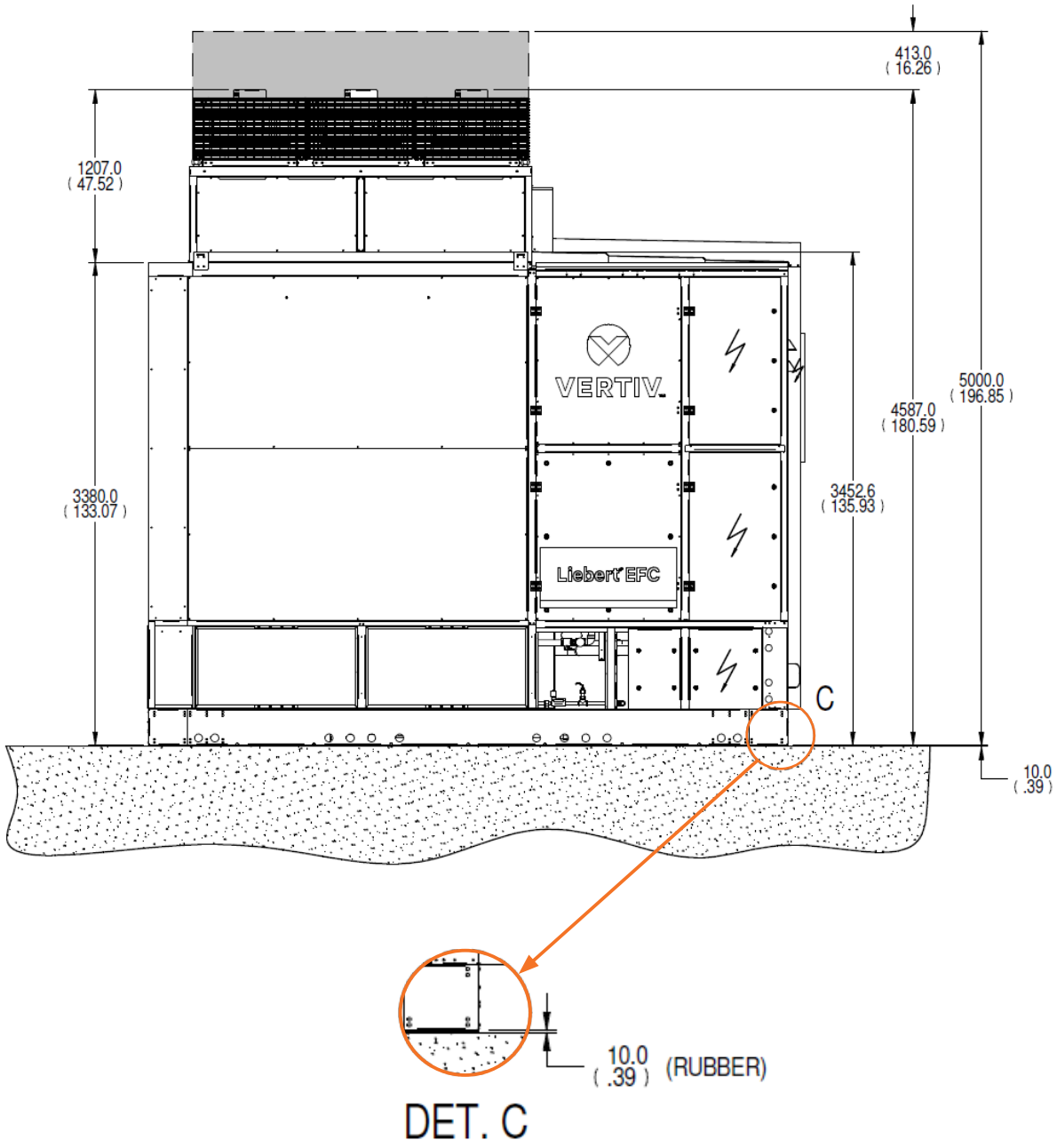
Note: *Insert rubber the between the basement and the structure that supports the unit.*

Overall unit dimensions EFC400



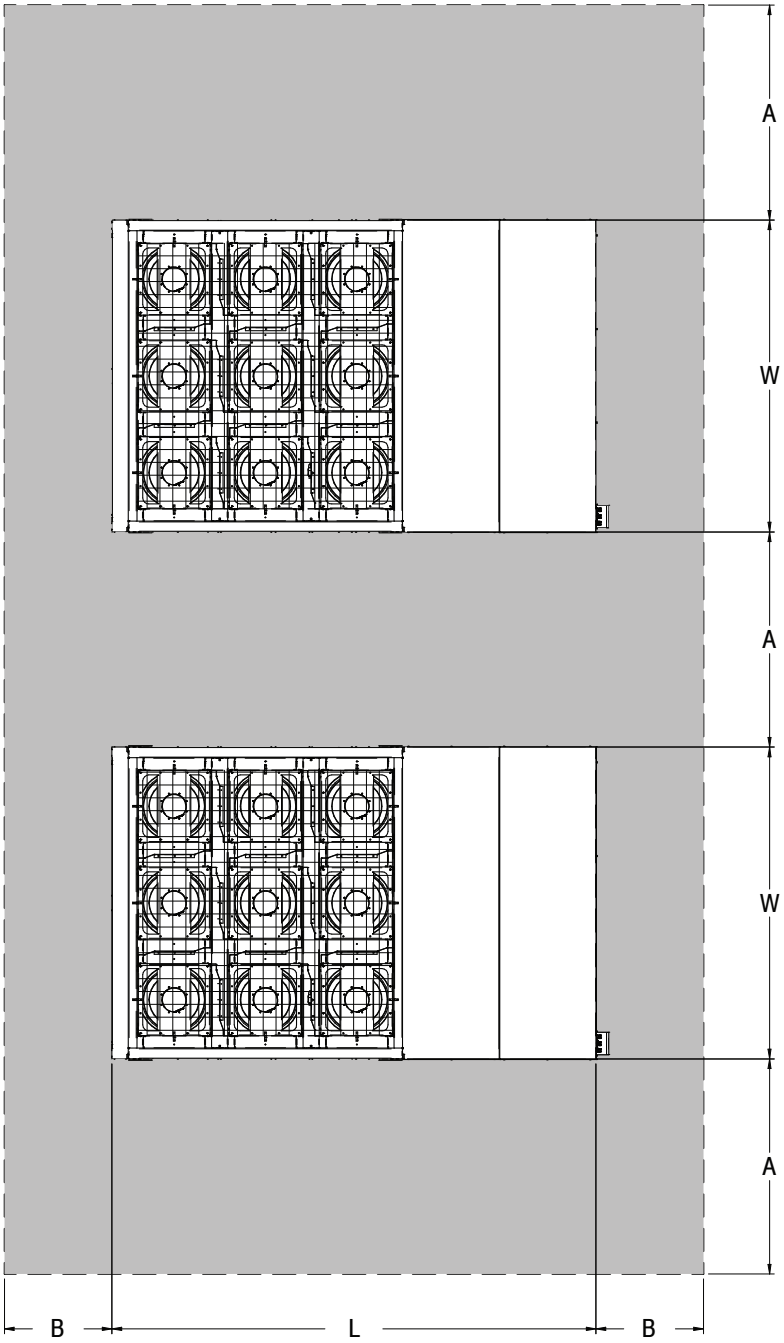
Note: *Insert rubber the between the basement and the structure that supports the unit.*

Overall unit dimensions EFC440



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

Distance between units



Tab 6.2 Dimensions

Unit	Dimensions			
	L (mm)	W (mm)	A (mm)	B (mm)
EFC250	3650	2500 (3500 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
EFC440	4500	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

6.3 - Water and drain connections

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

a. Provide adequate supports for external circuit and thermal expansion joints with vibration isolators.

b. Position water pipes and water circuit devices, checking inspection panel openings and access to any unit section.

c. 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:

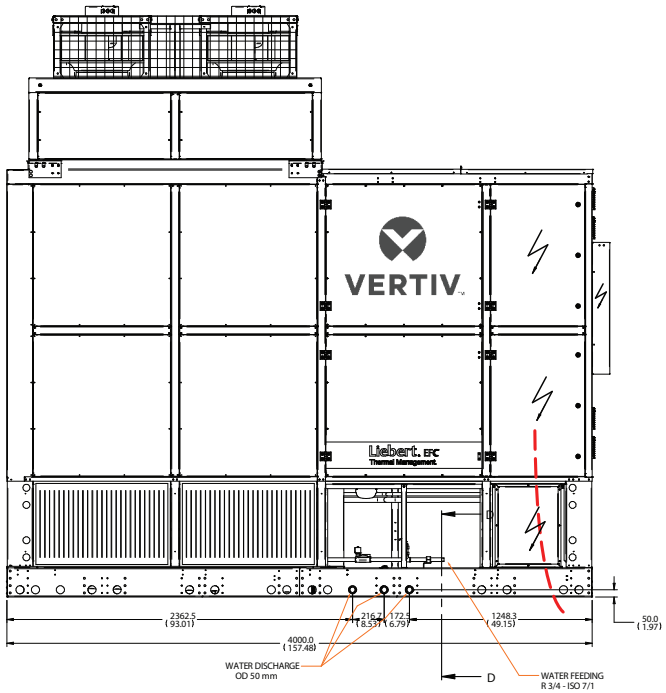
1. Water drain to be positioned at the unit lowest point;
2. For chilled water coil (**CW** Backup):
   - Vent valve at the circuit highest point to allow easy replenishment;
   - Shut-off valves, on water inlet and outlet.

Installer must obviously guarantee the requested value of water flow.

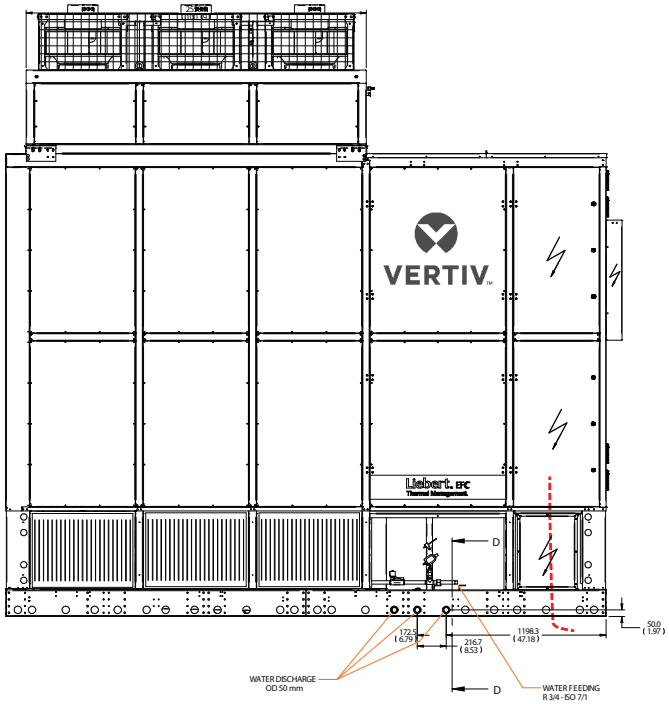
All connections should be made with the best available current workmanship practice according to the indicated dimensions of inlet and outlet diameters, using stainless steel, PVC or polythene tubing, while Copper has to be avoided.

Ensure the water discharge line is free, without any obstruction, with a drain capacity of at least 1200 l/h. This requirement must be guaranteed also when multiple units may require simultaneous bleed **OFF**. With this drain capacity, the unit tank full of water can discharge in around **20** minutes.

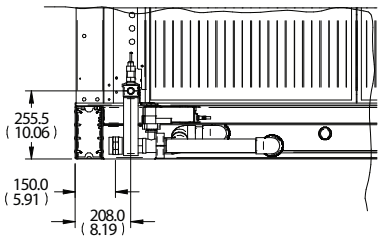
Note: *make sure that all connections have been done properly, which means they are completed and without mistakes.*



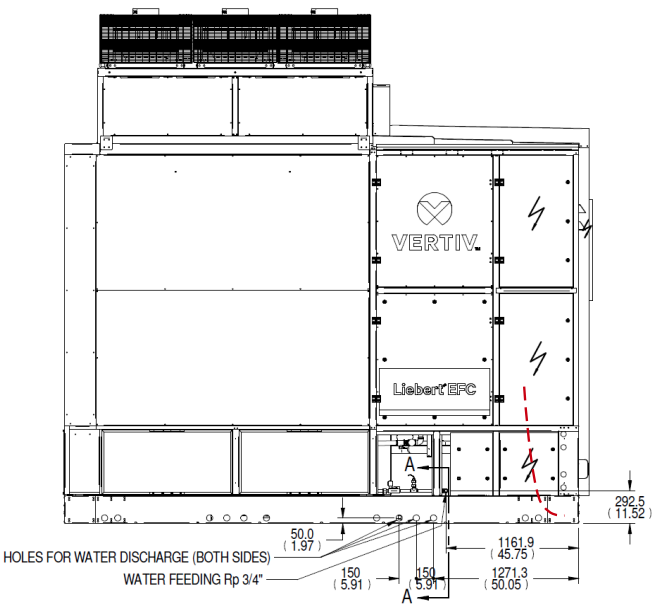
The water and drain connection of the **Liebert® EFC220** unit are presented in the picture below.



SECT. D-D



The water and drain connections of the **Liebert® EFC440** unit are presented in the picture below.

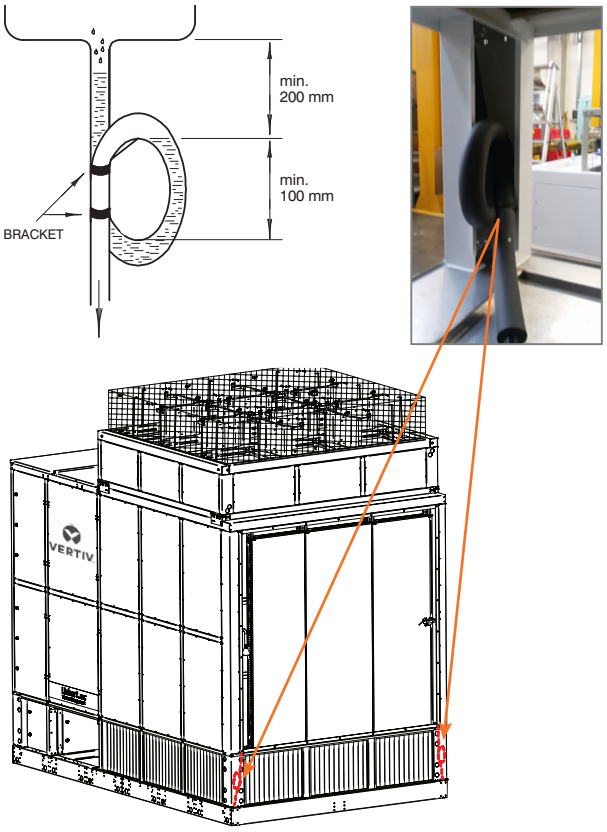


The evaporative system doesn't work when the external ambient temperature is low (near water freezing point).

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.

The water and drain connections of the **Liebert® EFC300, EFC320 and EFC400** unit are presented in the picture below.



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.

6.4 - 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 B*); all screws supplied must be used and sealing gasket should be interposed. Install antivibrating joints between duct and unit, to avoid vibration transmission.

Ensure the vertical angular can be removed after final installation to access to temperature/humidity sensors (see *positioning drawing*)

6.5 - Electrical connections

It's strongly recommended to have some engineers supervising this phase, in order to have connections done properly and completed without mistakes.

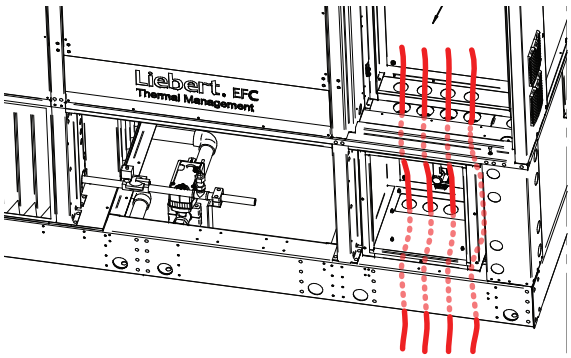
The unit name plate and the literature supplied with the unit show the electric features and the maximum full-load current input of all electric motors. Different main supplies, voltage and phases, may be needed for different uses, for this reason check carefully data on the name plate. Always use appropriate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

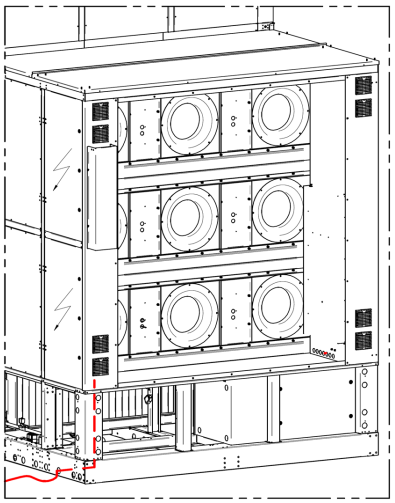
The supply cable of the main switch contains live high-voltage.

- 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.

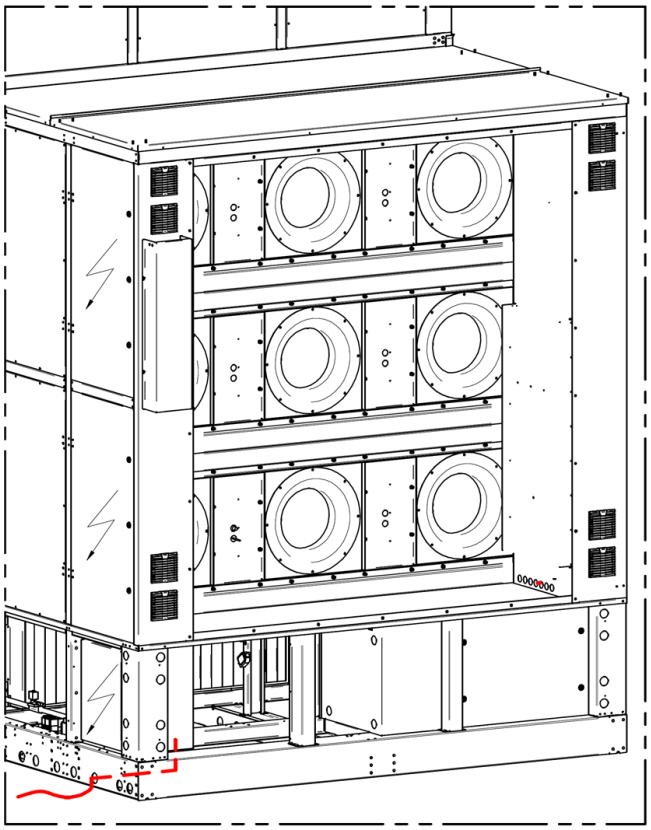
Refer to the unit electrical schematics for the installation. Follow all local codes.

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

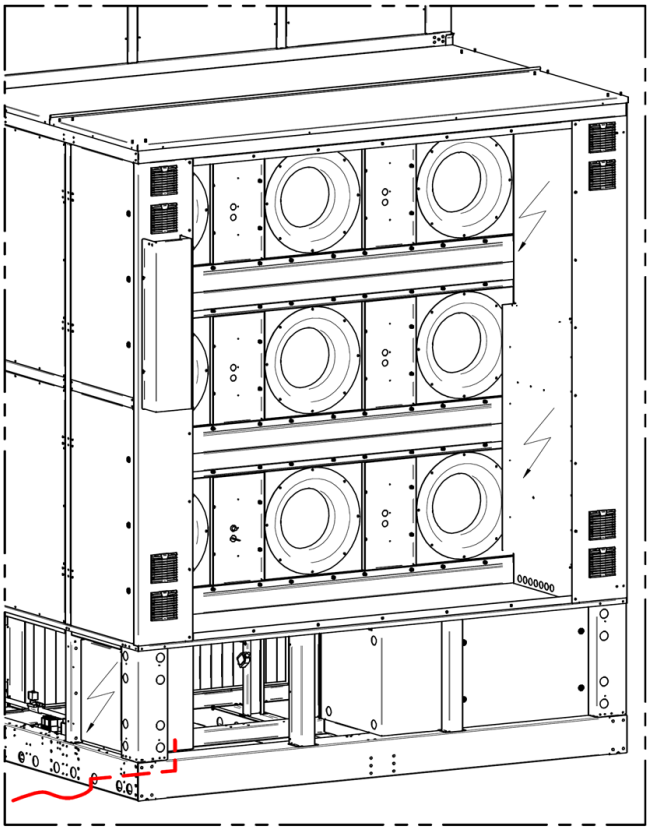
Refere to pictures below for electrical connections path for **EFC250**, **EFC300** and **EFC320**



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

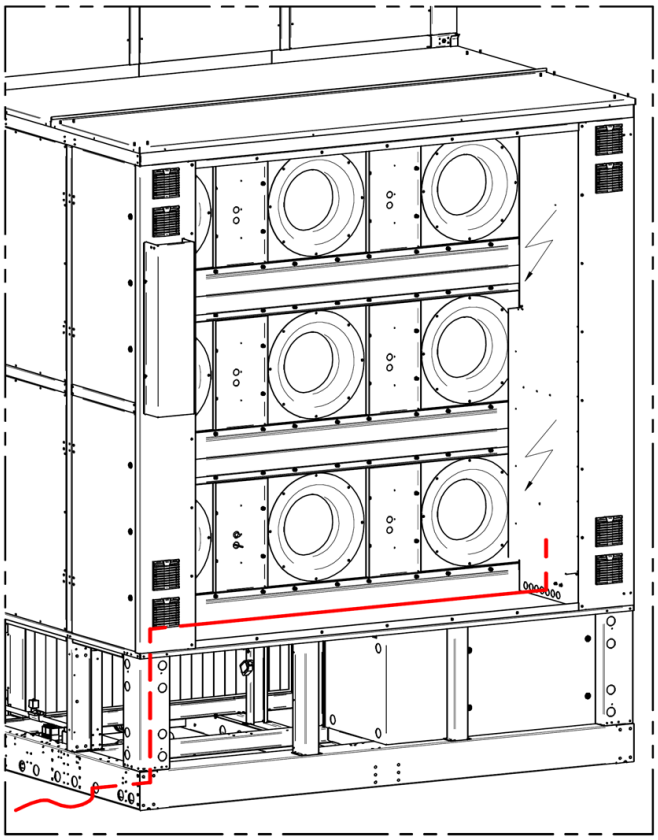


SINGLE UNIT LEFT (DIGIT 11) WITH ATS (DIGIT 18)

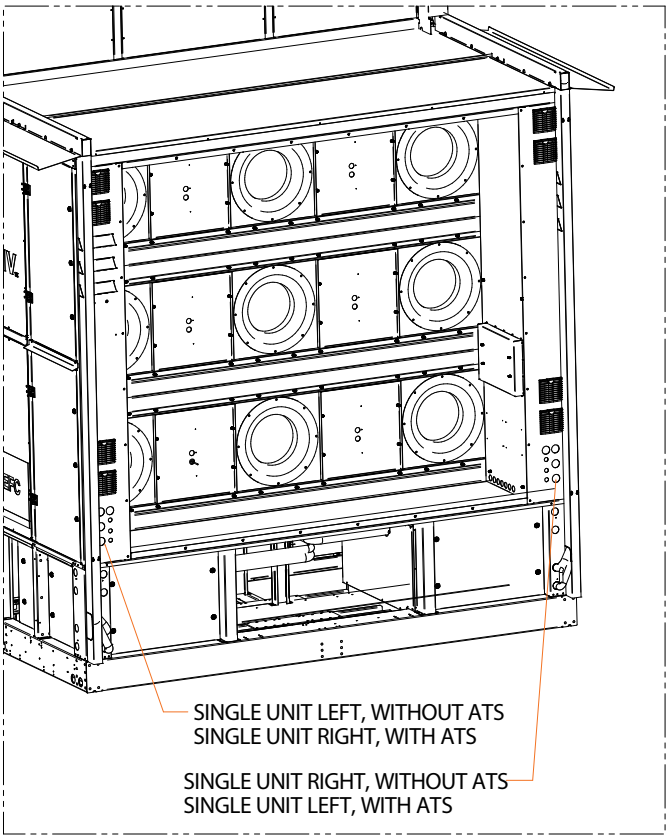


SINGLE UNIT RIGHT (DIGIT 11) WITH ATS (DIGIT 18)

Refere to pictures below for electrical connections path - For **EFC400** and **EFC440** unit.



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



6.6 - 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.

7 - Before Start-Up

ENSURE THE UNIT FEEDING WATER QUALITY IS IN LINE WITH INDICATONS ON CHAPTER 3.2

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.

7.1 - 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.

7.2 - 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.

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.

If the unit is not operated for long periods before installation, the following requirements must be observed to preserve fans operational life:

- If the fans are not operated for long periods in a dry atmosphere, they are to be started-up and operated at full speed for at least **one** hour every **four months**.
- If the fans are not operated for long periods in a damp environment (e.g. outdoors), they are to be started-up and operated at full speed for at least **two** hours **once a month** to move the bearings and allow any condensate that may have ingressed to evaporate.

7.3 - Air filters

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

7.4 - Evaporative system

For evaporative systems spraying nozzles, check that water jet of each nozzle is regular and clean those ones that appear to be clogged.
For conductivimeter, they are calibrated in factory; double check the calibration with portable calibrated instrument and, in case of needs, re-calibrate using the solution provided within the unit.
Calibration check should be done at least quarterly (see *Chapter 3.2*).

Set water feeding valve speed to limit water hammering (only in case of solenoid valve mounted) (see *Chapter 3.2*).

Once the water pump is run correctly for the first time, make sure that refilling water comply with the value shown in *Chapter 3.2, tables 3.1 and 3.2*

7.5 - 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.

7.6 - 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.

8 - Operation

8.1 - 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.

NOTICE The unit is not designed to provide humidity control, special configurations can be supplied to provide humidification or dehumidification.

COOLING

Air-to-air cooling mode

If the outdoor air condition is favorable, the unit works on air-to-air cooling mode (Dry mode): the outdoor air absorbs heat from the data center air.
In this condition, the large temperature difference between the external air and the data center air that pass through the crossflow heat exchanger can generate a vertical temperature gradient on the air supplied to the data center by the **EFC** unit.
When this occurs, the temperature setpoint is still ensured as it is measured considering the average between the readings of three temperature probes positioned respectively at the top, center and bottom of the data center delivery section of the **EFC**.
If the air is not mixed in the adjacent ductwork, or there is no plenum that provides an air mixing, the gradient could be maintained. This temperature stratification can be anyway addressed by adding a mixing system in the ductwork after the **EFC** units.
In dry mode, in case the outdoor temperature is below 10°C, the deviation from the average value can be up to 7K; this value is significantly reduced in case the evaporative system is activated. To be considered that this is influenced by the air flows both in primary and secondary sides.

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 recirculated water conductivity: 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; water feed is controlled a motorized ball valve, that it is normally closed and with spring return.
The correct water level is kept on the drain panel by two level switches (min level or max level reading).
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.

Performances: Due to the chemical and thermo-mechanical characteristics of the composite heat exchanger, it is expected that, after the initial start-up, a conditioning period is required in order to reach the nominal performances of the unit in evaporative cooling mode.

During this period no actions are required and the unit can work in evaporative cooling mode without any restriction, but the performance provided by the unit could result slightly lower than the one reported in the rating software datasheet. This occurrence will only take place during the commissioning phase after the first startup of the unit.

Data sheets from the rating software report the unit performance after a running-in period of **~50** hours in wet mode, even if it is expected it increases furthermore.

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.

TO PREVENT COMPRESSOR DAMAGE THE CRANK-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.

9 - Maintenance

9.1 - Maintenance and Spare Parts

9.1.1 - 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

9.1.2 - 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.).*

9.1.3 - 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.

9.2 - Periodical maintenance

WARNING: The operators must wear **PPE** (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). 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 tlocal certified and authorized water treatment companies and local authorities where required by legislation;
- 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 (that means not removable by finger), 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. Contact Vertiv™ Service to ensure the right chemical product and procedure to be used.
- Water regulary check to be compliant with water quality specifications in *Chapter 3.2* **is mandatory**.

WARNING: Recording water sampling following specifications in *Chapter 3.2* is a requirement for warranty to be valid.

WARNING: Avoid the contact of any part of the **EFC** with any type of organic solvent and aggressive detergent even if present in aqueous and/or diluted solution. Use only approved chemicals for descaling, anticorrosion, disinfection and cleaning: not approved substances could damage the unit components and invalidate the warranty. Contact Vertiv™ Service for approved chemical specifications.

For the whole activities list check *table 9.3* at page 44 or 45 and maintenance for evaporative system table in *Chapter 3.3.1*

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.

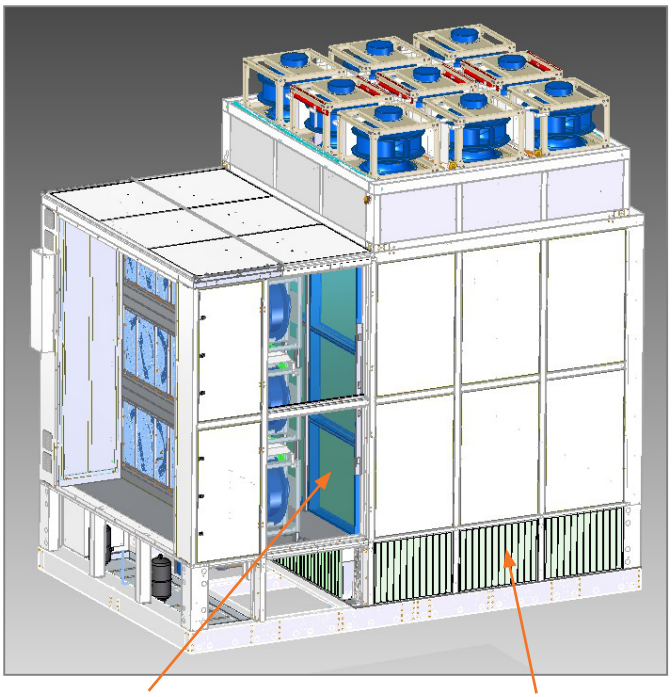
9.3 - Air filters

- 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).

External air filters: Since they filter external air and they avoid water to splash out the sump, it is necessary a check, clean, disinfect or replace them by following the table in *Chapter 3.2*.

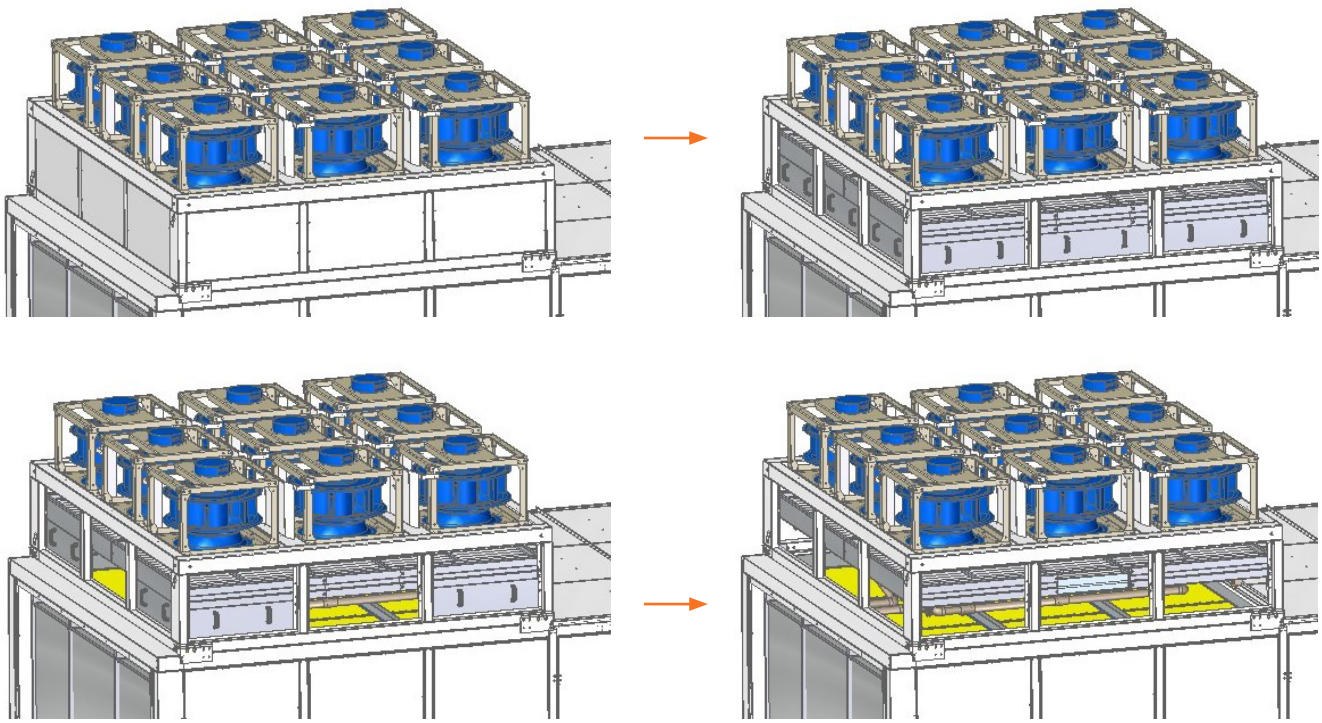
WARNING: the lack of filter cleaning or replacement can cause a decrease in the unit/plant efficiency because:

- 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.

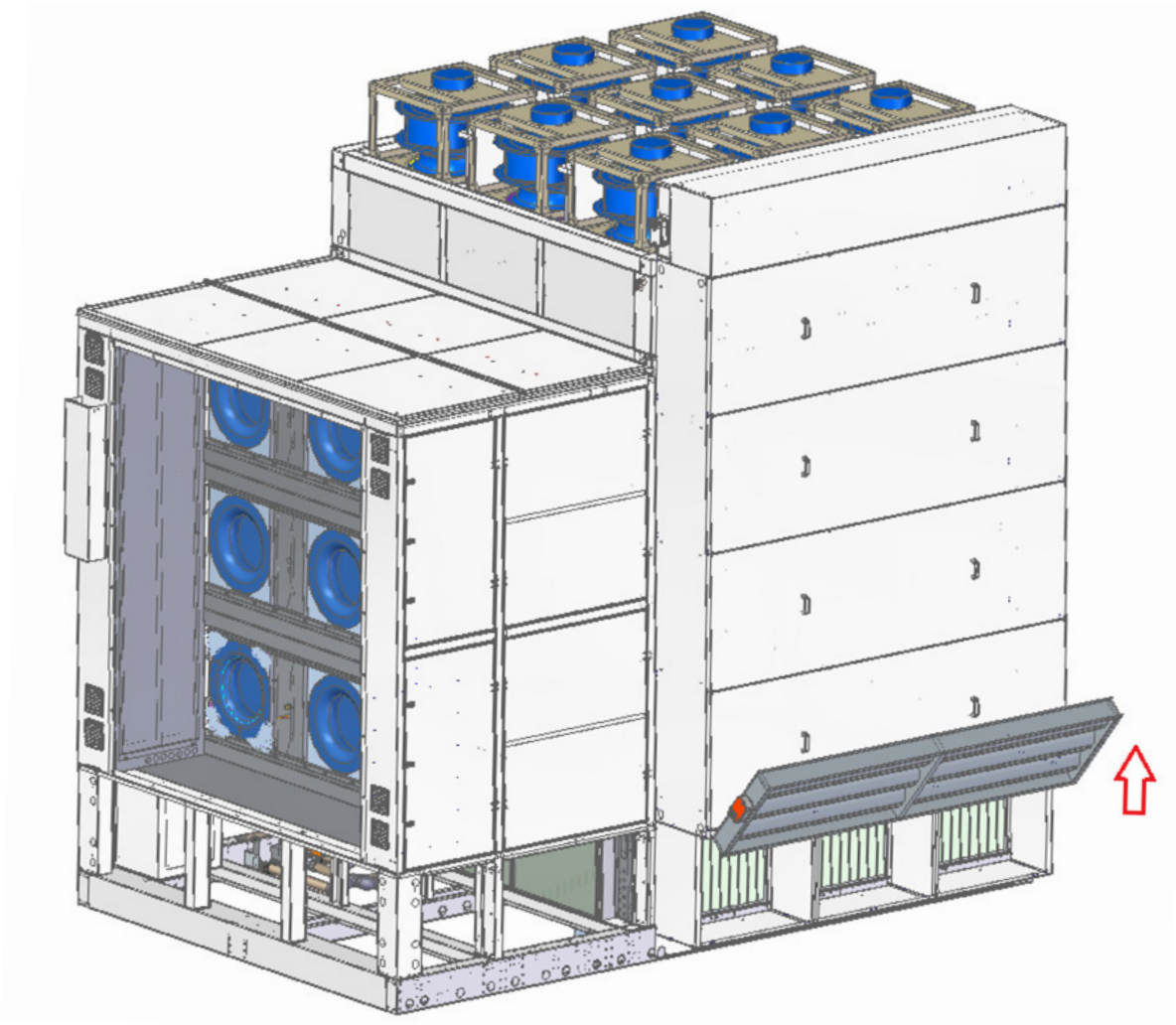


Components to clean/disinfect

Heat exchanger, access panels, external air filters.
Remove middle internal panel before. **Attention not to damage the heat exchanger!**



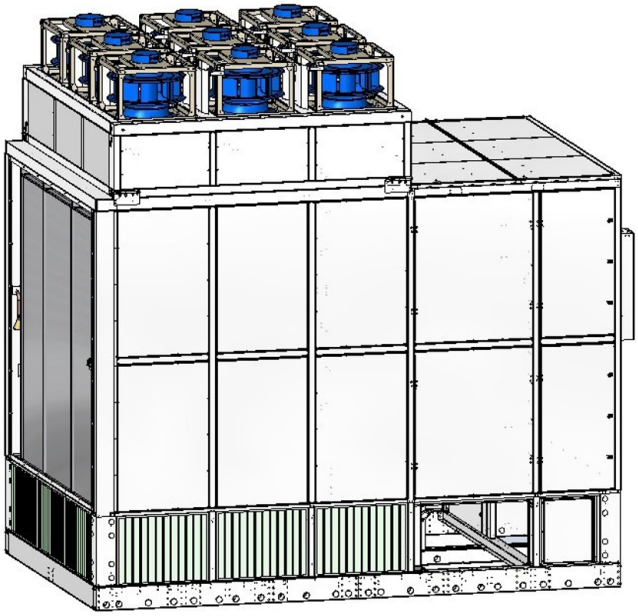
With Low Ambient Kit option, rotate the damper upwards to access to external air filters.



9.4 - Fans

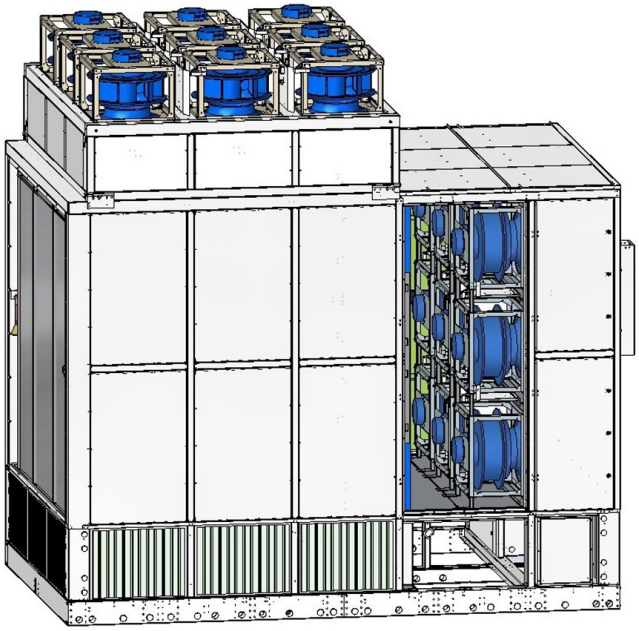
If maintenance or replacement of the data center side fans is necessary the operators must follow the next steps:

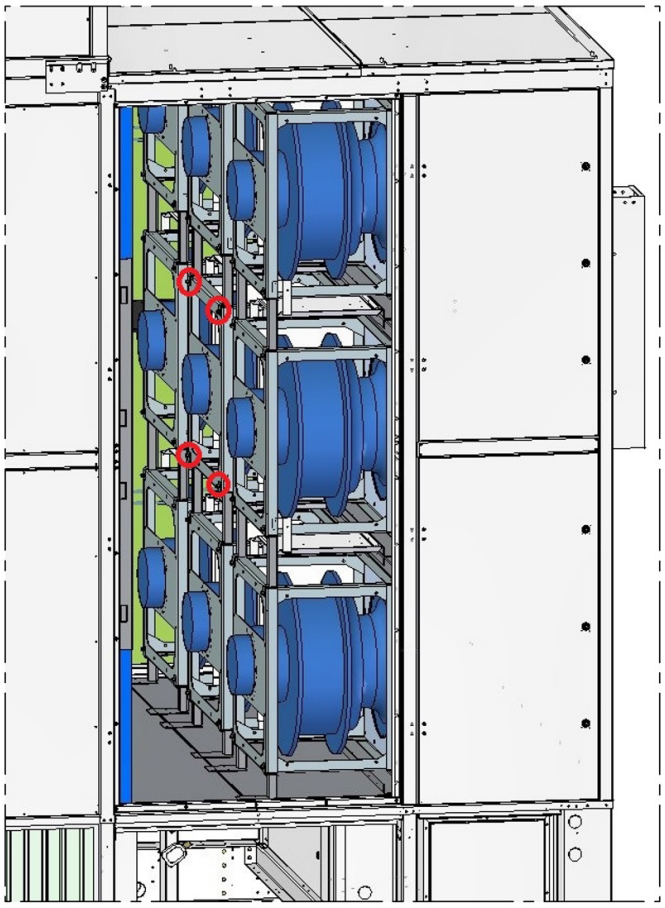
1. Remove the side panels;



NOTE: *Orange stiffener on unit top will be used to hold the fan by the eye-bolt/belt.*

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

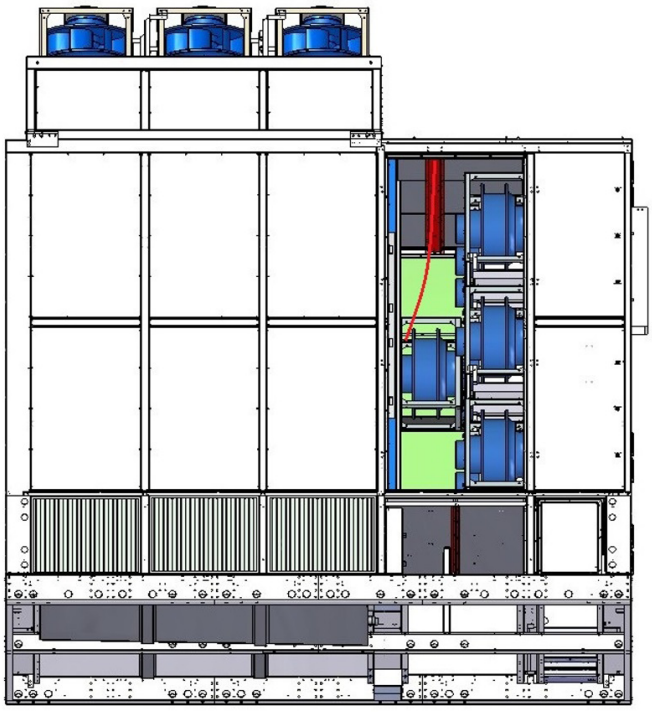




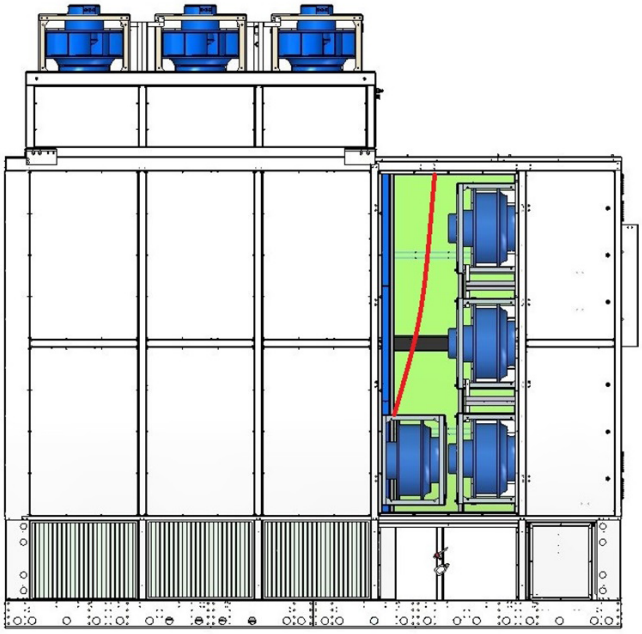
WARNING!

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;

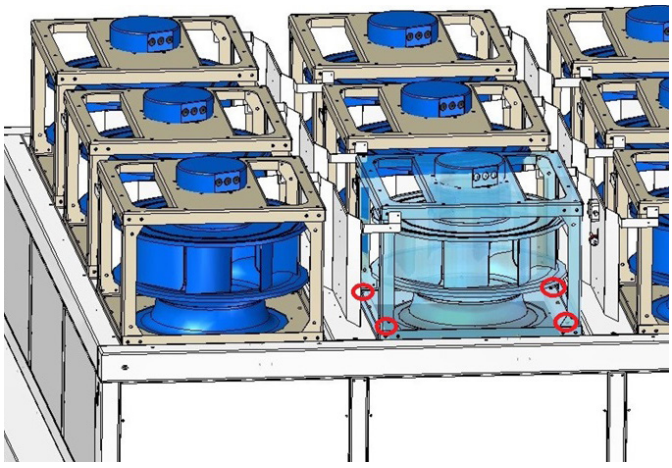


4. Lower the fan on the unit bottom.

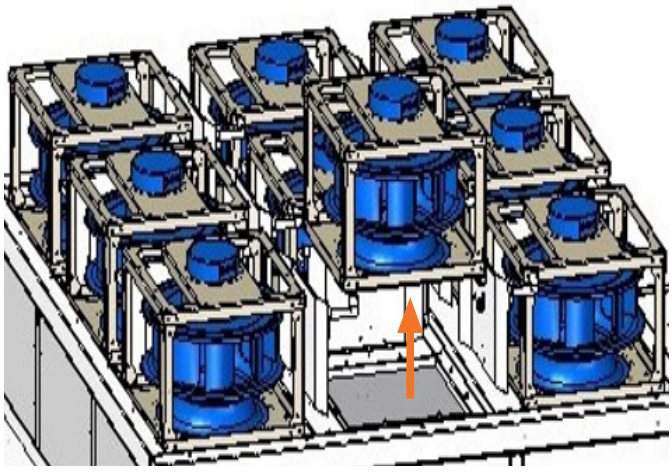


If maintenance or replacement of the process side fans is necessary, the operators must follow the next steps:

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.



9.5 - 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.

9.6 - Refrigeration circuit

WARNING: The operators must wear gloves to avoid burns caused by hot parts of mechanical cooling system.

WHEN REPAIRING THE REFRIGERATION CIRCUIT, COLLECT ALL REFRIGERANT IN A TANK: 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.

WARNING: During brazing or unbrazing activities, protect surrounding components from direct heat. Particular attention must be paid with the brazed joints close to the heat exchanger. Temperatures in the direct proximity of the composite heat exchanger plates and of the painted metal frame of the heat exchanger must be kept below 70°C. If this condition is not respected, the heat exchanger could be irreversibly damaged.

9.6.1. Oil Charge R410A

The additional oil charge is already charged in factory. Check the right oil level in sight glass during the commissioning (see *8.1*). If the level is too low see *9.6.2*.

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. 9.1* and *Tab. 9.2*).

Tab. 9.1 - 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. 9.2 - 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.

9.6.2. Oil topping-up of an installed circuit

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

9.7 - 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.

9.8 - 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.

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

9.9.1. 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 an 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.

9.9.2. 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

9.9.3. 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 chapter 8.9 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.*

9.9.4. Operators

9.9.4.1.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.

9.9.4.2. 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 CO_2 equivalent of fluorinated greenhouse gases. Leakage test not required **Case 2** - Hermetically sealed equipment contains less than 10 tonnes of CO_2 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.

9.9.5. 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	---

9.9.6. 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 CO_2 Equivalent. Use the following rule for computation: where: $$\text{Tonnes of } CO_2 = \frac{\text{kg of refrigerant x GWP of refrigerant}}{1000}$$

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.*

9.9.7. Record Keeping

Operators of equipment which is required to be checked for leaks (see *9.9.5 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 *9.9.5 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 9.3 Periodical maintenance schedule

COMPONENT		MAINTENANCE PERIOD EVERY			
		1 Month	3 Months	6 Months	1 Year
FANS **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 status of filter (for soiling, damage, corrosion)		X		
	Clean or replace if necessary.		X		
	Carry out controls more frequently in dusty environments.	X			
EXTERNAL AIR FILTERS	Check status of filter (for soiling, damage, scaling, mold) Clean or replace if necessary.		X		
	Carry out controls more frequently in dusty environments.	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 *Chapter 3.2*.				
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			
		1 Month	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	
DROPLET SEPARATOR	Clean droplet separator (*figure 3.6*) **NOTE:** *in case of high solid deposit or in case of droplet separator surface damage, replace with new one.*		X		
	Replace droplet separator (*figure 3.6*)				X

10 - Anomalies and their probable causes

Tab. 10.1 - 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
	Too much air pressure drop	Check system/plant design
		Adapt fan section
	Dampers shut **OFF**	Open and adjust dampers
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
4) Thermal capacity is lower than the expected one	Air underflow	See anomaly 2)
5) Evaporative system	Water supply insufficient or shut **OFF**	Open external supply valve and verify the functionality of the unit inlet supply valve.
		Check pump electric connections
		Clean water strainers
		Check and adjust water ball-cock after the pump if present.
		Check water level switches
	Clogged nozzles / filters	Clean nozzles / filters
6) Droplet carryover is noticed	Droplet separator damaged	Replace droplet separator
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 - Technical data table

Tab. A.1a - Electrical data

Configuration	Model	Power supply	Electrical Data			min/max Cu cable size mm²
			FLA [A]	LRA [A]	RESIDUAL-CURRENT CIRCUIT BREAKERS IΔn=0.3A (400V)*	
Evaporative Cooling Fans + Pump	**EFC250**	400 V / 3 Ph + N / 50 Hz + earth	100	112	150	35
Evaporative Cooling + DX Fans + Pump + Compressor(s)	**EFC250**	400 V / 3 Ph + N / 50 Hz + earth	134(168)**	274(308)**	150 (200)	50
Evaporative Cooling Fans + Pump	**EFC300**	400 V / 3 Ph + N / 50 Hz + earth	178,2	196,2	200	70
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	95
Evaporative Cooling Fans + Pump	**EFC320**	400 V / 3 Ph + N / 50 Hz + earth	147	159	150	70
Evaporative Cooling + DX Fans + Pump + Compressor(s)	**EFC320**	400 V / 3 Ph + N / 50 Hz + earth	181 (215)**	321 (355)**	200 (250)	70 (95)
Evaporative Cooling Fans + Pump	**EFC400**	400 V / 3 Ph + N / 50 Hz + earth	150	168	200	50
Evaporative Cooling + DX Fans + Pump + Compressor(s)	**EFC400**	400 V / 3 Ph + N / 50 Hz + earth	(218)** ((286))***	(358)** ((426))***	(250)** ((300))***	(95)** ((150))***
Evaporative Cooling Fans + Pump	**EFC440**	400 V / 3 Ph + N / 50 Hz + earth	168.8	186.8	200	70
Evaporative Cooling + DX Fans + Pump + Compressor(s)	**EFC440**	400 V / 3 Ph + N / 50 Hz + earth	(236.8)** ((304.8))***	(376.8)** ((444.8))***	(250)** ((350))***	(120)** ((185))***

* **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:

1. *The cables have to be sized in compliance with local standards and according to the type and characteristics (e.g. Ampere) of installation.*
2. *Value of cable size is related to PVC insulation, 40°C ambient temperature and unipolar cable type.*
3. *The data in the tables do not consider the absorbed current for other options not explicitly described.*
4. *The specific energy allowed to flow from the circuit breakers, installed by the user, must be lower than 300.000A² x s.*
5. *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.*

Enclosure A - Technical data table

Tab. A.1b - Electrical data

Component	Model	Quantity	FLA	LRA	Power input	cosϕ
		no.	[A]	[A]	[kW]	
Fans primary	EFC250	6	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
Fans primary	EFC440	9	9.4	0.1	6	0.9
Fans process		8	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. Compressors data values refer to standard compressors size*

Tab. A.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]
EFC250_ _ _X	23	3.25	1.5
EFC250_ _ _T	27.5	2 x 3.25	1.0
EFC300_ _ _X	29	3.25	2.0
EFC300_ _ _T	37	2 x 3.25	2.0
EFC320_ _ _X	29	3.25	2.0
EFC320_ _ _T	37	2 x 3.25	2.0
EFC400_ _ _T	38	2 x 3.25	2.0
EFC400_ _ _D	26 + 26	4 x 3.25	1.5 + 1.5
EFC440_ _ _T	36	2 x 3.25	2.0
EFC440_ _ _D	27 + 27	4 x 3.25	2.0 + 2.0

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

Enclosure A - Technical data table

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

MODEL	BASE OIL CHARGE (*) [l] oil within compressor (Data in brackets refer to Digital Scroll Compressor Cooling System, when the data differs)		Max System Refrigerant Charge before oil addition(*) [kg – each circuit]	Oil to be added over the Max System Refrigerant Charge (*) [l – each circuit]
	Initial oil charge	Max topping up		
EFC250_ _ _X	3.25	3.14	13	a
EFC250_ _ _T	2 x 3.25	2 x 3.14	13	a
EFC300_ _ _X	3.25	3.14	13	a
EFC300_ _ _T	2 x 3.25	2 x 3.14	13	a
EFC320_ _ _X	3.25	3.14	13	a
EFC320_ _ _T	2 x 3.25	2 x 3.14	13	a
EFC400_ _ _T	2 x 3.25	2 x 3.14	13	a
EFC400_ _ _D	2 x 3.25	2 x 3.14	13	a
EFC440_ _ _T	2 x 3.25	2 x 3.14	13	a
EFC440_ _ _D	2 x 3.25	2 x 3.14	13	a

a = (0.025 x (total refrigerant charge for each circuit [kg] - max system refrigerant charge before oil addition [kg])) + 0.09
(*) The recommended oil for units with R410A refrigerant is EMKARATE RL 32-3MAF

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).*

Tab. A.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	0.047	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	0.203	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* below.

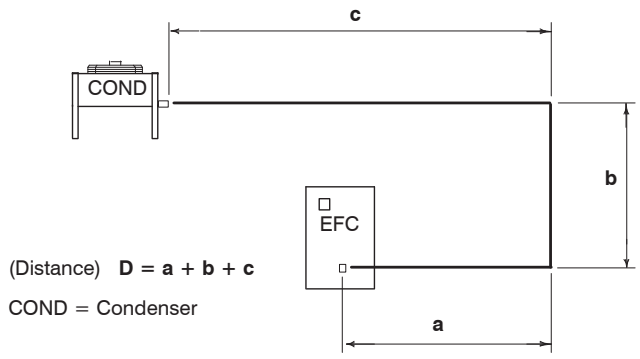
(4) Topping up is requested for short pipeline too, due to the extra-charge of refrigerant.

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*).

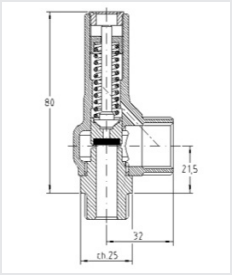
NOTE: *The refrigeration circuit is supplied pressurized with helium at 2 bar.*

Fig. 1 - Pipeline EFC - condenser



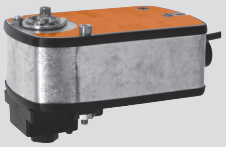
Enclosure A - Technical data table

Tab. A.4 – Calibration of electrical components

Component	Details and Setting	Notes
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) Normally closed	
Clogged Filter Differential Pressure Switch (CF)	Filter Coarse 60% = 2 mbar ePM10 50% = 3 mbar Normally closed	
Safety Valve	Setting Pressure 45 bar	
Conductivimeter		

Enclosure A - Technical data table

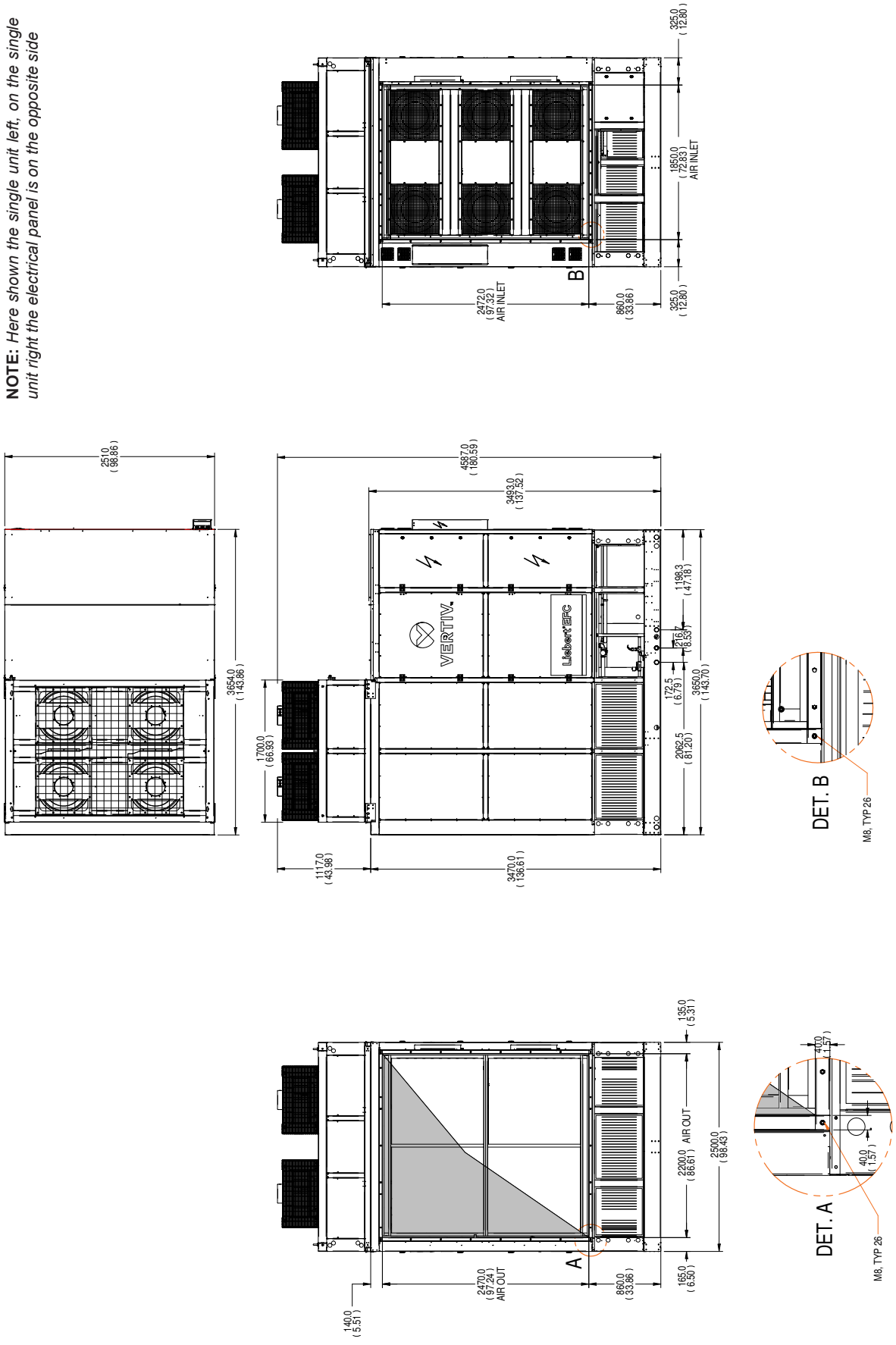
Tab. A.5 - Adjustments and calibrations of valves (see Enclosure D - Refrigerant, Hydraulic and electrical connections)

Component	Calibration & Operating	Application	Model	Drawing
Thermostatic expansion valve	Superheating control 6 - 8K	All Versions	Sporlan BBIZE / OZE	
Actuator for water feeding valve (if installed)	ON - OFF	All versions	Belimo LRF24-SR	
Ball valve for water feeding (if installed)	ON - OFF	All versions	R2020-S2	
Actuator for water draining valve (if installed)	Modulating action	All versions	SRF24A-R	
Ball valve for water draining (if installed)	Modulating action	All versions	Belimo K240B	

Enclosure B - Dimensional Data/Connections

Liebert® EFC250 Single Unit Left

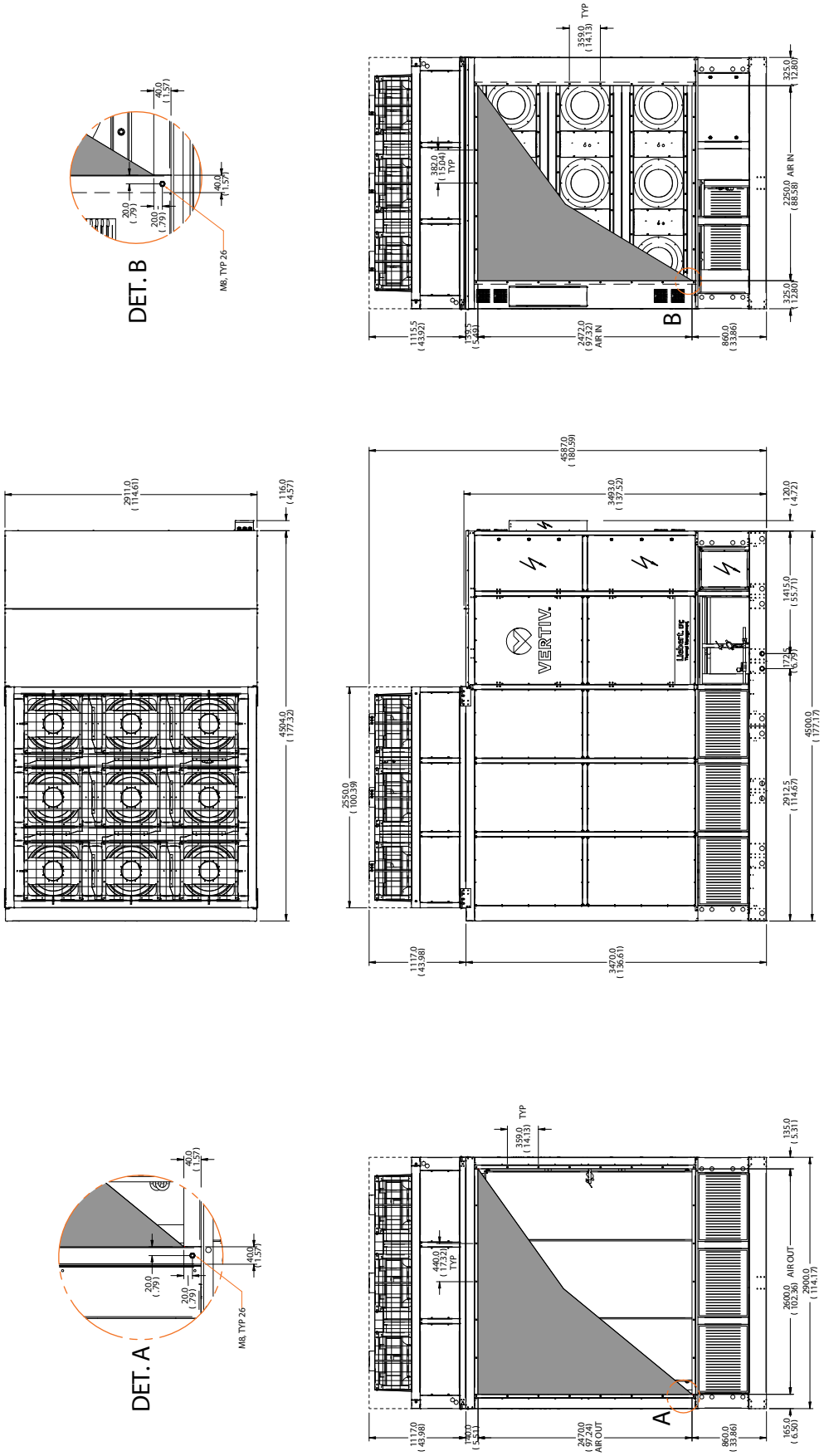
NOTE: *Here shown the single unit left, on the single unit right the electrical panel is on the opposite side*



Enclosure B - Dimensional Data/Connections

Liebert® EFC300 Single Unit Left

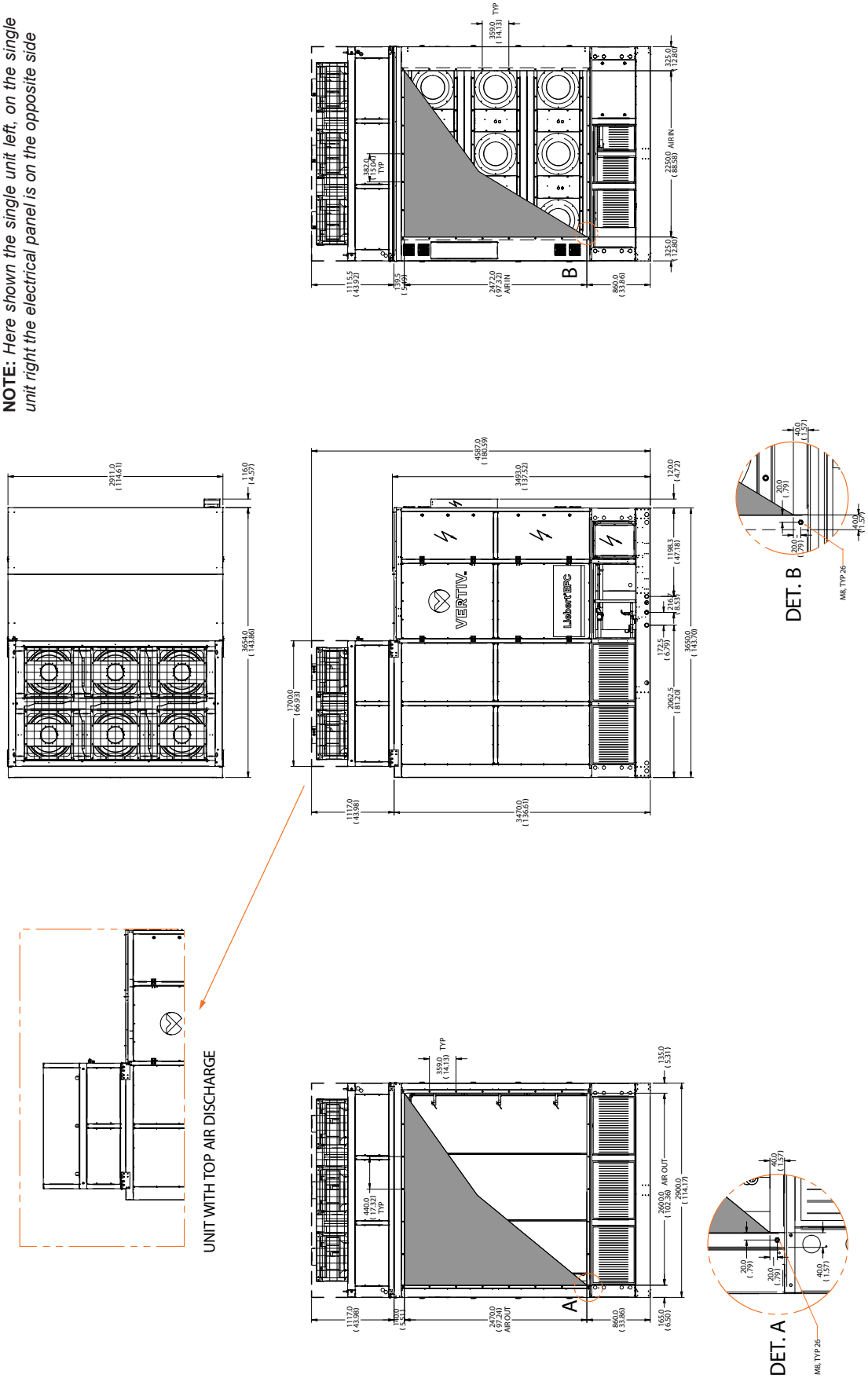
NOTE: *Here shown the single unit left, on the single unit right the electrical panel is on the opposite side*



Enclosure B - Dimensional Data/Connections

Liebert® EFC320

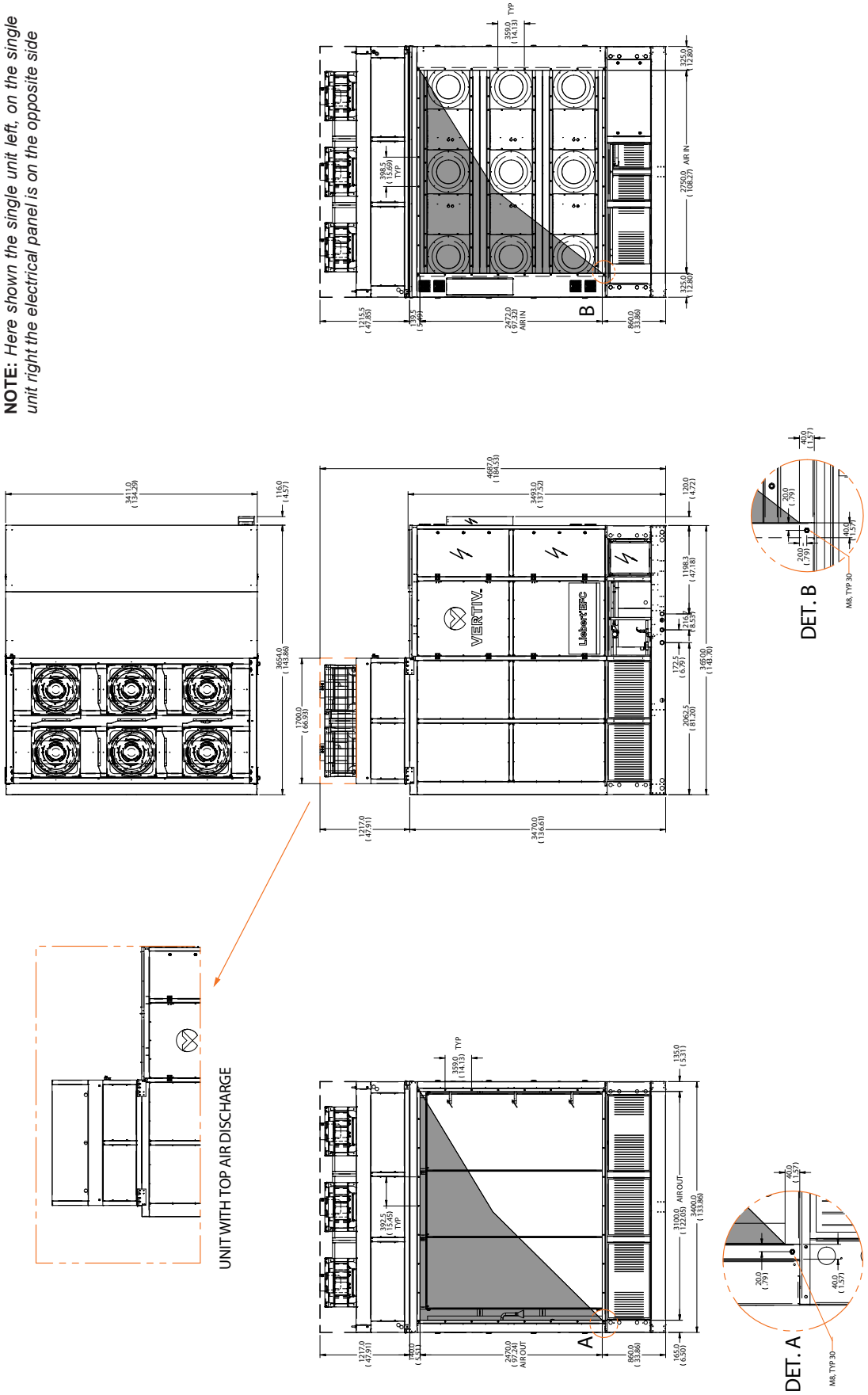
NOTE: *Here shown the single unit left, on the single unit right the electrical panel is on the opposite side*



Enclosure B - Dimensional Data/Connections

Liebert® EFC400

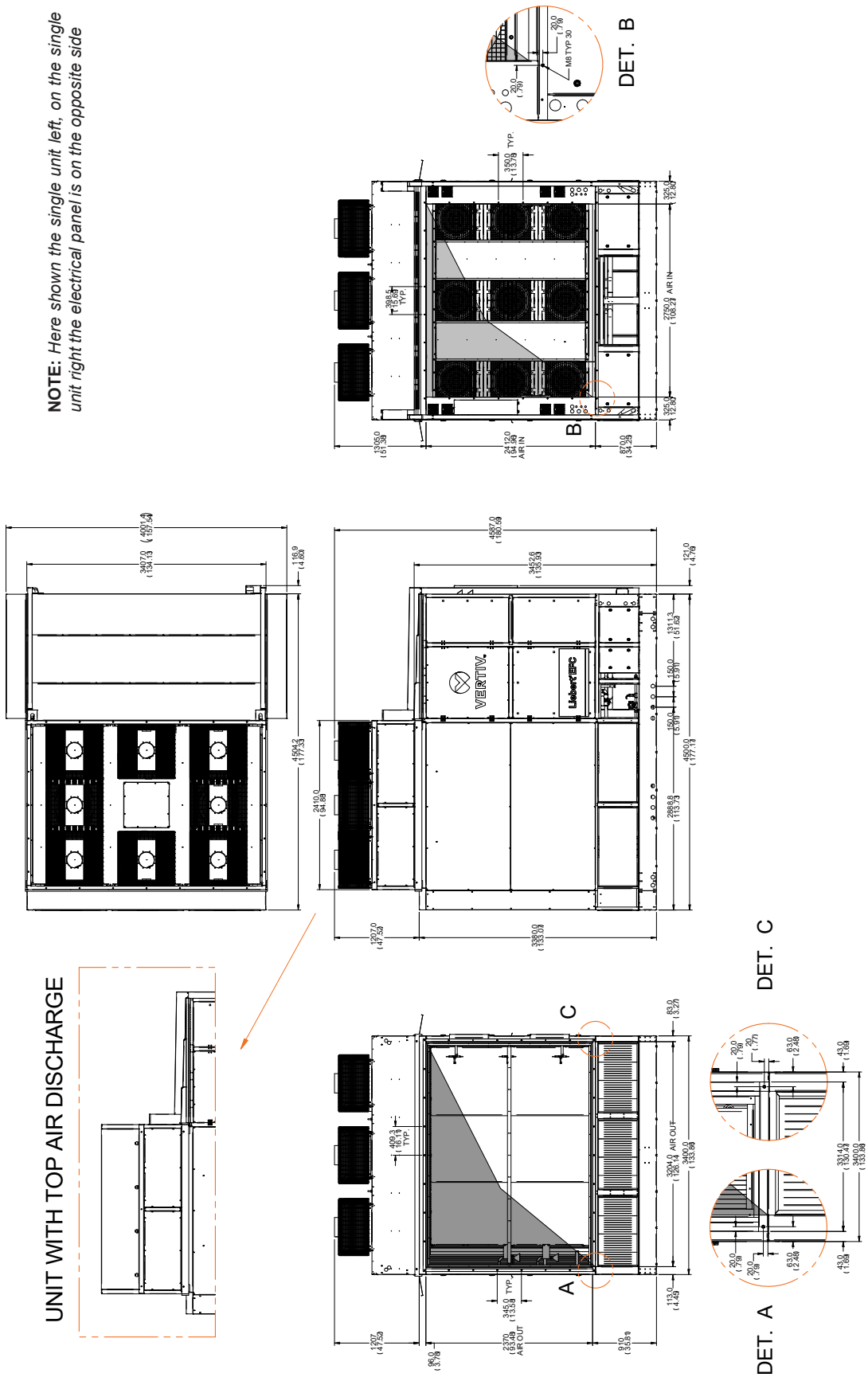
NOTE: *Here shown the single unit left, on the single unit right the electrical panel is on the opposite side*



Enclosure B - Dimensional Data/Connections

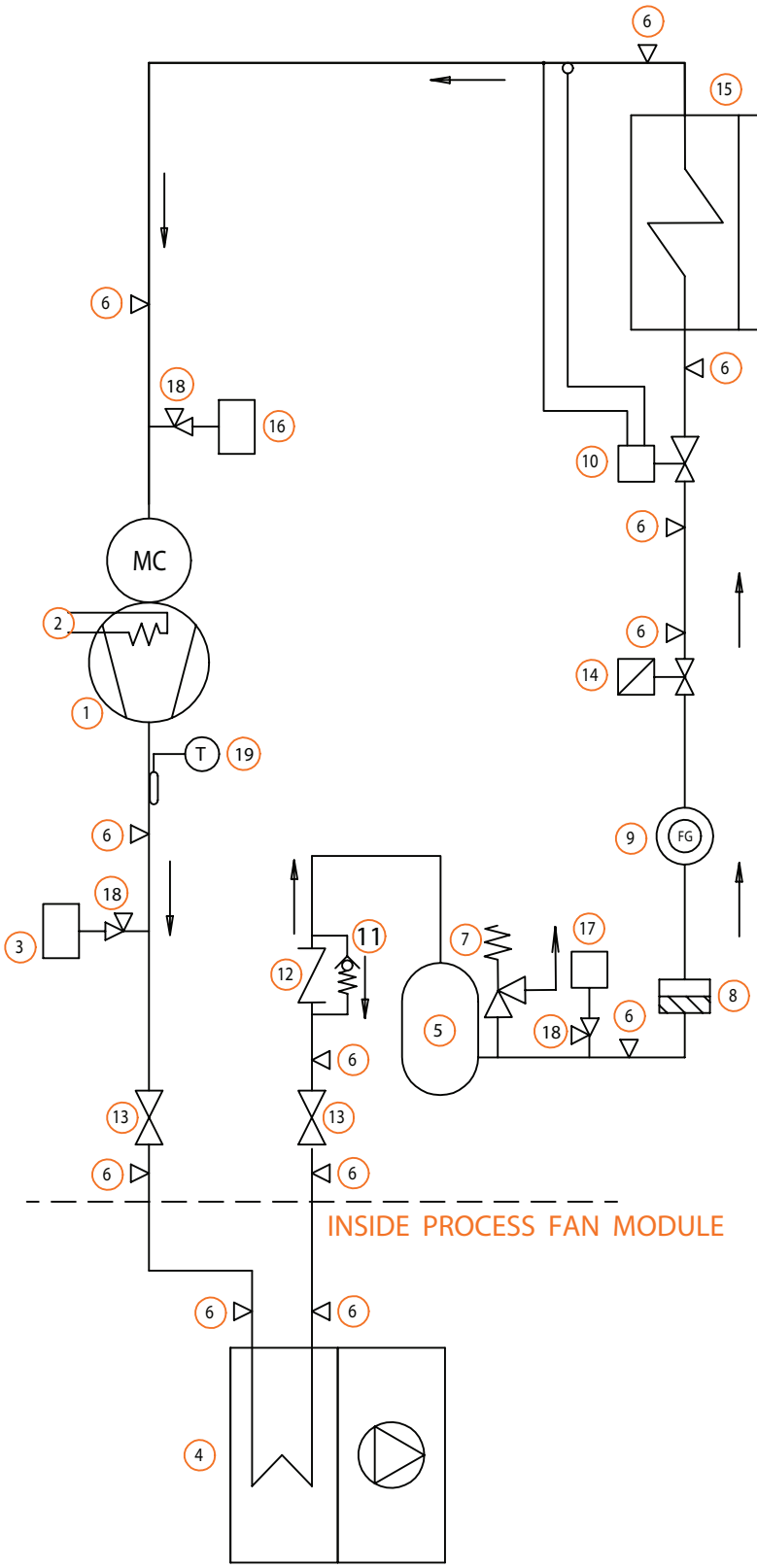
Liebert® EFC440

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



Enclosure C - Refrigerant, Hydraulic and Electrical Connections

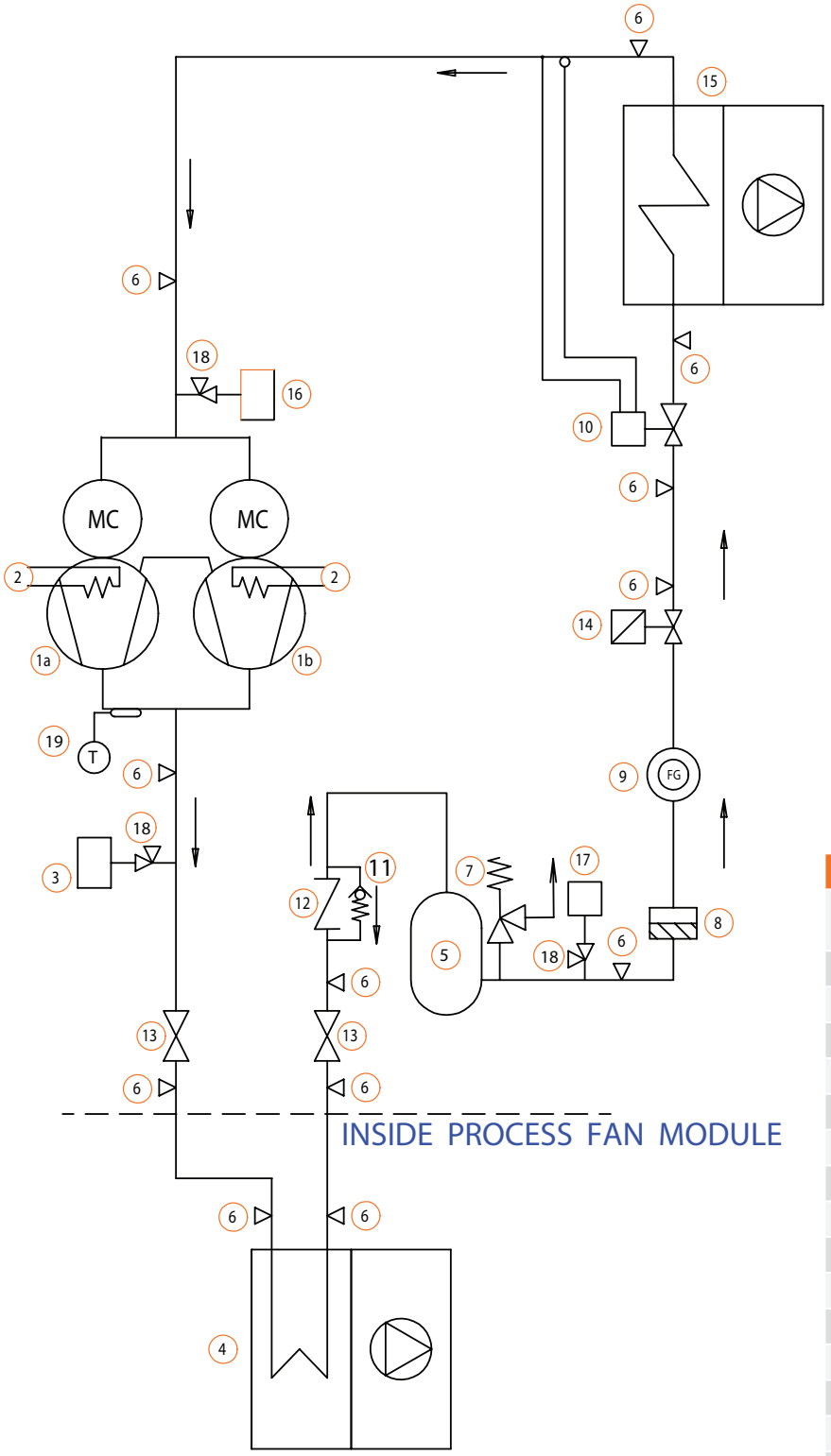
Fig. C.1 - DX system refrigerant circuit - Single DIGITAL SCROLL compressor - TXV



Pos.	DESCRIPTION
19	NTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRANSDUCER
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 C - Refrigerant, Hydraulic and Electrical Connections

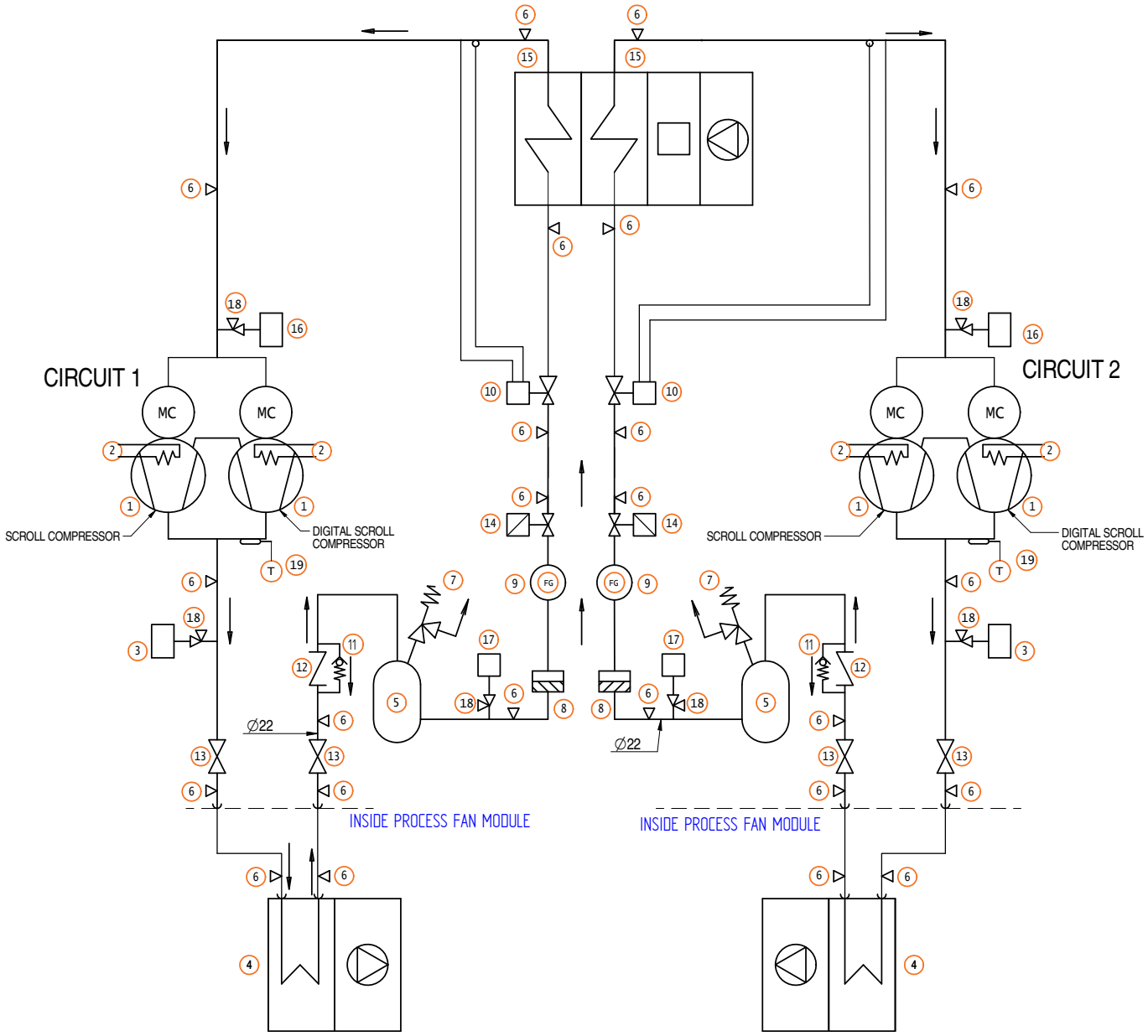
Fig. C.2 - DX system refrigerant circuit - Tandem DIGITAL SCROLL compressor - TXV



Pos.	DESCRIPTION
19	NTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRANSDUCER
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 C - Refrigerant, Hydraulic and Electrical Connections

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

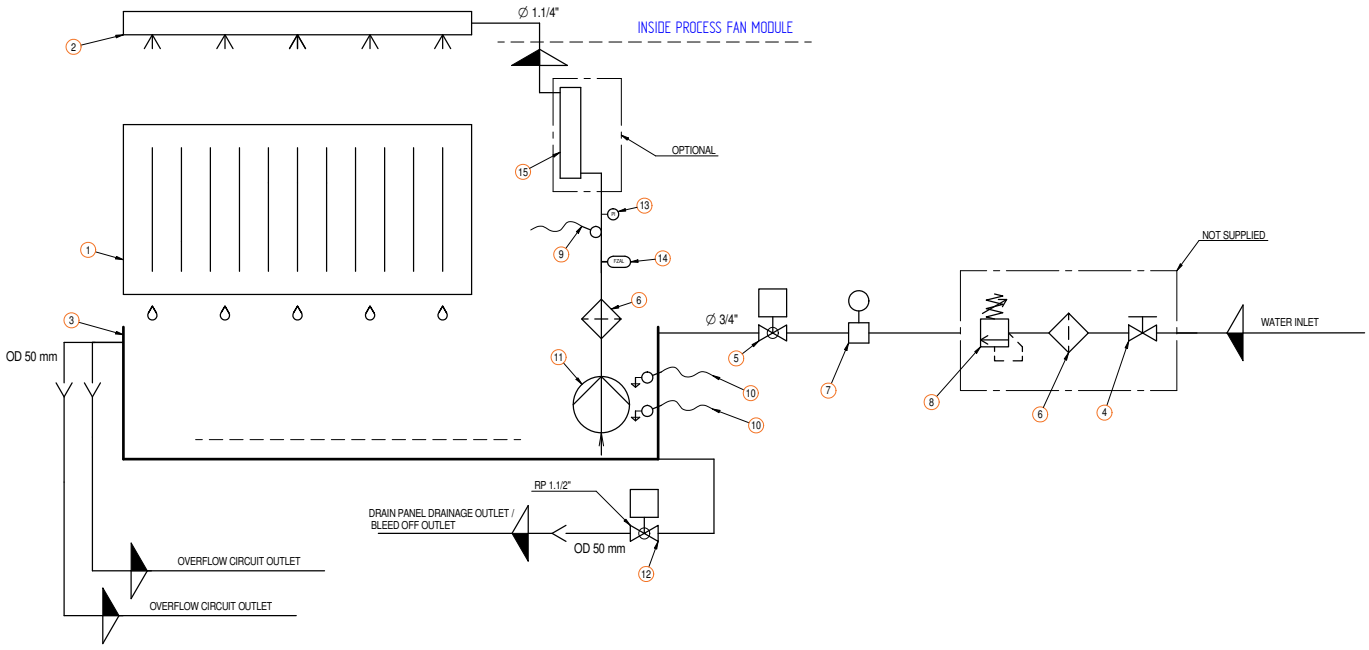


Pos.	DESCRIPTION
19	PTC TEMPERATURE SENSOR FOR DIGITAL COMP.
18	ACCESS VALVE 1/4 SAE
17	HIGH PRESSURE TRASDUCER
16	LOW PRESSURE TRANSDUCER
15	EVAPORATOR
14	SHUT OFF SOLENOID VALVE
13	SHUT-OFF VALVE
12	CHECK VALVE
11	CHECK VALVE 10 bar

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 C - Refrigerant, Hydraulic and Electrical Connections

Fig. C.4 - Hydraulic circuit Evaporative System - configuration with pH probe and UV lamp



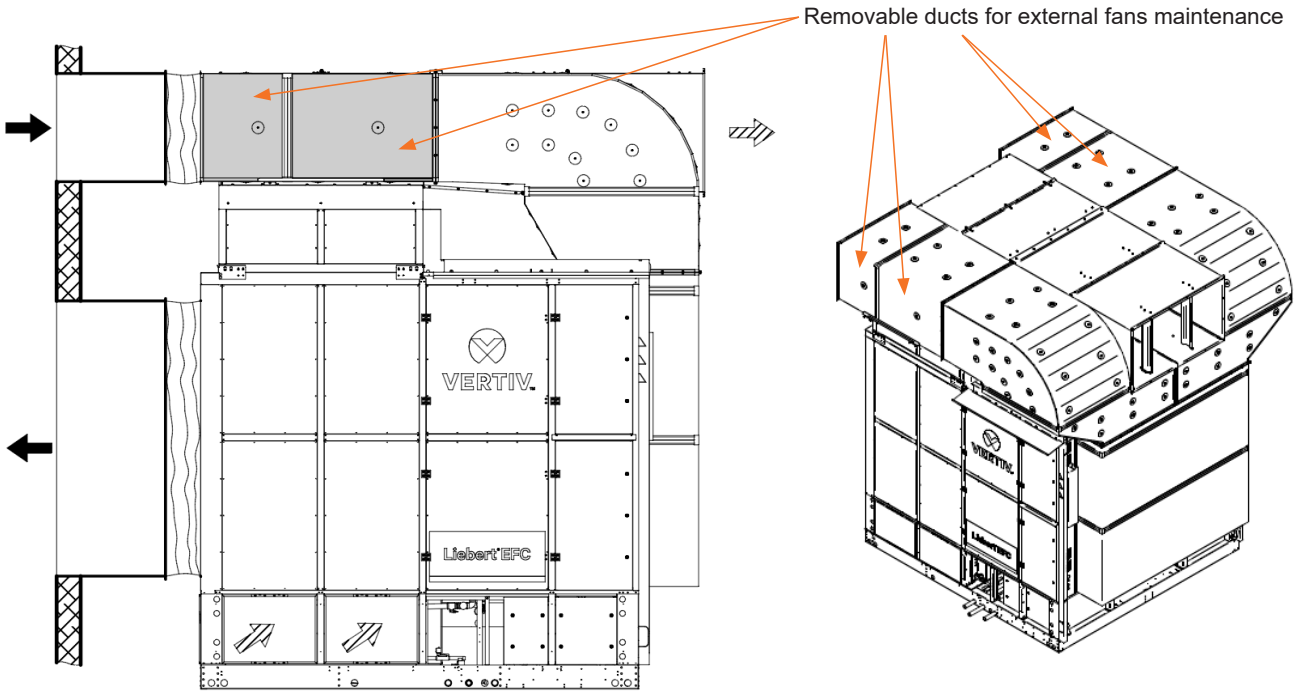
Pos.	DESCRIPTION
15	UV LAMP (WHERE INSTALLED)
14	FLOW SWITCH
13	MANOMETER
12	MOTORIZED BALL VALVE
11	PUMP
10	LEVEL SWITCH
9	CONDUCTIVIMETER
8	PRESSURE REGULATOR

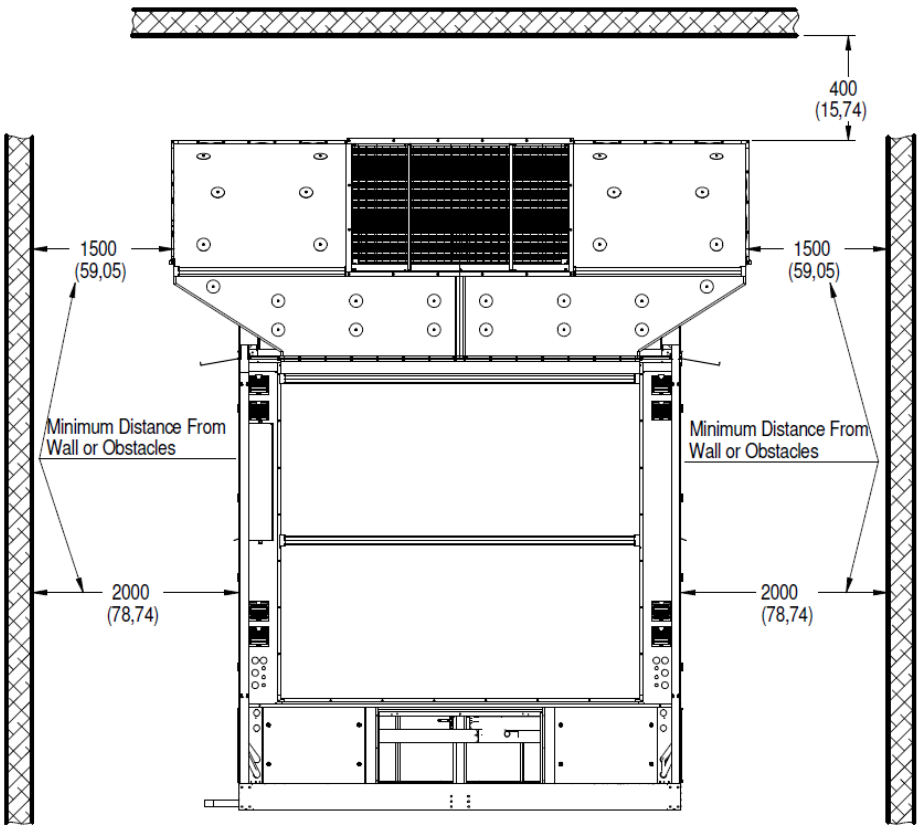
Pos.	DESCRIPTION
7	FLOW METER
6	FILTER
5	BALL VALVE
4	VALVE
3	DRAIN PANEL
2	SPRINKLERS
1	PLATE HEAT EXCHANGER

Enclosure D - Accessories

D.1 - TOP SUCTION DUCTING

A top suction ducting accessory is available to allow perimeter configuration; this layout allow to suct the air from the unit top/back and delivering it on the same side.
See material specification on *table D.1*





Enclosure D - Accessories

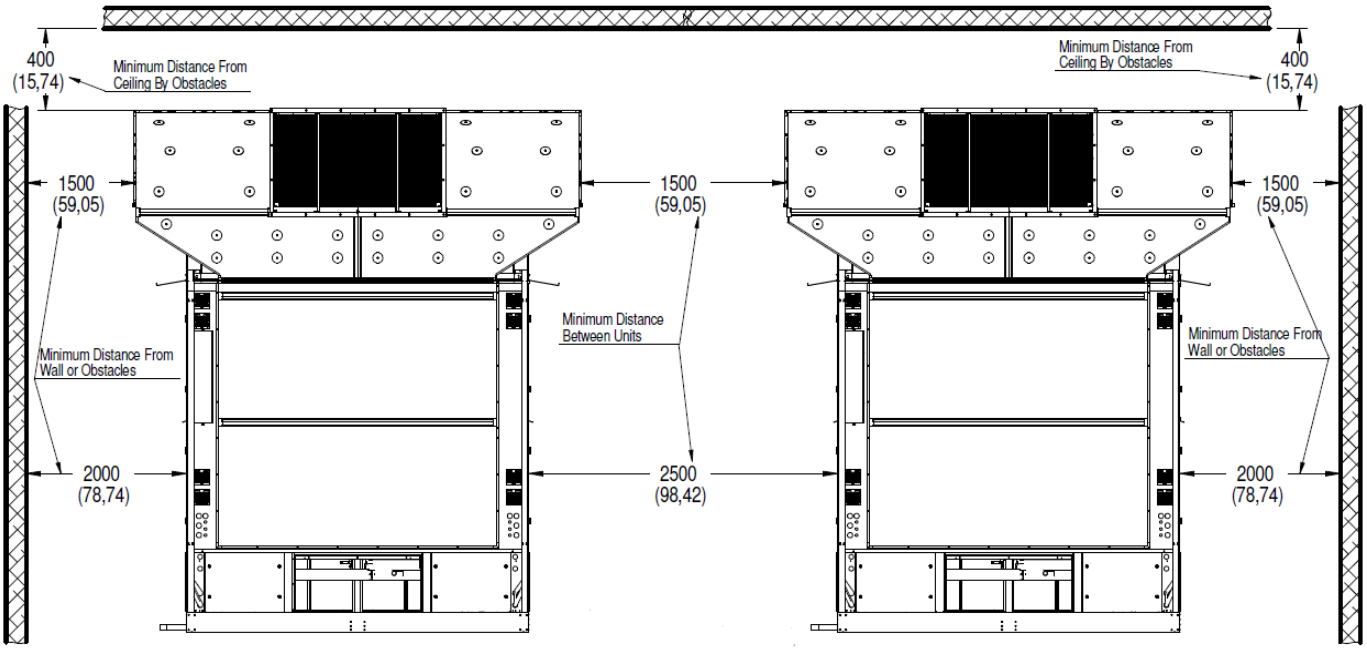
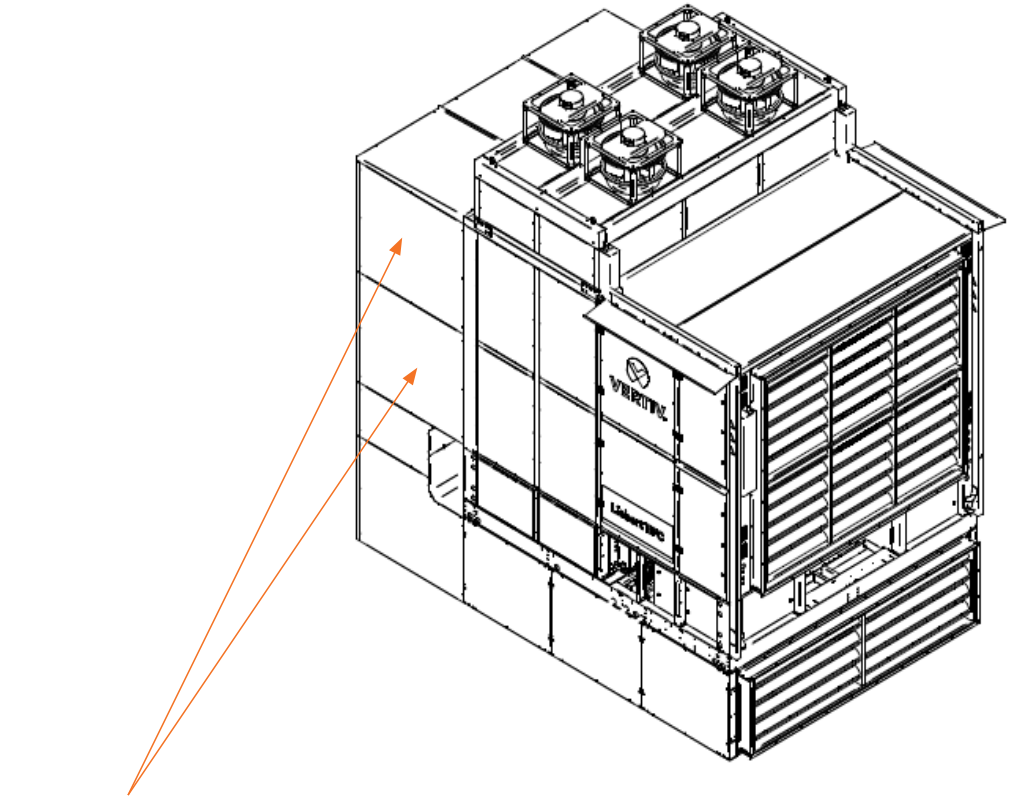


Table D.1 - Ducting material specification

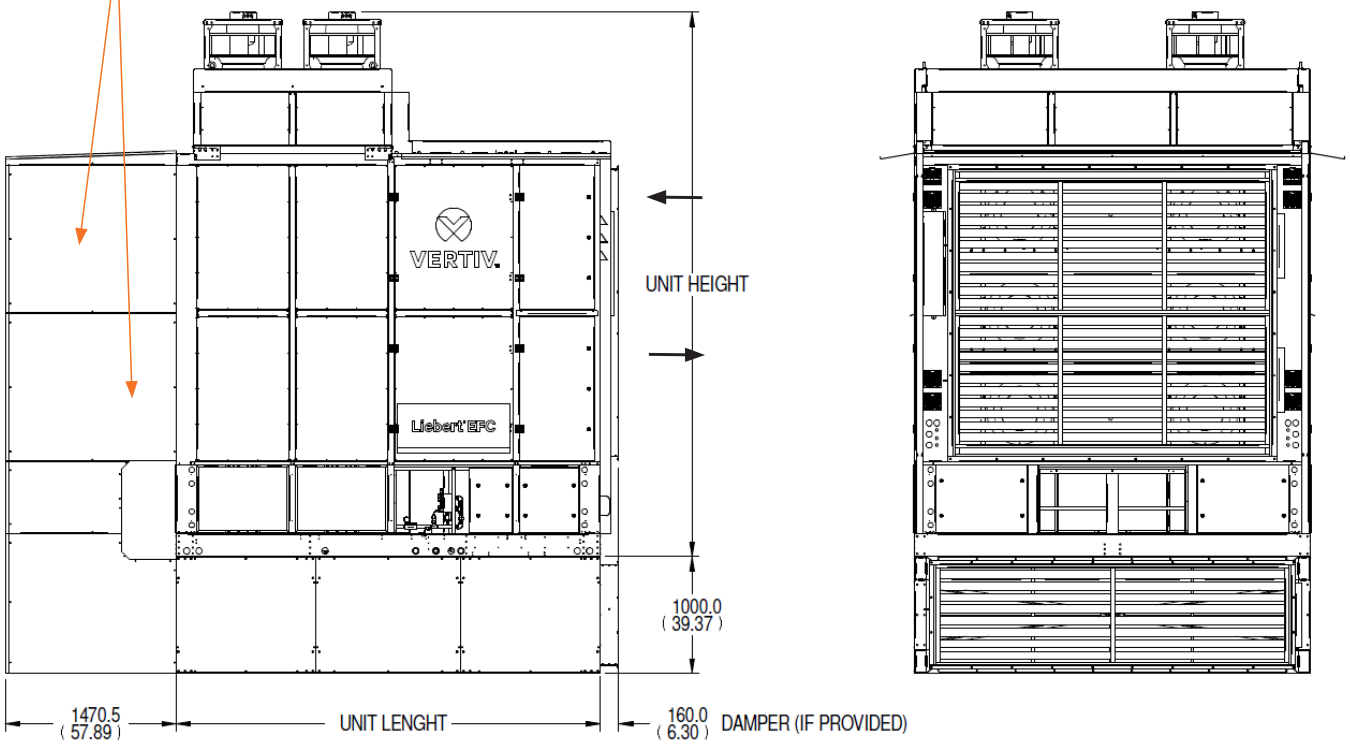
TOP SUCTION DUCTING MATERIAL TECHNICAL SPECIFICATION:	
MATERIAL NAME	19HV30S PIRAL HD HYDROTEC PANEL TSC
DESCRIPTION	Sandwich panel of 30.5 mm thickness made of an insulation component in rigid polyurethane foam coated with 500 micron thick embossed aluminium on one side (external) with 80 micron thick smooth aluminium on the other side (internal), suitable for outdoor installation in a temperature range from -30°C to +65°C in continuous operation.
INSULATING MATERIAL CHARACTERISTICS	The insulating material is foamed using as expanding agent only water and therefore it doesn't contain CFC, HCFC, HFC and HC. The density of the PUR foam is of 48 kg/m³, the initial thermal conductivity, measured according to the ISO 8302 standard, is 0,024 W/(mK)
THERMAL CONDUCTIVITY	The foam of the panel has measured at the average temperature of 10°C (high percentage of closed cells, exceeding 95%)
LEAKAGE RATE	The duct system (panels, flanges, sealing) has a leakage rate class C as per UNI EN 13403 (max leakage rate: 0.22 [l/(s*m²)] @ -750 [Pa], 0.15 [l/(s*m²)] @ +400 [Pa], 0.27 [l/(s*m²)] @ +1000 [Pa], 0.42 [l/(s*m²)] @ +2000 [Pa].

D.2 - BASE PLENUM DUCTING

A base plenum accessory is available to allow perimeter configuration. A steel frame is provided to keep a duct made by sandwich panel with an insulation material below the unit, to allow delivering the air from the unit bottom/front and sucting it on the same side. The insulation material is a closed cell, chemically cross-linked polyolefin resin foam (th. 20 mm) covered with aluminium (th. 50 um), thermal conductivity is 0.04 W/mK.



Removable panels for probes access



Enclosure D - Accessories

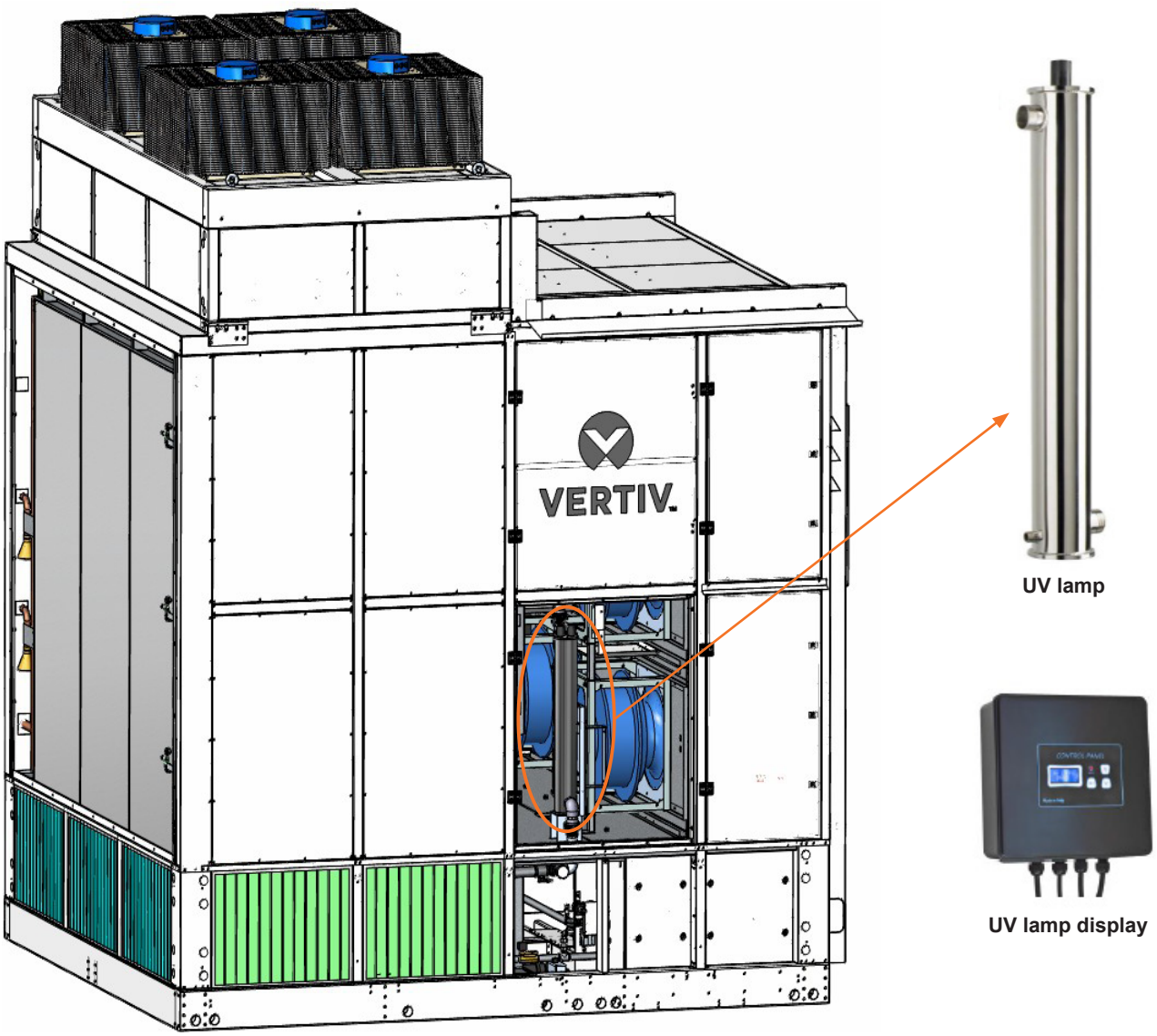
D.3 - UV LAMP

An UV lamp can be provided upon request to mitigate the harmful bacteria and viruses proliferation in recirculated water by a physical principle which is the output of ultra-violet irradiation.

The UV light given out by special mercury vapours lamps (UV-C rays lambda = 254 nm) is highly germicidal because it interacts at a molecular level by interfering with the development of every kind of micro-organism.

If the water to be treated contains sulphydric acid or more than 0.3 p.p.m. of iron or filtrable solids, once passed through the sterilizer, it leaves a residual sediment on the quartz sleeve, which, therefore, must be periodically cleaned (the frequency depends on the quantity and quality of water treated).

Refer to UV lamp manual for specific use and maintenance.

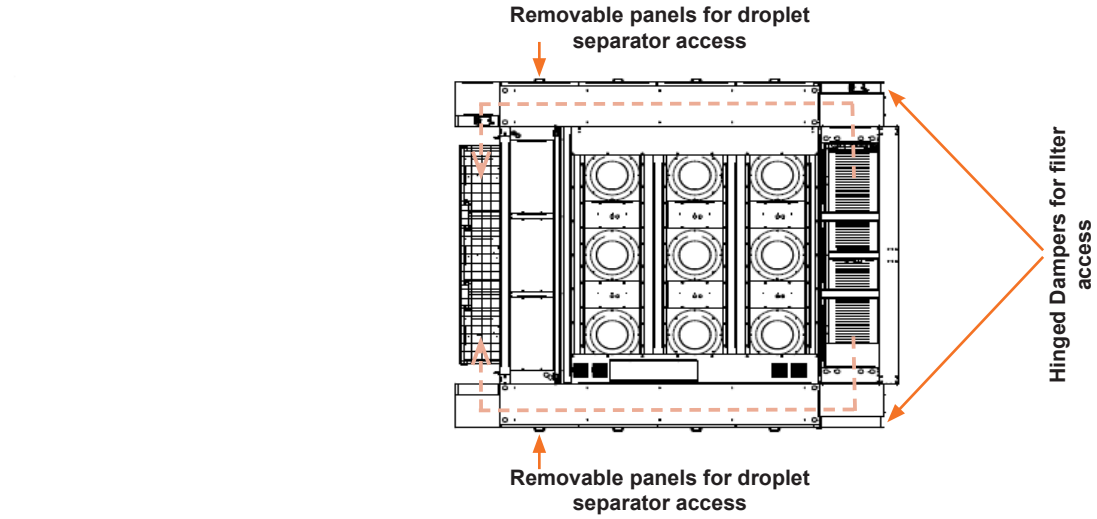


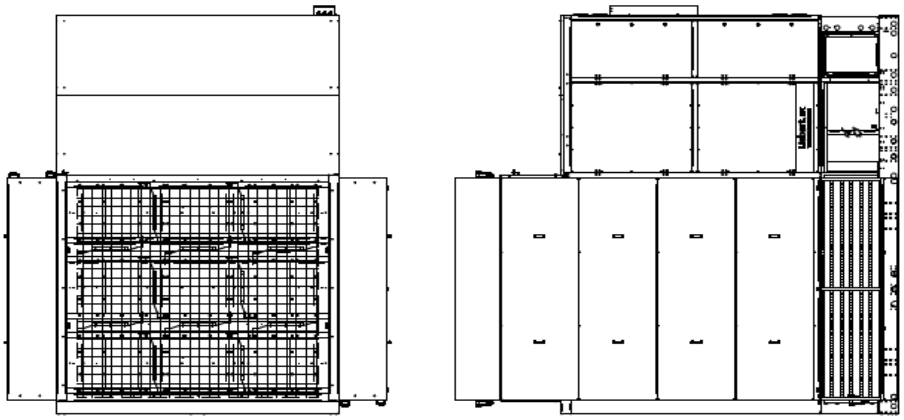
Whilst UV systems and the mitigation bacteria cycle (also known as anti-legionella cycle) can greatly reduce the risk of dangerous microbiological growth, it is still the responsibility of the end user to make sure local regulations are being followed and the system is safe. In particular, water should be regularly tested and if needed, treated to either control the growth of legionella (and other microorganisms) or limit their ability to grow.

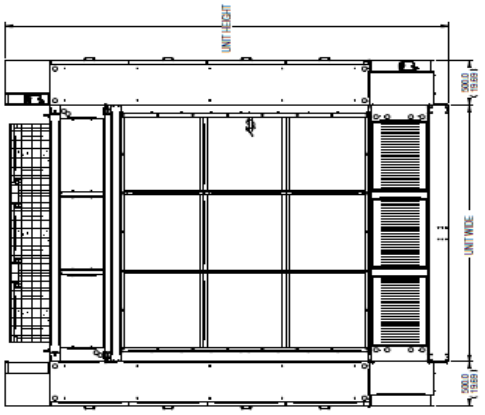
Enclosure D - Accessories

D.4 - LOW TEMPERATURE KIT

In case of extreme low temperature, a low ambient kit is available to recirculate part of the exhaust air discharged on the external side (hot) on the unit external side inlet



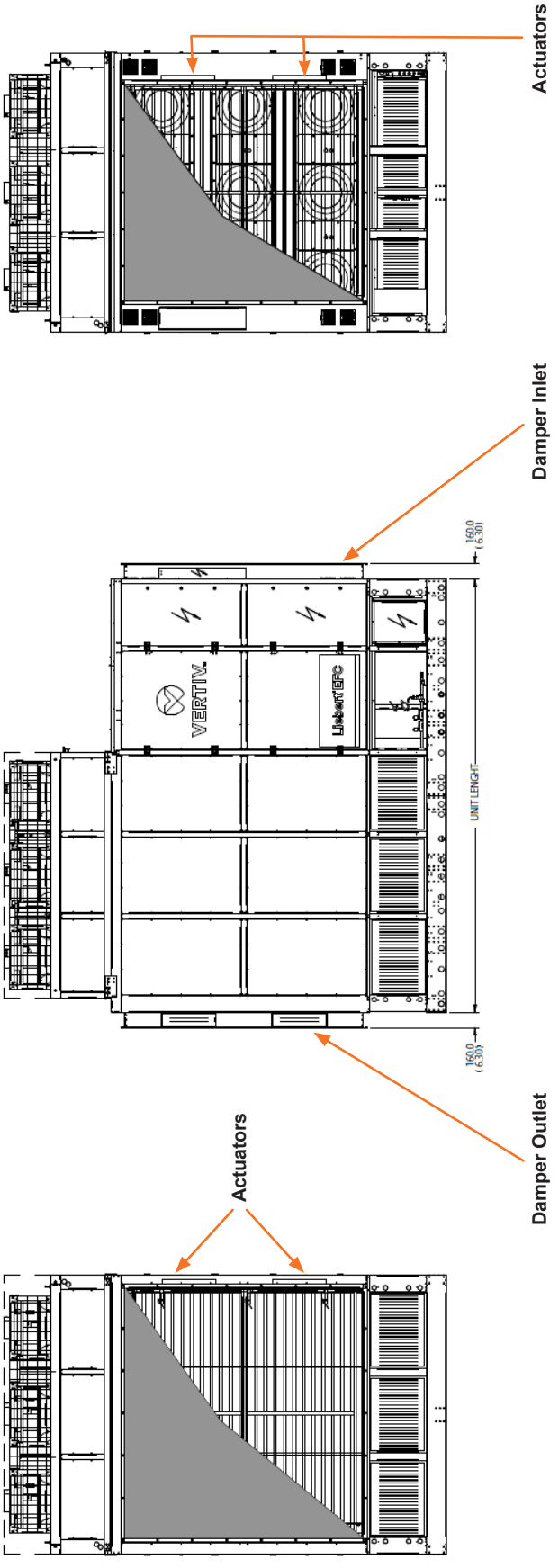




Enclosure D - Accessories

D.5 - DAMPERS

Dampers are available to close the datacenter air inlet/outlet side to allow unit isolation/maintenance in case of other units connected on the same main duct.



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