

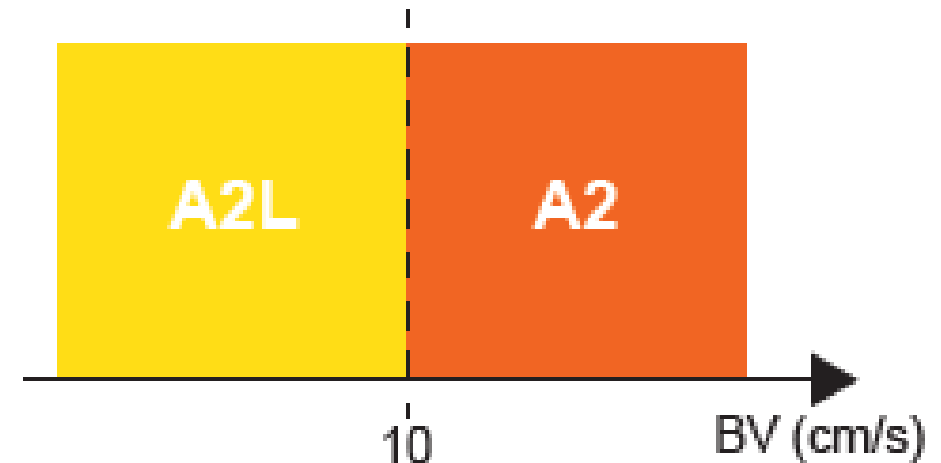
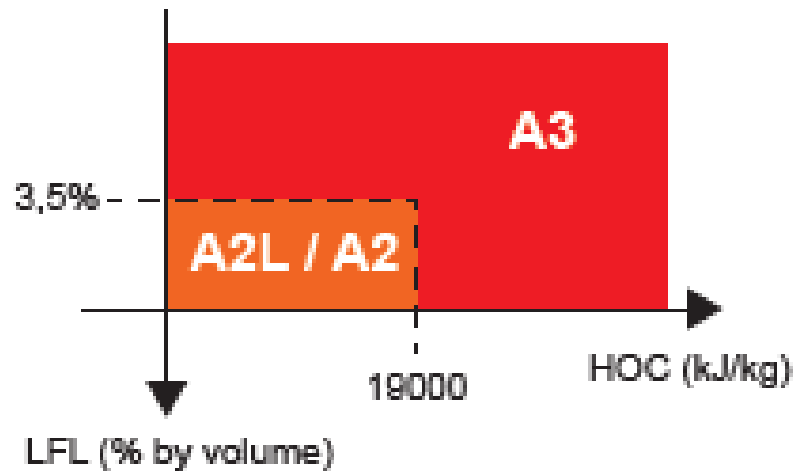


Application of A2L refrigerants in split air-to-air systems from the safety point of view



What is an A2L refrigerant?

- A2L means a non-toxic mildly-flammable refrigerant.
- the parameters which identify an A2L refrigerant are the **LFL** (lower flammability limit) , the **HOC** (heat of combustion) and the **BV** (burning velocity)



What is an A2L refrigerant?



GWP	677 (AR5)
ISO 817 Classification	A2L
PED group	1
Type	Pure gas
Glide	No
LFL [kg/m ³]/[%vol]	0,307/14,4
BV [cm/s]	6,7
HOC [kJ/kg]	9500
RCL [kg/m ³]	0,061
QLMV [kg/m ³]	0,063
QLAV [kg/m ³]	0,15

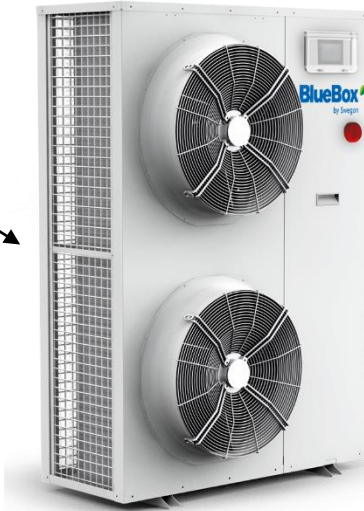
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What is a split air-to-air system?

- It consists of **2 separate units** , connected by **refrigerant piping**
- It's used to **heat/cool the air** using **external air as source**
- It can be used in a **wide range of applications**:
 - ❑ IEQ → AHU with integrated DX coil , combined with a remote (reversible) condensing unit
 - ❑ IT Cooling → Air cooled CRAC
 - ❑ Residential and Commercial cooling and heating (split and VRF systems)

Application – Air handling Units

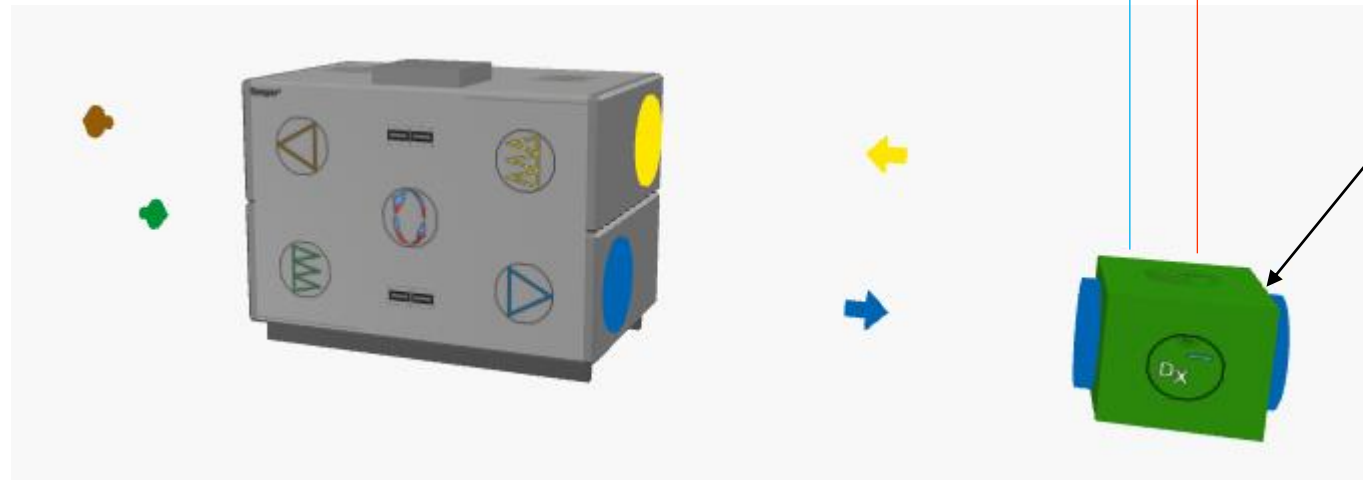
Component 1 :
(Reversible)
Condensing unit
EPSILON Sky



Component 2 :
Coil
(evaporator/condenser)
installed in AHU duct



Refrigerant piping



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Application – IT Cooling

Component 1 :
Condensing unit
EPSILON Sky



Component 2 :
CRAC – Coil
(evaporator) in
unit



Refrigerant piping

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Which are the benefit of split systems?

- Low installation cost
- Flexibility/Scalability
- Water(glycol)-free design
- mid-term availability according approved F-Gas revision (R32 will be banned on split air-to-air systems with rated capacity under 12 kW starting from 2029 and over 12 kW starting from 2033)

FIRST STEP

Years	Capacity	Product Type	Limit
2027	< 12 kW	Split Air to Water	GWP 150 with safety exception (no limits)
2029	< 12 kW	Split Air to Air	GWP 150 with safety exception (no limits)
2029	> 12 kW	All Split	GWP 750 with safety exception (no limits)

SECOND STEP

Years	Capacity	Product Type	Limit
2033	> 12 kW	All Split	GWP 150 with safety exception (no limits)
2035	< 12 kW	All Split	NO F-Gas with safety exception (no limits)

Regulation framework : EN378

- EN378 - Refrigerating systems and heat pumps - Safety and environmental requirements
 - ☐ Part 1 (EN 378-1:2016+A1:2020) : Basic requirements, definitions, classification and selection criteria
 - ☐ Part 2 (EN 378-2:2016) : Design, construction, testing, marking and documentation
 - ☐ Part 3 (EN 378-3:2016+A1:2020) : Installation site and personal protection
 - ☐ Part 4 (EN 378-4:2016+A1:2019) : Operation, maintenance, repair and recovery

R32 is “A2L” refrigerant . Compared to “A1” R410A , this impacts on:

- installation assessment concerning surrounding space, maintenance etc. Generally, it is the responsibility of the installer to carry out a **flammability risk assessment and a classification of the danger zone at the site of installation**, as required by standard EN378-3.
- **minimum area/volume of occupied space** (calculation according to EN378-1)

EN378-1 : Installation sites classification

The installation site (where the unit/system is installed), can be classified (section 5.3):

Class I: mechanical equipment in occupied spaces (laundry, garage, living room, public closed spaces ...)

Class II: compressors and pressure vessels outdoor or in machinery room and the rest of the unit into an occupied space.

Class III: Outdoor or Machinery Room (MR). Both requires additional provision to be respected.

Class IV: ventilated enclosure. The refrigerant circuit is installed into a box that aspires the air from the room where the box is installed and discharge the «exhaust» air outdoor trough a dedicated and insulated duct.

The access categories define the skill of the people than can access a specific area (into buildings or outdoor) from safety point of view (section 5.1):

General Access (a): for example, theaters, schools, hotels, hospitals, ... Everybody can go in there.

Supervised Access (b): for example, Business or professional offices, laboratories, ... Everybody can go in there but together with people instructed about safety.

Authorized Access (c): Manufacturing facilities, e.g., for chemicals, food, beverage, ice, ice-cream, refineries, ... Only authorized and instructed people about safety can go in there.

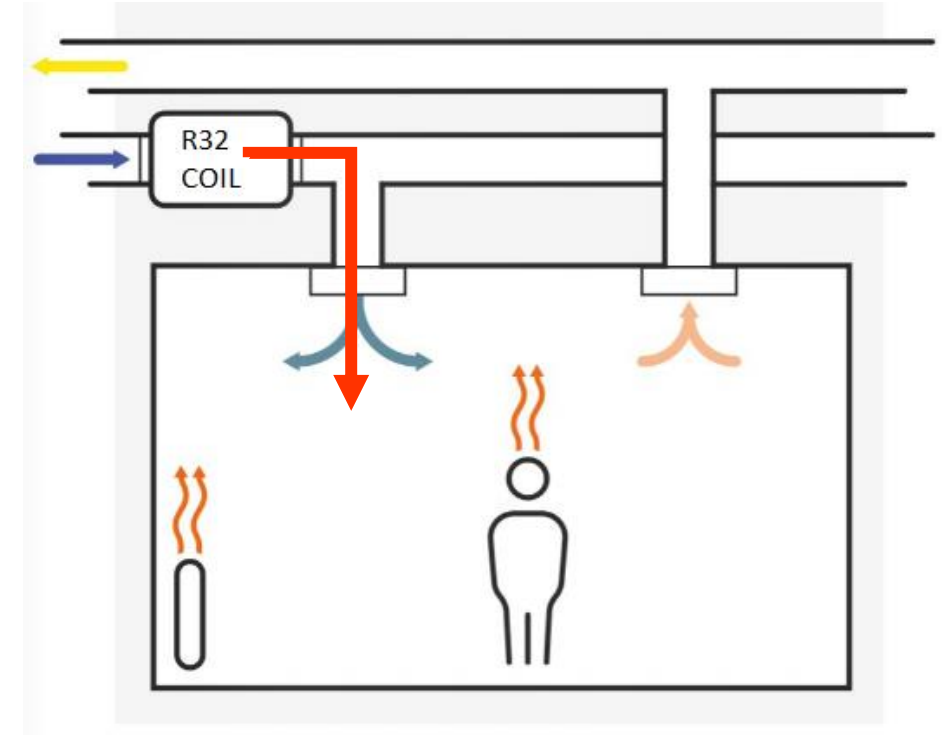
EN378-1 : Installation sites classification

Direct Systems

- The evaporator, condenser or gas cooler of the refrigerating system is in direct contact with the air or the substance to be cooled or heated.
- A ducted system is classified as a direct releasable system if the conditioned air is in direct contact with refrigerant-containing parts of the circuit and the conditioned air is supplied to an occupied space. Direct ducted systems are considered to be located in location class I or II.



Air to air systems are classified as direct releasable systems according to EN378-1 so they are classified either location I or II.



EN378-1 : Charge limits

- With R410A only “toxicity A” of refrigerant was taken account for calculate the refrigerant charge limits requirements and generally the limit was 0,42 kg/m³ for occupied space;
- For A2L refrigerant , charge limits are the smallest resulting from toxicity and flammability limits , but flammability restrictions are most of the times more tightening than toxicity ones;
- With R32 , both “toxicity A” and “mild flammability 2L” need to taken account and this increase restriction in terms of minimum volume needed;
- R32 toxicity limit it's 0,30 kg/m³

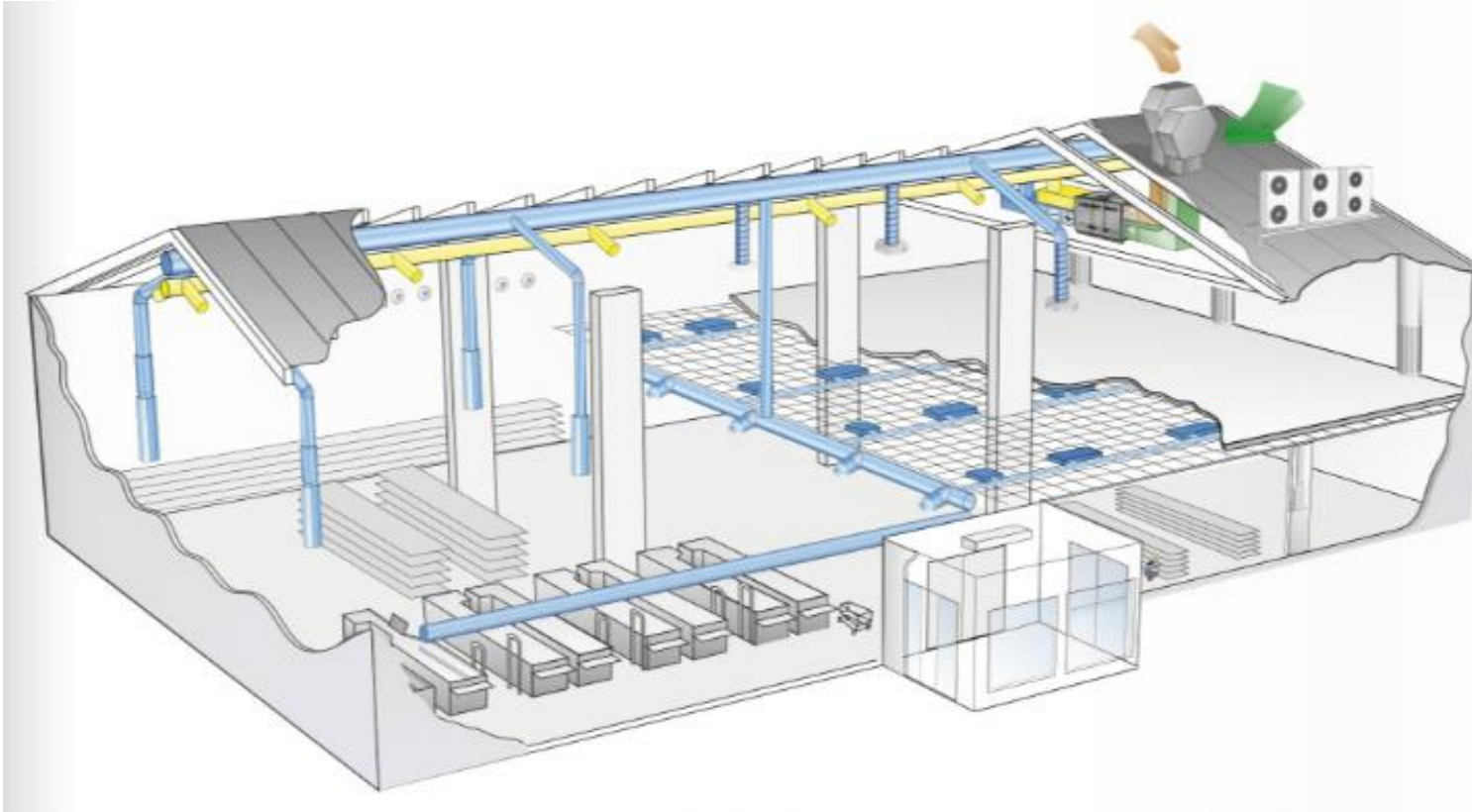
EN378-1 : Charge limits based on flammability (A2L refrigerants)



Access Category		Location classification					
		I		II		III	IV
a	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$				No charge restriction	$m_3 \times 1,5$
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$					
b	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$					
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$				
c	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$					
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$				
	<1person per 10m ²	20 % x LFL x Room volume and not more than 50 kg or According to C.3 and not more than $m_3 \times 1,5$	No charge restriction				

$m_2 = 26m^3 \times LFL$, $m_3 = 130m^3 \times LFL$

Application - Air Handling Units



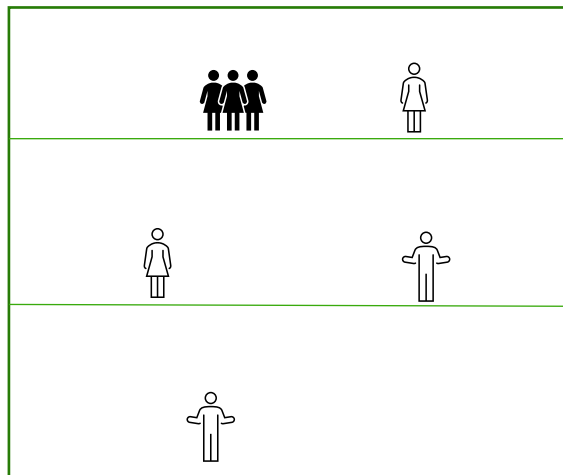
- AHU installation classification
- Estimation of refrigerant charge of the system
- Check of compliance with EN378-1 limitations for refrigerant charge

The analysis of the building area/volume and of the AHU installation becomes even more important when using A2L refrigerant compared to traditional systems using R410A.

Installation classification

The responsibility to carry out a flammability risk assessment and a classification of the danger zone as required by EN378-3 is up to the installation responsible. Refer to EN378-3 for prescriptions regarding open air installation and machinery room installation

System in OPEN AIR – EPSILON Sky and AHU (COIL) in OPEN AIR

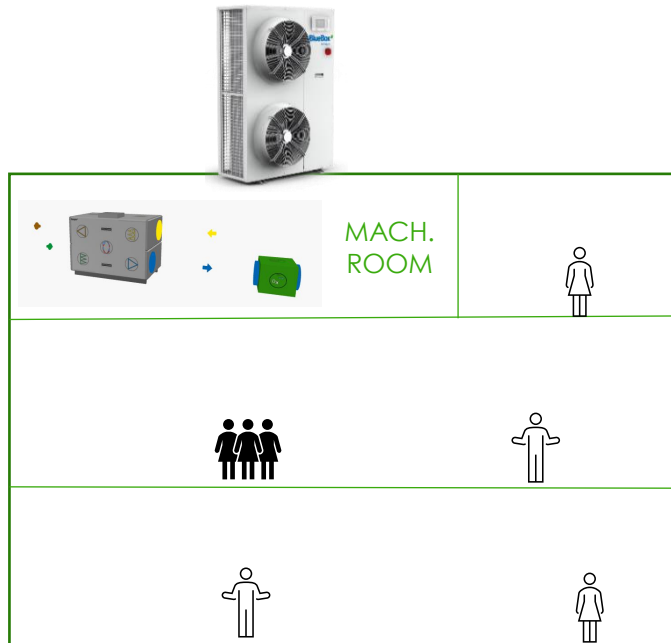


Epsilon + AHU are classified as “direct ducted system” so installation class according to EN378-1 is **class II**.

(A leak in the coil will cause direct leak of refrigerant in occupied space since coil is installed in air supply duct)

Installation classification

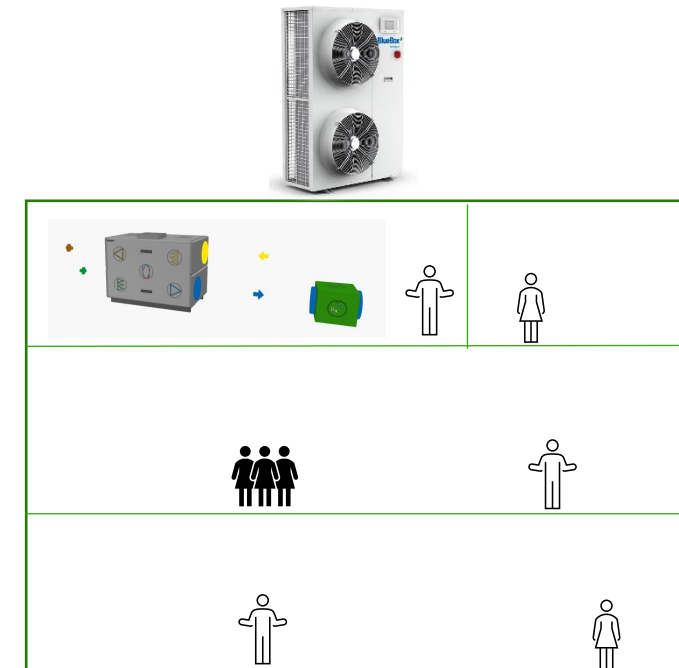
EPSILON SKY in OPEN AIR
AHU (COIL) in MACHINERY ROOM



AHU (COIL) IN MACHINERY ROOM:

Machinery room installation shall comply with EN378-3 , with specific requirements for A2L refrigerants . Installation responsible must evaluate carefully the risk

EPSILON SKY in OPEN AIR
AHU (COIL) in OCCUPIED SPACE



AHU (COIL) IN OCCUPIED SPACE

Installation of AHU in occupied space shall be evaluated carefully ; **the space where AHU is installed must respect minimum area/volume requirements according to EN378-1**

How to calculate system charge?

- Calculation of refrigerant charge of the system is basic to evaluate flammability limits
- Let's consider a real life example to see how to proceed ; we have to sum the charge of Epsilon Sky , remote coil and interconnecting pipes

EPSILON SKY Hi LE R7

			6	12	18	24	30	36	45
Cooling									
Refrigeration capacity	(1)	kW	7.75	11.62	19.8	24.95	33.23	37.88	46.66
Total absorbed power	(1)	kW	2.32	3.63	6.15	7.58	10.26	12.11	16.41
EER	(1)		3.35	3.2	3.22	3.29	3.24	3.13	2.84
Compressors									
Compressors/Circuits		n°	1/1						
Minimum capacity reduction step	(7)	%	26	24		30	24		20
Refrigerant charge CH (Cu/Al)	(3)	kg	1.7	2.6	3.1	4.2	4.6		4.8
Fans									

EPSILON Sky Hi LE 45

Factory pre-charge = 4,8 kg

Data from EPSILON Sky
technical catalogue

How to calculate system charge?

Connecting pipe
Maximum lenght = 30 m
Suction gas (d= 28 mm) →
Estimated charge = 0,013*30 =
0,39 kg
Two phase mix (d = 16 mm) →
Estimated charge = 0,017*30 =
0,51 kg

Model	Equivalent length 10 m		Equivalent length 20 m		Equivalent length 30 m	
	Gas	Flash/Liquid	Gas	Flash/Liquid	Gas	Flash/Liquid
6	12	10	12	10	-	-
12	14	10	14	10	-	-
18	16	12	16	12	18	12
24	18	12	18	12	22	12
30	22	16	22	16	22	16
36	22	16	22	16	22	16
45	22	16	22	16	28	16

Diameter (mm)	Gas intake (kg/m)	Gas delivery (kg/m)	Liquid (kg/m)	two-phase mix (kg/m)
10	0,002	0,003	0,046	0,006
12	0,003	0,005	0,071	0,009
16	0,004	0,009	0,138	0,017
18	0,006	0,011	0,181	0,022
22	0,009	0,017	0,282	0,034
28	0,013	0,027	0,432	0,053

Data from EPSILON Sky user manual

How to calculate system charge?



EPSILON Sky Hi LE 45

Factory pre-charge = 4,8 kg

+

Connecting pipe

Maximum lenght = 30 m

Suction gas (d= 28 mm) →

Estimated charge = $0,013 \times 30 = 0,39$ kg

Two phase mix (d = 16 mm) →

Estimated charge = $0,017 \times 30 = 0,51$ kg

+

Remote Coil

Maximum suggested volume = 7,5 liters

Estimated charge = volume * 0,25 = 1,88 kg

=

Estimated total system charge = $4,8 + 0,39 + 0,51 + 1,88 = 7,58$ kg

Note: the final charge may differ slightly according to the necessary adjustments during start-up

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How to calculate system charge?

As a side note it is important , when planning the layout of the refrigerant interconnecting piping , to limit the piping size to DN25 (for copper pipes this corresponds to outer diameter 28 mm).

In this way , the piping will remain under Article 4.3 ; otherwise , a site pressure test at 1.1 times the design pressure will be needed (see EN378-2 and EN 14276-2). For EPSILON Sky design pressure is 45 bar so test should be performed at 49,5 bar.

Limitation on piping diameter has a direct effect on the limitation of the heating/cooling capacity of the system which results to be in the range of 40-50 kW.

Model	Equivalent length 10 m		Equivalent length 20 m		Equivalent length 30 m	
	Gas	Flash/Liquid	Gas	Flash/Liquid	Gas	Flash/Liquid
6	12	10	12	10	-	-
12	14	10	14	10	-	-
18	16	12	16	12	18	12
24	18	12	18	12	22	12
30	22	16	22	16	22	16
36	22	16	22	16	22	16
45	22	16	22	16	28	16

For EPSILON Sky the pipe outer diameter is maximum 28 mm

Check compliance with charge limits



Access Category		Location classification			
		I	II	III	IV
a	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$		No charge restriction	$m_3 \times 1,5$
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
b	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$		
c	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$		
	<1person per 10m ²	20 % x LFL x Room volume and not more than 50 kg or According to C.3 and not more than $m_3 \times 1,5$	No charge restriction		

$m_1 = 4m^3 \times LFL$, $m_2 = 26m^3 \times LFL$, $m_3 = 130m^3 \times LFL$

Check compliance with charge limits

- Calculation according to section C.2
- Cap for charge is $m_2 \times 1,5$ which for R32 is $26\text{m}^3 \times \text{LFL} \times 1,5 \rightarrow 11,97 \text{ kg}$
- Under $m_1 \times 1,5$ which for R32 is $4\text{m}^3 \times \text{LFL} \times 1,5 \rightarrow 1,84 \text{ kg}$

$$A_{\min} \geq \frac{m^2}{(2,5 \cdot \text{LFL}^{5/4} \cdot h_0)^2}$$

$$V_{\min} \geq A_{\min} \cdot h$$

$A_{\min}$ = minimum required area [m^2]
 m = refrigerant charge amount [kg]
 LFL = Lower flammability limit [kg/m^3]
 h_0 = height factor of the appliance [m]
 h = room height [m]

$m_1 = 4\text{m}^3 \times \text{LFL}$, $m_2 = 26\text{m}^3 \times \text{LFL}$, $m_3 = 130\text{m}^3 \times \text{LFL}$

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Check compliance with charge limits

Air diffusers position influences the calculation of minimum area

If air diffusers are at ceiling level, charge limitations are less tightening.



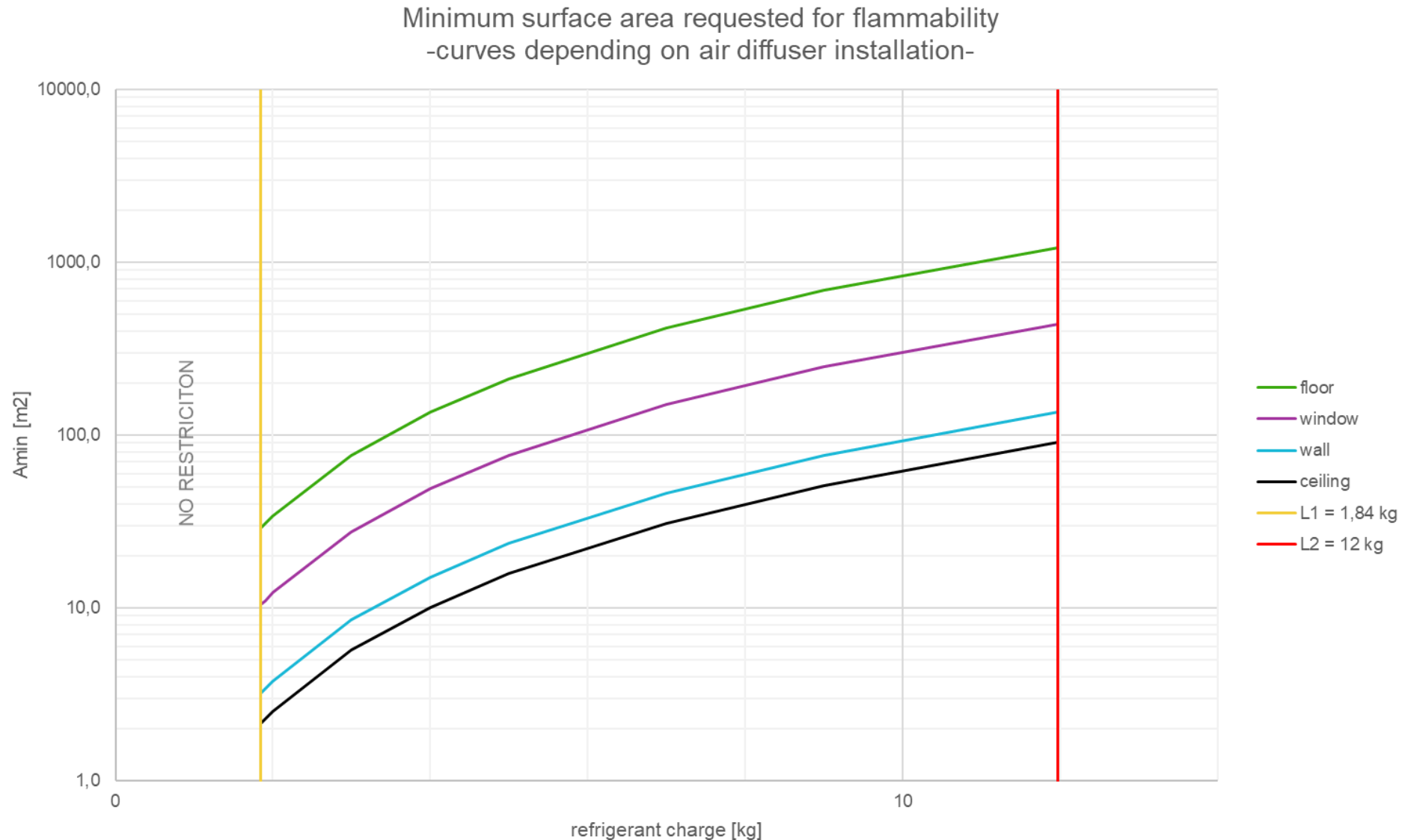
Ceiling $\rightarrow h_0 = 2,2 \text{ m}$



Floor $\rightarrow h_0 = 0,6 \text{ m}$

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Check compliance with charge limits



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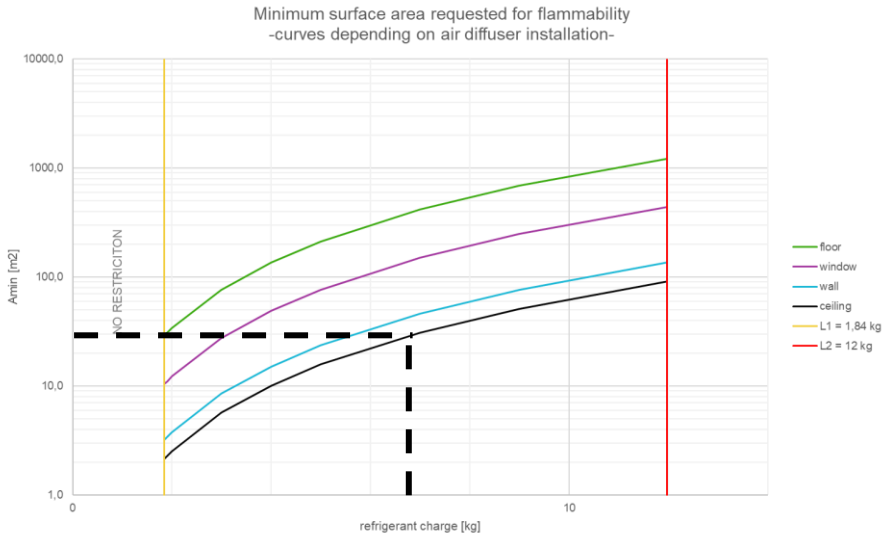
Check compliance with charge limits



EXCEL TOOL FOR QUICK AND EASY ESTIMATION

	Fill in Blue Cells
What is the location classification ?	Class II
What is the access category ?	a-general access
What is the scope of the refrigeration system?	Human confort
What is the refrigerant used by the refrigeration system?	R32
EPSILON Sky Model	45
Is the EPSILON Sky unit cooling (LE) or reversible (LE HP)	LE
Connection pipe lenght [m]	30,0
Remote coil volume [l]	7,5
What is air diffusers position?	Ceiling

ESTIMATED TOTAL SYSTEM REFRIGERANT CHARGE [kg]	6,78
Is the refrigerant charge acceptable?	YES
MINIMUM AREA REQUIREMENT [m ²] Occupancies except those on the lowest underground floor of the building	29,1
MINIMUM AREA REQUIREMENT [m ²] Occupancies on the lowest underground floor of the building	29,1



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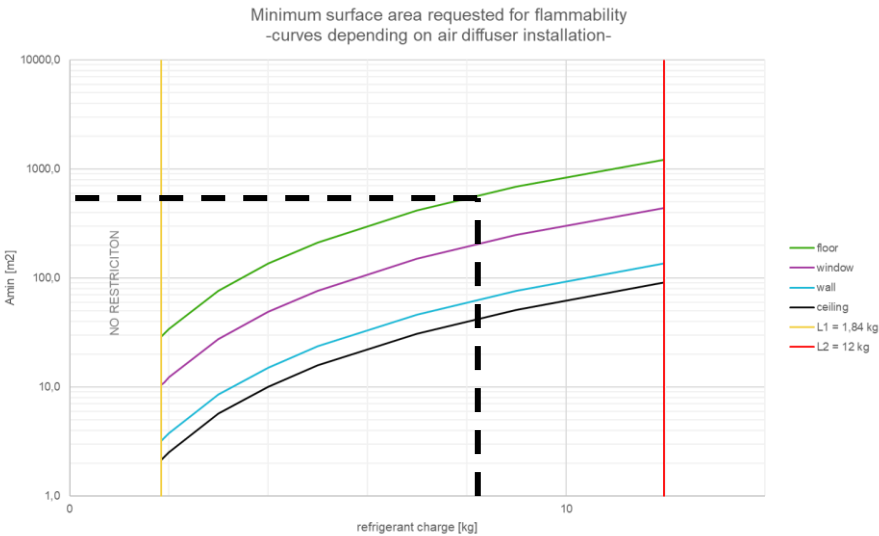
Check compliance with charge limits



EXCEL TOOL FOR QUICK AND EASY ESTIMATION

	Fill in Blue Cells
What is the location classification ?	Class II
What is the access category ?	a-general access
What is the scope of the refrigeration system?	Human confort
What is the refrigerant used by the refrigeration system?	R32
EPSILON Sky Model	45
Is the EPSILON Sky unit cooling (LE) or reversible (LE HP)	LE HP
Connection pipe lenght [m]	30,0
Remote coil volume [l]	7,5
What is air diffusers position?	Floor

ESTIMATED TOTAL SYSTEM REFRIGERANT CHARGE [kg]	8,25
Is the refrigerant charge acceptable?	YES
MINIMUM AREA REQUIREMENT [m ²] Occupancies except those on the lowest underground floor of the building	579,0
MINIMUM AREA REQUIREMENT [m ²] Occupancies on the lowest underground floor of the building	579,0



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Check compliance with charge limits



EXCEL TOOL FOR QUICK AND EASY ESTIMATION

	Fill in Blue Cells	Warning/Message	
What is the location classification ?	Class II		Class II: compressors and pressure vessels outdoor or in machine room where Class III: mechanical Air to air systems are classified as direct releasable
What is the access category ?	a-general access		General Access (a): for Supervised Access (b): for example, Business or pro Authorized Access (c): Manufacturing facilities, e.g., for ch
What is the scope of the refrigeration system?	Human confort		
What is the refrigerant used by the refrigeration system?	R32		
EPSILON Sky Model	6		
Is the EPSILON Sky unit cooling (LE) or reversible (LE HP)	LE		
Connection pipe lenght [m]	25,0	PIPE EXCEEDS MUST ACCEPTABLE LENGHT-TRY WITH SHORTER PIPE LENGHT	
Remote coil volume [l]	4,0	VOLUME IS TOO BIG ,USE A SMALLER VALUE	Maximum lenght for connection piping is 20m for EPSILON S According to EPSILON Sky model , the volume of remote coil EPSILON Sky 6 : 2,4 l EPSILON Sky 12 : 3,5 l EPSILON Sky 18 : 4,5 l EPSILON Sky 24 : 5,7 l EPSILON Sky 30-36-45: 7,5 l

Warnings, messages and notes to help the input and output handling

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Calculation of minimum volume of occupied space

EN378-1 Section 7

Guidelines for minimum volume calculations:

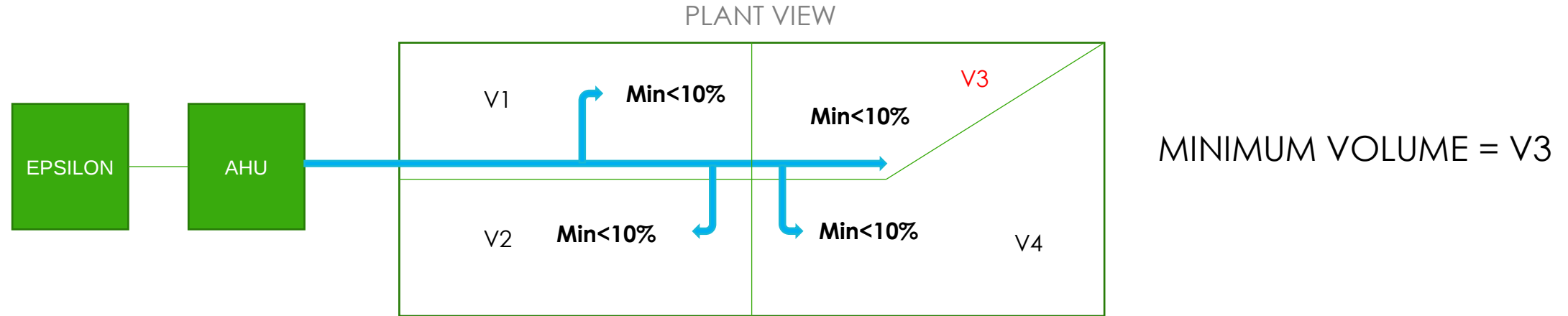
- *Where the evaporator or condenser is located in an air supply duct system serving multiple spaces, the volume of the smallest single space shall be used. (**SEE CASE A**)*
- *If the air flow to a space cannot be reduced to less than 10 % of the maximum air flow by the use of an air flow reducer, then that space shall be included in the volume of the smallest human occupied space. (**SEE CASE B**)*
- *Multiple spaces that have appropriate openings (which cannot be closed) between the individual spaces or are connected with a common ventilation supply, return or exhaust system not containing the evaporator or the condenser shall be treated as a single space. (**SEE CASE C,D**)*
- *Where the evaporator or condenser is located in an air supply duct system and the system serves an unpartitioned multi-storey building, the occupied volume of the smallest occupied storey of the building shall be used. (**SEE CASE E**)*

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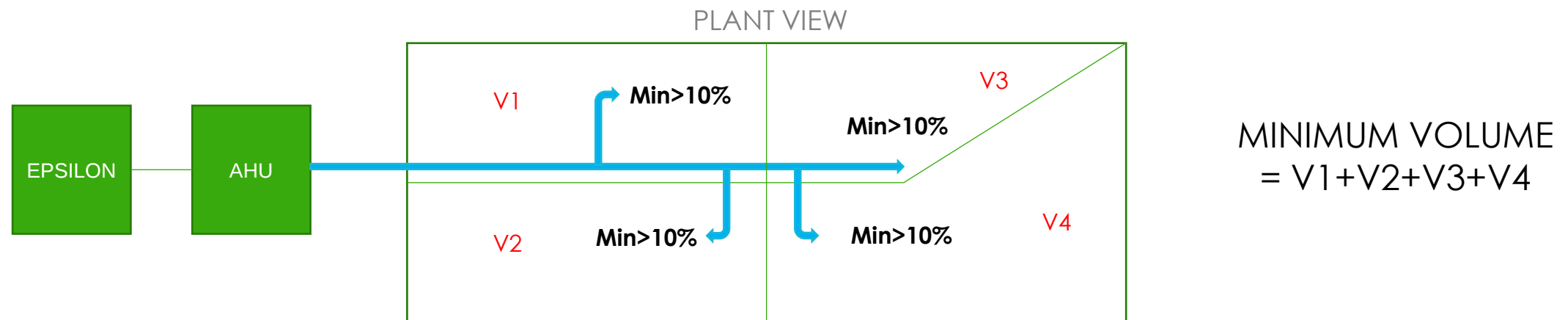
Calculation of minimum volume of occupied space

General rules of MINIMUM VOLUME CALCULATION for multiple occupied space-HUMAN COMFORT

- CASE A- Multiple occupied space with a minimum air flow **less than 10% of max flow**



- CASE B- Multiple occupied space with a minimum air flow **not less than 10% of max flow**

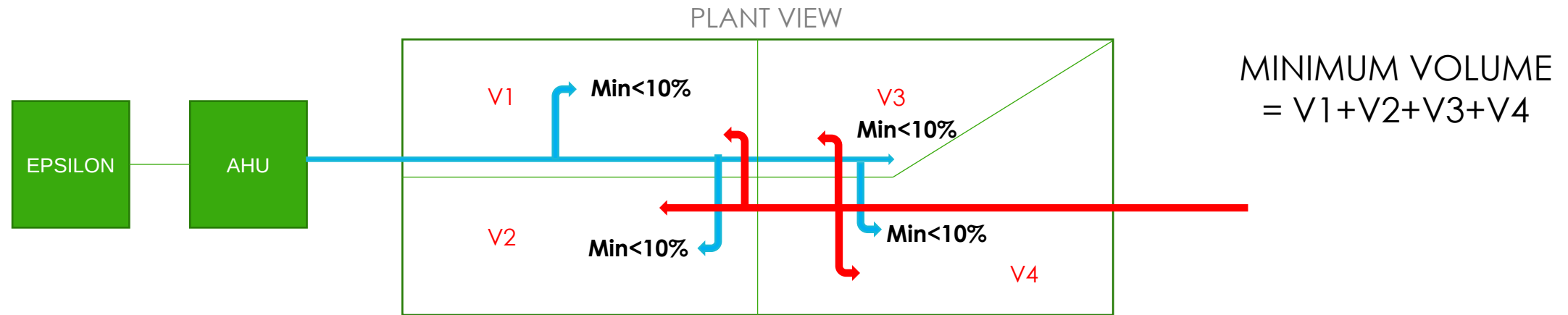


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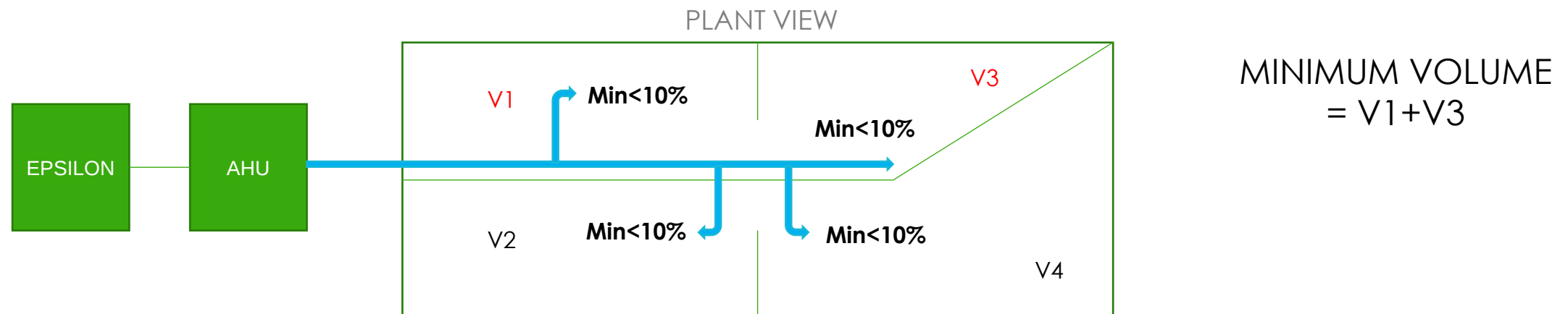
Calculation of minimum volume of occupied space

General rules of MINIMUM VOLUME CALCULATION for multiple occupied space-HUMAN COMFORT

- CASE C- Multiple occupied space with a common ventilation system **not containing the ref. HX**



- CASE D- Multiple occupied space with **opening between rooms** which cannot be closed

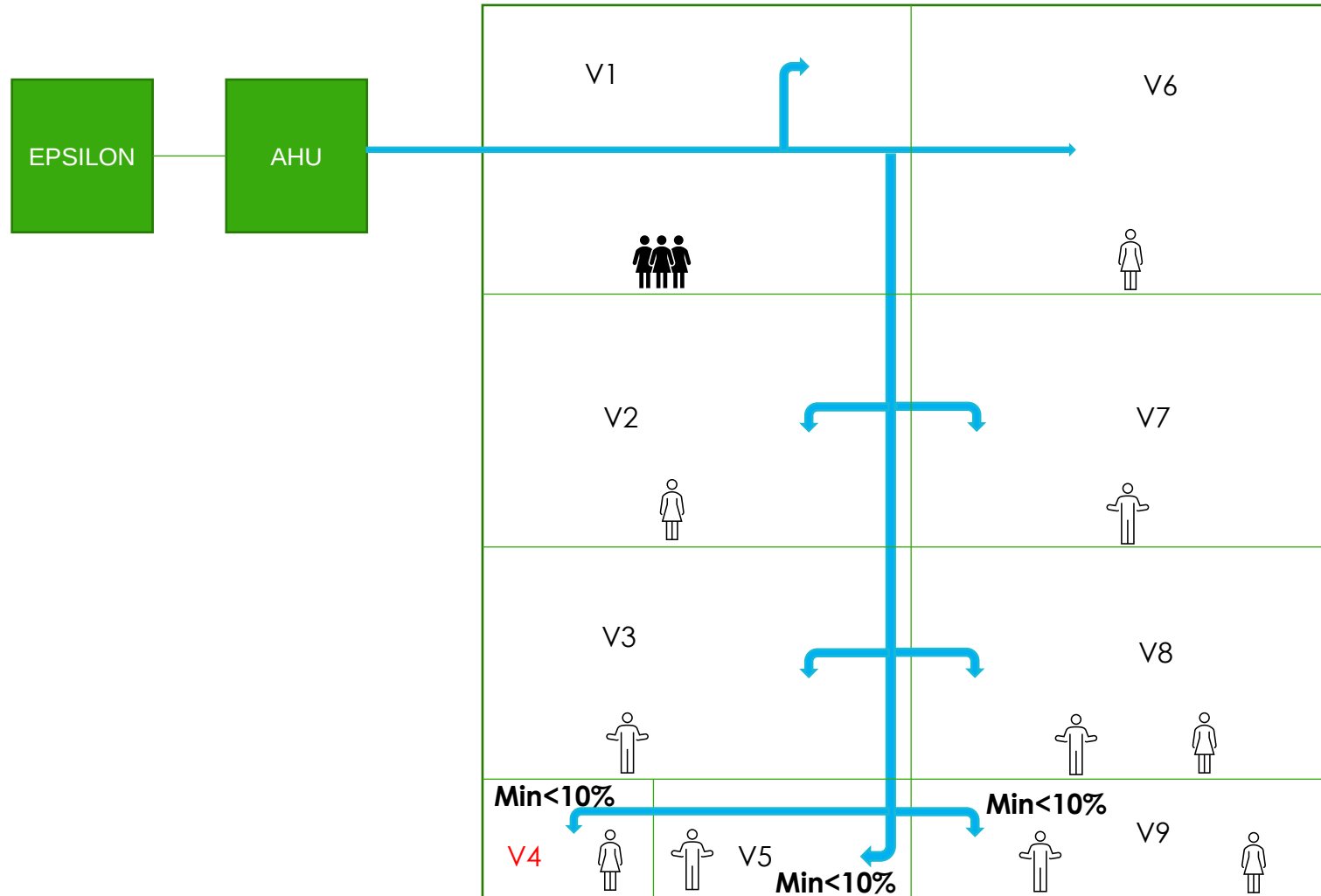


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Calculation of minimum volume of occupied space

General rules of MINIMUM VOLUME CALCULATION for multiple occupied space-HUMAN COMFORT

- CASE E- Multi storey building with unpartitioned duct system

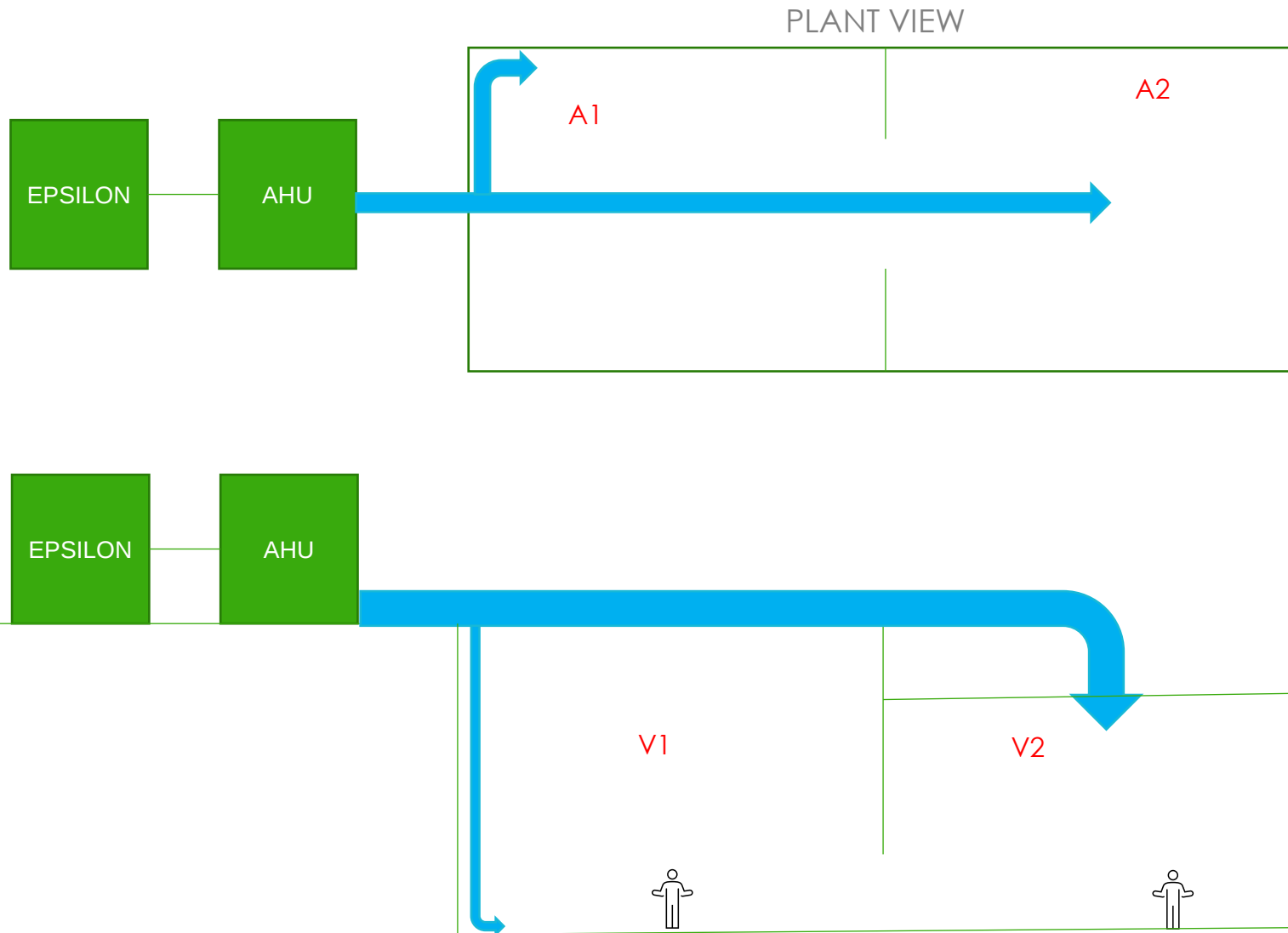


MINIMUM VOLUME
= V4

Combination of CASE E with
B,C or D are possible for single
storey

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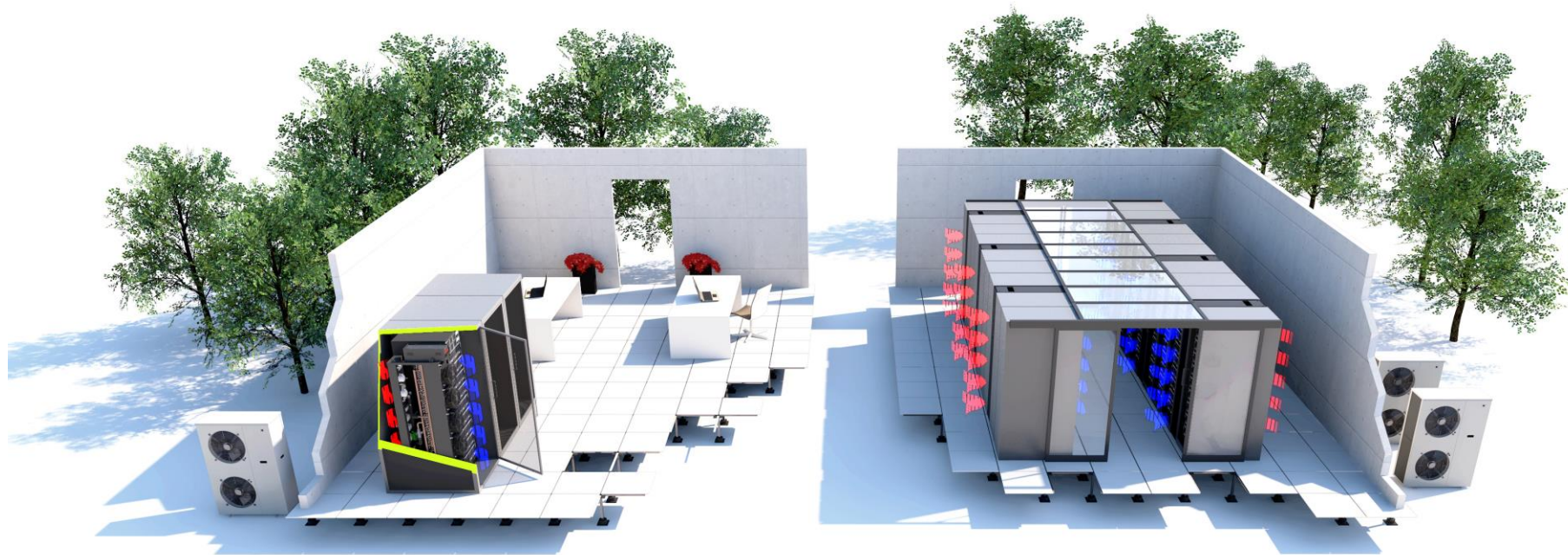
Example of application



- V1 (A1) and V2 (A2) are communicating with **opening between rooms** which cannot be closed
- In V1 terminals of air distribution are at floor level, in V2 at ceiling level
- We can calculate $A_{\min}$ with C.2 (see below) considering worse case (floor)
- When checking if $A_{\min}$ requirements is satisfied, we can sum A1 with A2 and check if $A1+A2$ is $> A_{\min}$

$$A_{\min} \geq \frac{m^2}{(2,5 \cdot LFL^{5/4} \cdot h_0)^2}$$

Application – IT Cooling



Installation classification

EPSILON Sky in OPEN AIR
COOLBLADE/DATATECH Sky in
MACHINERY ROOM



EPSILON Sky in OPEN AIR
COOLBLADE/DATATECH Sky in
OCCUPIED SPACE



DATATECH/COOLBLADE can be installed either in a machinery room or in an occupied space .

Installation assessment must be performed by installation responsible.

From now on , we will focus on installation in occupied space.

Pay attention when planning the piping layout that , if piping pass through an occupied space , also that space shall comply with minimum volume requirement.

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Check compliance with charge limits



Access Category		Location classification			
		I	II	III	IV
a	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$		No charge restriction	$m_3 \times 1,5$
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
b	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$		
c	Human comfort	According to C.2 and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$			
	Other applications	20 % x LFL x Room volume and not more than $m_2 \times 1,5$ or According to C.3 and not more than $m_3 \times 1,5$	20 % x LFL x Room volume and not more than 25 kg or According to C.3 and not more than $m_3 \times 1,5$		
	<1person per 10m ²	20 % x LFL x Room volume and not more than 50 kg or According to C.3 and not more than $m_3 \times 1,5$	No charge restriction		

$m_1 = 4m^3 \times LFL$, $m_2 = 26m^3 \times LFL$, $m_3 = 130m^3 \times LFL$

Check compliance with charge limits (C.3)



What are the system requirements to apply the C.3 calculations? All the listed below

- *systems where all branches (e.g. headers or Tees) and all changes in diameter (e.g. reducers) in refrigerant-containing piping in the occupied space in question are manufactured from factory made fittings or manifolds;*
- *systems which are split systems and where design, sizing, and selection of materials and of components of field installed refrigerant-containing piping in the occupied space in question are in accordance with the instructions of the manufacturers of the factory-made units;*
- *systems where no valves (e.g. expansion valves, switch-over valves, service valves) or service ports are installed in the in the occupied space in question, with the exception of valves or service ports which are part of the factory-made units;*
- *system location is class II;*
- *systems where the heat exchanger in the indoor unit and the control of the system are designed to prevent damage due to ice formation;*
- ***systems where the refrigerant-containing parts of the indoor unit are protected against fan breakage or the fan is designed to prevent breakage;***
- *systems where only permanent joints are used in the occupied space in question except for site made joints directly connecting the indoor unit to the piping;*
- ***systems where the refrigerant-containing pipes in the occupied space in question are installed in such way that it is protected against accidental damage in accordance with EN 378-2:2016, 6.2.3.3.4 and~ EN 378-3:2016+A1:2020 , 6.2;***
- *alternative provisions to ensure safety are provided;*
- *doors of the occupied space are not tight-fitting;*
- ***effect of flow down is mitigated*** according to EN378-1 C.3.2.4;

Installation responsible must check the system is compliant with all the points above

Check compliance with charge limits (C.3)

(for occupancies except those on the lowest underground floor of the building)

$$\frac{m}{V} < QLMV$$

No additional safety measures needed

$$QLMV < \frac{m}{V} < QLAV$$

1 extra safety measure needed

$$QLAV < \frac{m}{V} < 1,5 \cdot m_3$$

2 extra safety measure needed

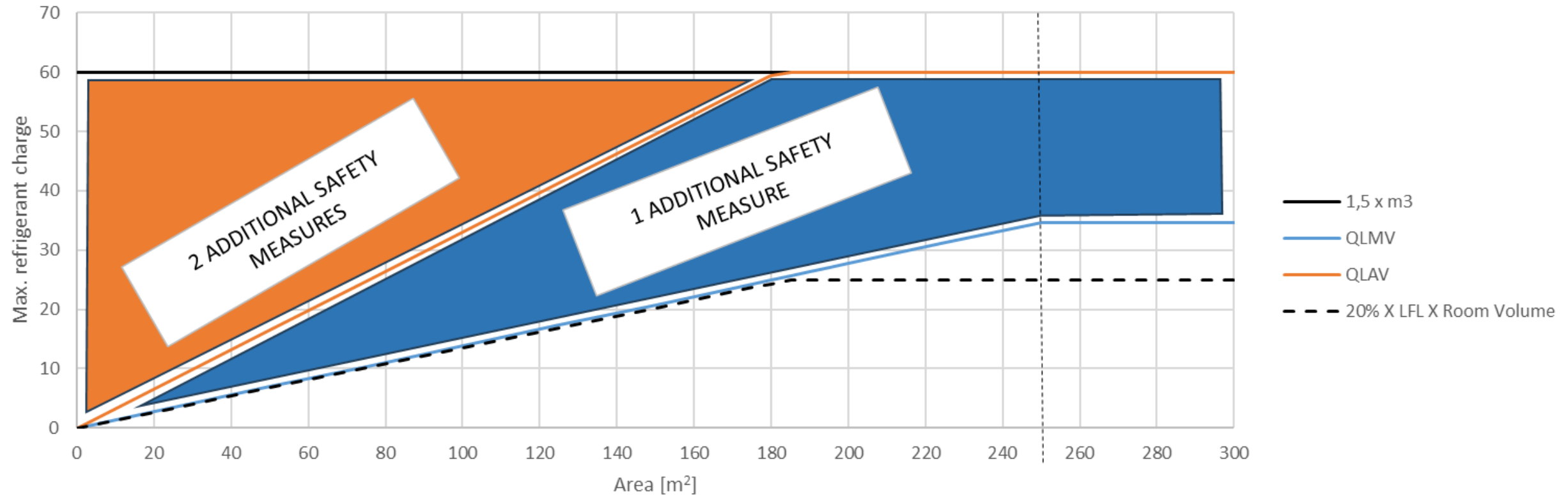
Safety measures: ventilation , shut off valves , leak detection + alarm

V_{min} = minimum volume [m^3]
 m = refrigerant charge amount [kg]
 $QLMV$ = Quantity limit minimum ventilation [kg/m^3]
 $QLAV$ = Quantity limit additional ventilation [kg/m^3]

Check compliance with charge limits (C.3)

(for occupancies except those on the lowest underground floor of the building)

Maximum refrigerant charge calculation according to C.3 - Room Height 2,2 m



Check compliance with charge limits (C.3)

(for occupancies on the lowest underground floor of the building)

$$\frac{m}{V} < RCL$$

No additional safety measures needed

$$RCL < \frac{m}{V} < QLMV$$

1 extra safety measure needed

$$QLMV < \frac{m}{V} < QLAV$$

2 extra safety measure needed

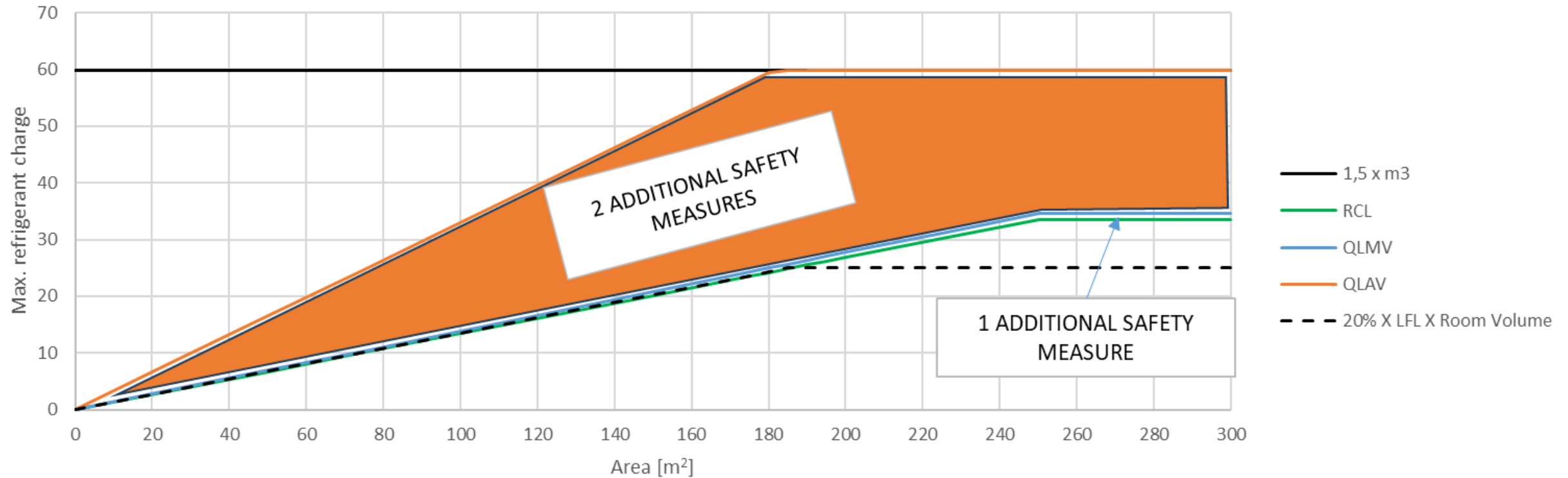
Safety measures: ventilation , shut off valves , leak detection + alarm

V_{min} = minimum volume [m^3]
 m = refrigerant charge amount [kg]
 RCL = Refrigerant concentration limit [kg/m^3]
 $QLMV$ = Quantity limit minimum ventilation [kg/m^3]
 $QLAV$ = Quantity limit additional ventilation [kg/m^3]

Check compliance with charge limits (C.3)

(for occupancies on the lowest underground floor of the building)

Maximum refrigerant charge calculation according to C.3 - Room Height 2,2 m - Lowest underground floor



Check compliance with charge limits



EXCEL TOOL FOR QUICK AND EASY ESTIMATION

	Fill in Blue Cells
What is the location classification ?	Class II
What is the access category ?	c-authorized access
What is the scope of the refrigeration system?	Other applications
What is the refrigerant used by the refrigeration system?	R32
EPSILON Sky Model	30
DATATECH MODEL	DATATECH LTD SKY 31.1
Connection pipe lenght [m]	30,0
Is the system compliant with EN378-1 C3 requirements?	NO
What is the room height? [m]	2,2

ESTIMATED TOTAL SYSTEM REFRIGERANT CHARGE [kg]	6,21
Is the refrigerant charge acceptable?	YES
MINIMUM AREA REQUIREMENT [m ²] Occupancies except those on the lowest underground floor of the building	46,0
MINIMUM AREA REQUIREMENT [m ²] Occupancies on the lowest underground floor of the building	46,0

$$m = 0,2 \cdot LFL \cdot Room\ Volume$$



$$A_{min} = \frac{m}{0,2 \cdot LFL \cdot h}$$

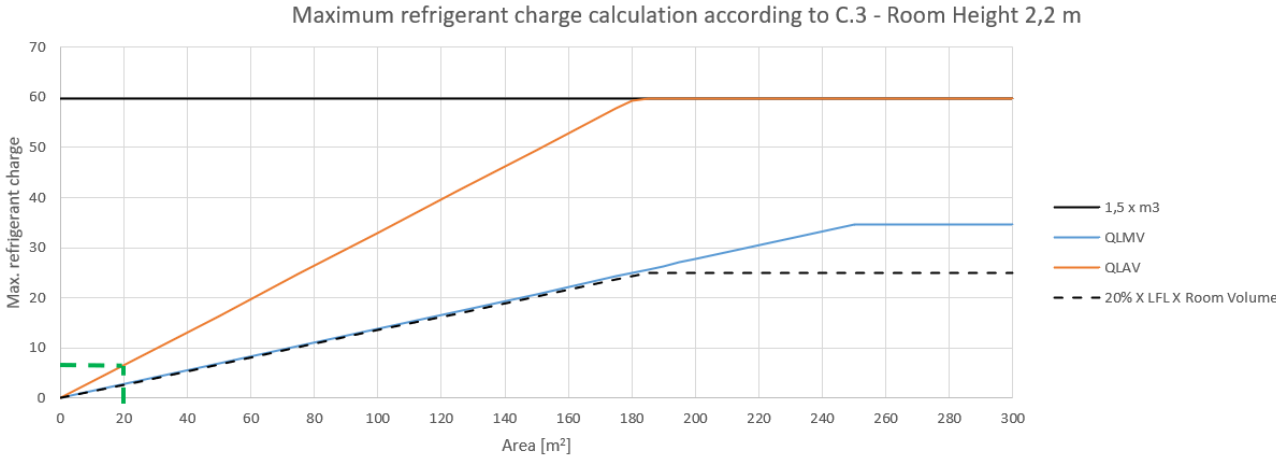
Check compliance with charge limits



EXCEL TOOL FOR QUICK AND EASY ESTIMATION

	Fill in Blue Cells
What is the location classification ?	Class II
What is the access category ?	c-authorized access
What is the scope of the refrigeration system?	Other applications
What is the refrigerant used by the refrigeration system?	R32
EPSILON Sky Model	30
DATATECH MODEL	DATATECH BTD SKY 31.1
Connection pipe lenght [m]	30,0
Is the system compliant with EN378-1 C3 requirements?	YES

ESTIMATED TOTAL SYSTEM REFRIGERANT CHARGE [kg]	6,21
Is the refrigerant charge acceptable?	YES
MINIMUM AREA REQUIREMENT [m ²] Occupancies except those on the lowest underground floor of the building	18,8
MINIMUM AREA REQUIREMENT [m ²] Occupancies on the lowest underground floor of the building	44,8



How many additional safety measures are applied (if present)?	1
What is the room height? [m]	2,2

EPSILON SKY R7

Split versions



EPSILON SKY Hi LE

Condensing unit



6 - 40kW



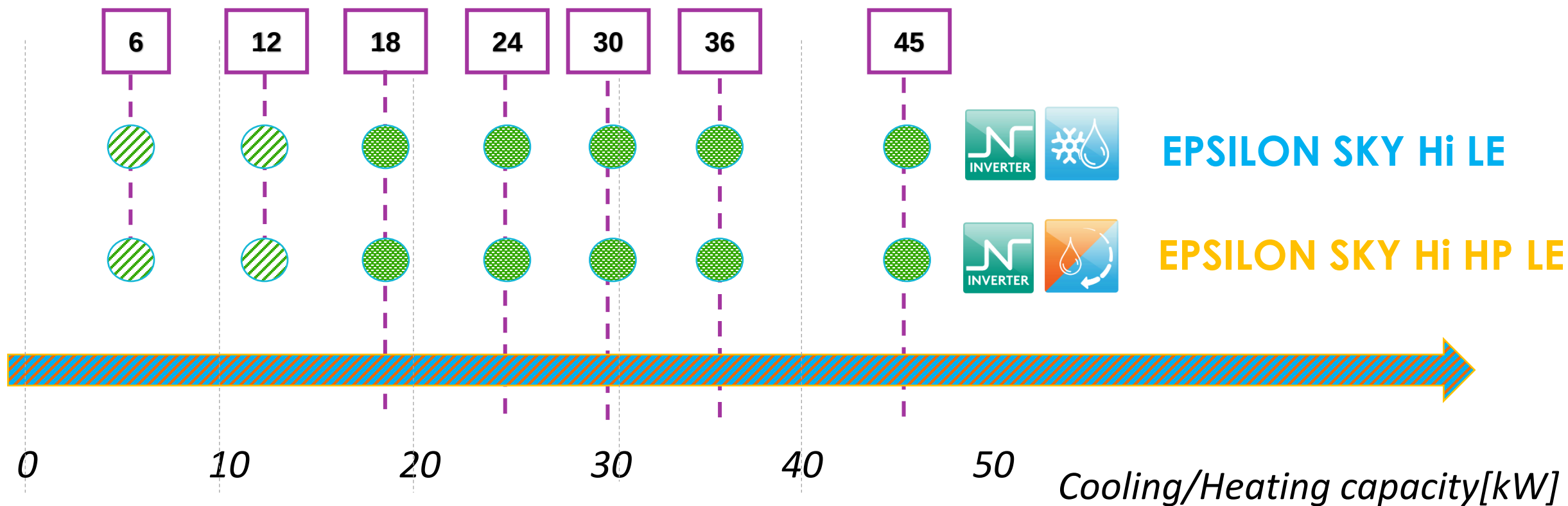
EPSILON SKY Hi HP LE

Reversible condensing unit



6 - 40kW

Line-up EPSILON Sky



Rotary
compressor



Scroll
compressor

Technology insight – Charge reduction

Thanks to low-charge refrigerant circuit and 5mm tube coil design ,
refrigerant charge is reduced by up to **60%** for heat pump
configuration.

EPSILON ECHOS + LE HP



EPSILON Sky Hi LE HP

R410A



R32

**5 models
9-37 kW**



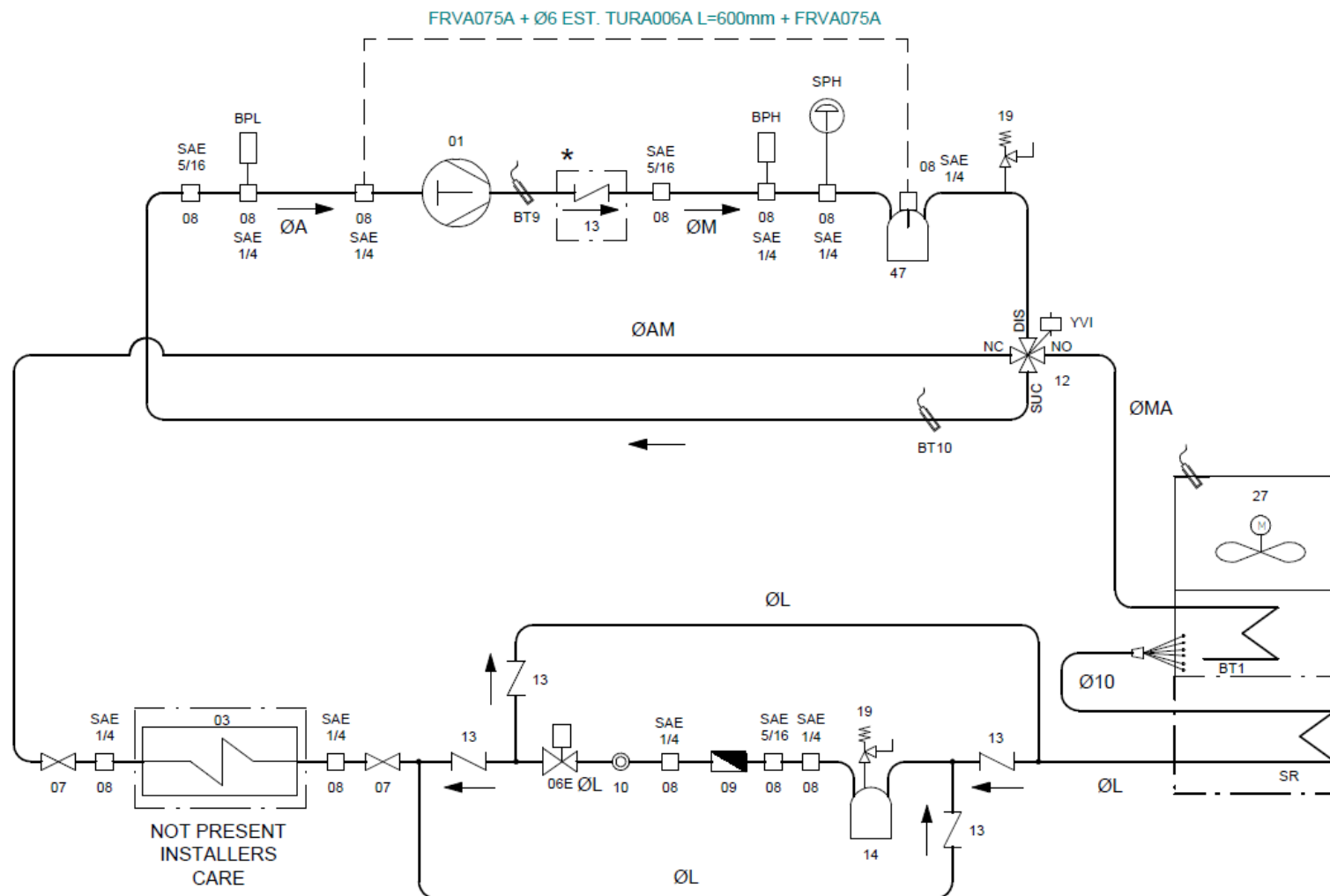
**7 models
7-45 kW**

**Refrigerant charge
up to 12,5 kg**



**Refrigerant charge
up to 4,8 kg**

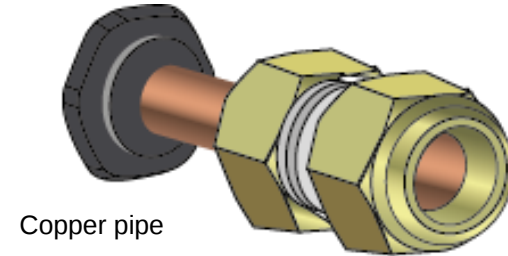
Technology insight – Charge reduction



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Technology insight – Refrigerant connections

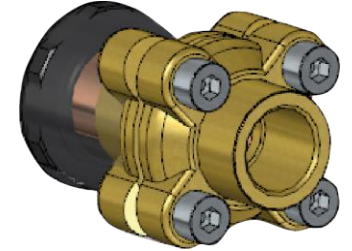
SAE/FLARE



Copper pipe

SAE/Flare connector

FLANGED

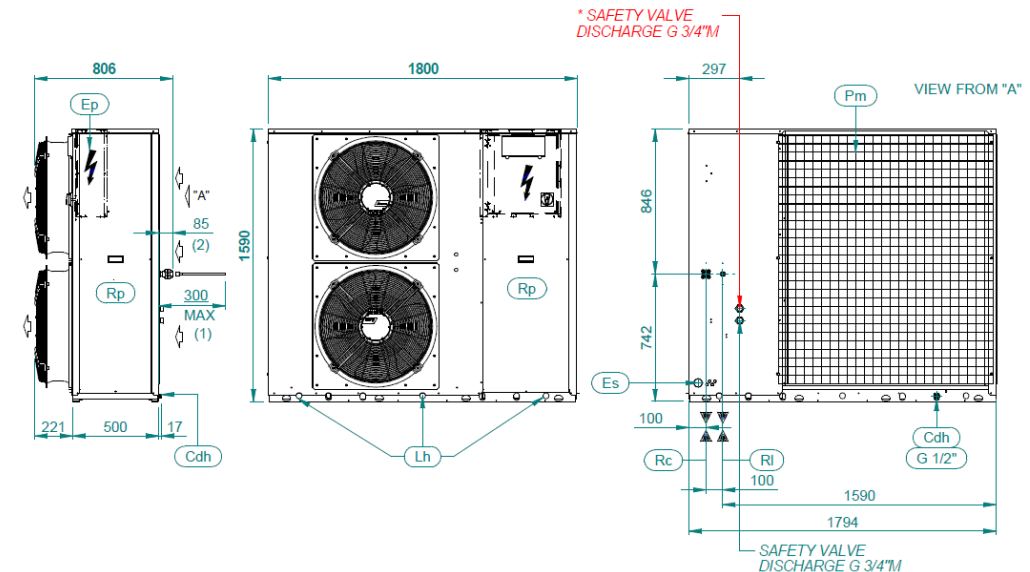


- Easy gas/liquid connections for LE and LE HP units

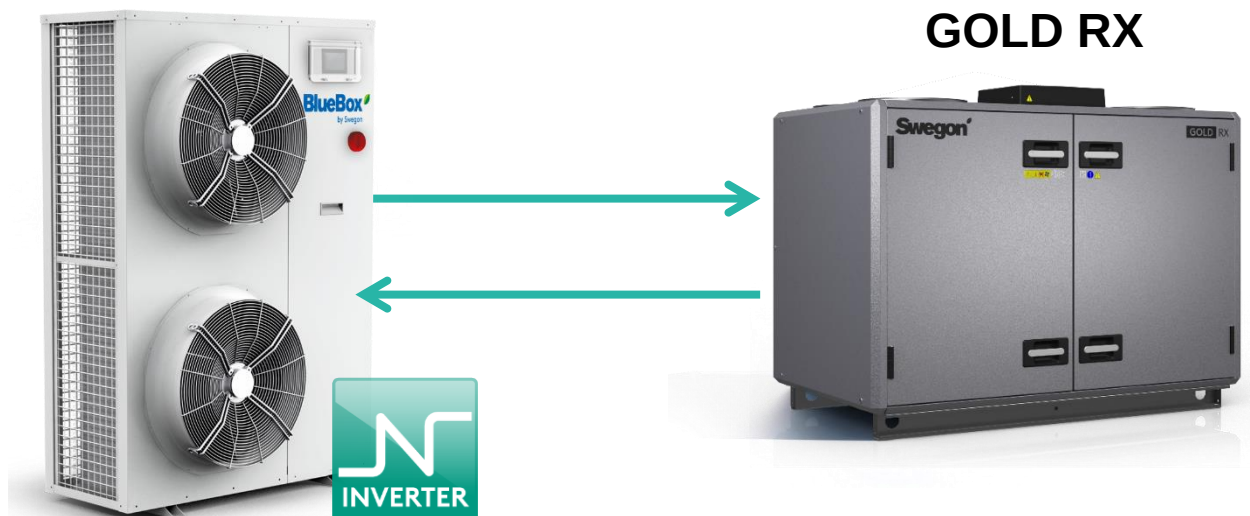
- Easy connection of safety valve(s)

Safety valve discharge shall be conveyed far from the unit following prescription from unit manual ; exhaust point must not be close to opening where refrigerant might be contained , fresh air inlet and ignition sources , as defined in standard EN 378.2.

Risk assesment of the area is in responsability of the installation supervisor.



Applications for Air Handling Units



Upgraded interface



Defrost				Dynamic	
Status: No defrost					
Defrost number	21				
Outdoor Temp.	-5.6 °C	15.0 °C	Parameter value		
Evaporation temp.	4.0 °C	-10.1 °C	Prest to force defrost		
Delay start defrost	0 : 1 : 0	60 sec			



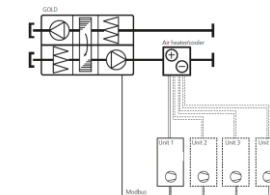
Expansion valve			
Suction pressure probe	8.26 bar		
Suction temp.	4.0 °C		
Superheating	20.7 °C		
Setpoint SH	16.7 °C	Steps	250
	5.0 °C	100.0 %	



SmartLink DX

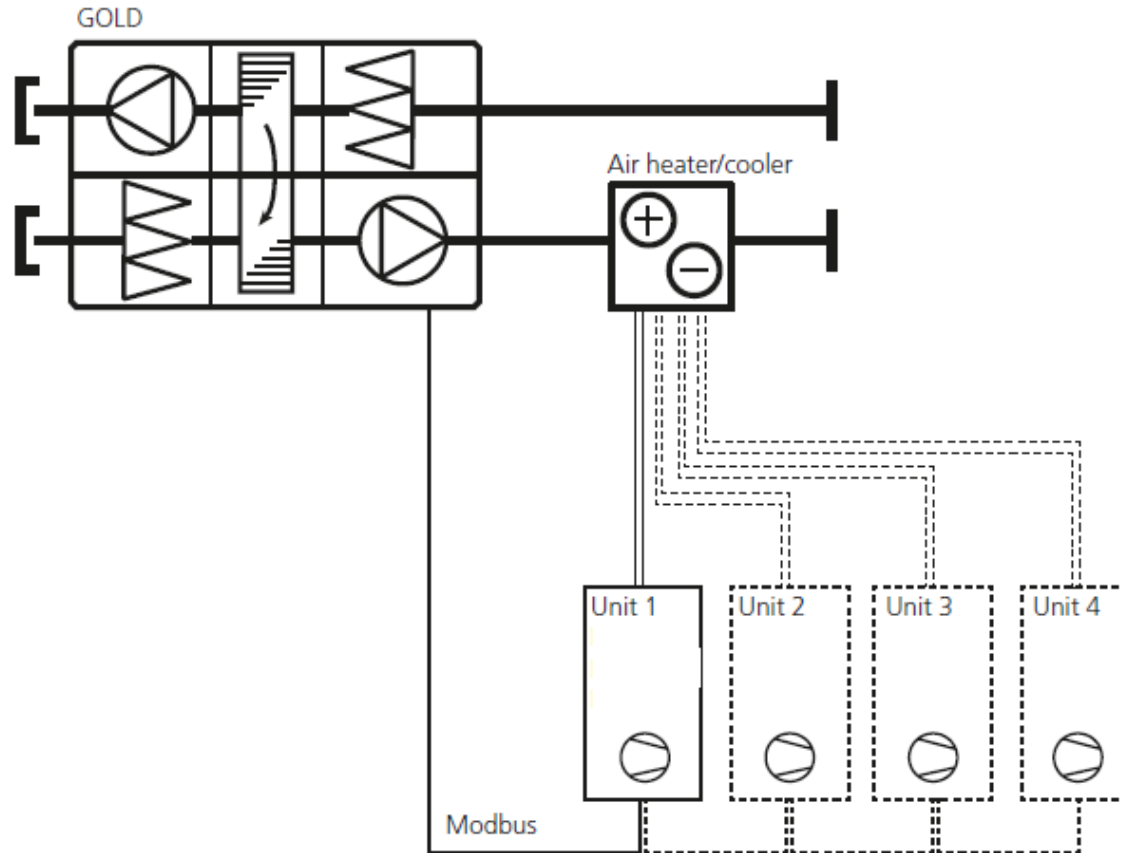
EPSILON SKY Hi LE

EPSILON SKY Hi HP LE



Applications

for Air Handling Units with DX coil



SmartLink DX:

- Up to 4 units can be connected to a **Gold RX unit**
- Optimization of system working mode to keep safe and efficient
- EPSILON Sky unit while guaranteeing good indoor climate

Coil must be in split design → each ESPILON Sky unit must be connected to an independent refrigerant circuit

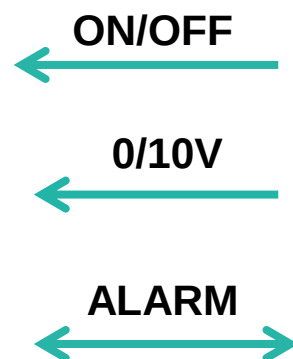
EPSILON Sky

for IT Cooling – Direct Expansion

Specific accessory to control compressor activation ,cooling capacity modulation and alarms.



EPSILON SKY Hi LE
Condensing unit



DATATECH and COOLBLADE BTDX Sky R7

Datatech/Coolbalde BTDX Sky R7

Additional devices and operating functions for R32

A

To mitigate the risk resulting from the presence of mildly flammable refrigerant in the refrigerant circuit, the fans in the units are always in operation.

B

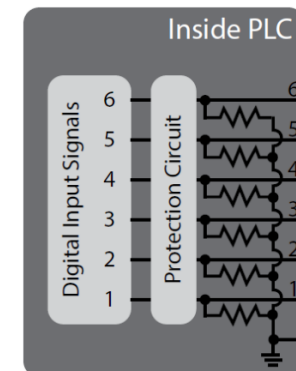
Air flow is monitored to check its presence and must be connected to device (SEP separated electrical panel) able to remove the power supply.

C

Digital input for refrigerant leak alarm (leak detector not provided).



Always switch on



Datatech/Coolbalde BTDX Sky R7

Additional devices and operating functions for R32

A

To mitigate the risk resulting from the presence of mildly flammable refrigerant in the refrigerant circuit, the fans in the units are always in operation, even when the unit is switched to "OFF" from the display.

Will not be achieved the lower flammable limit (LFL), that is the minimum concentration of a substance in air which can be ignited and cause propagation of flame.

If there isn't request of cooling the fan operates at minimum speed.

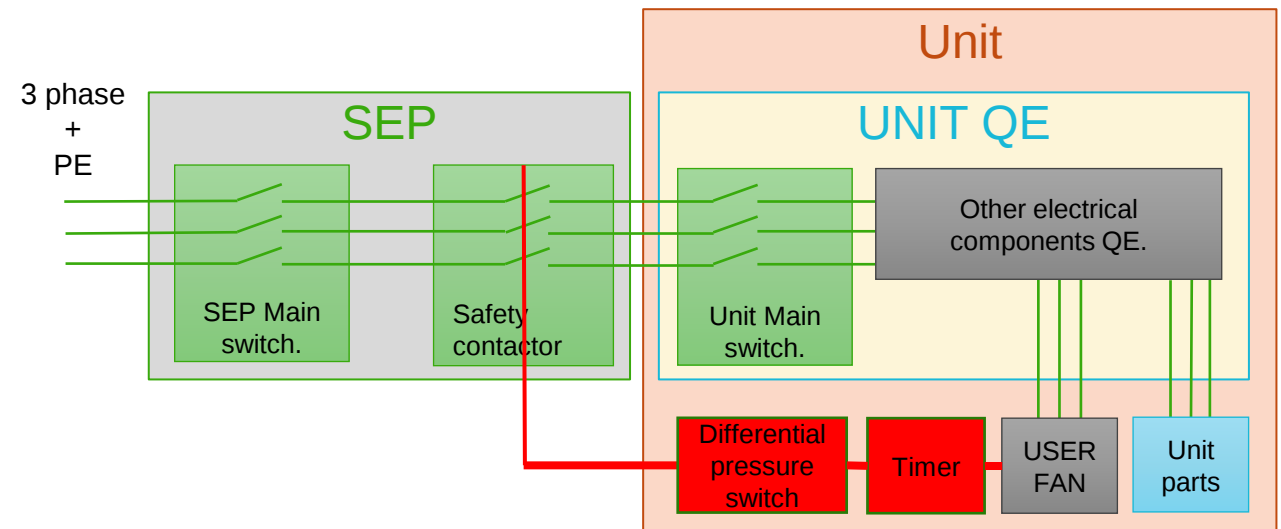
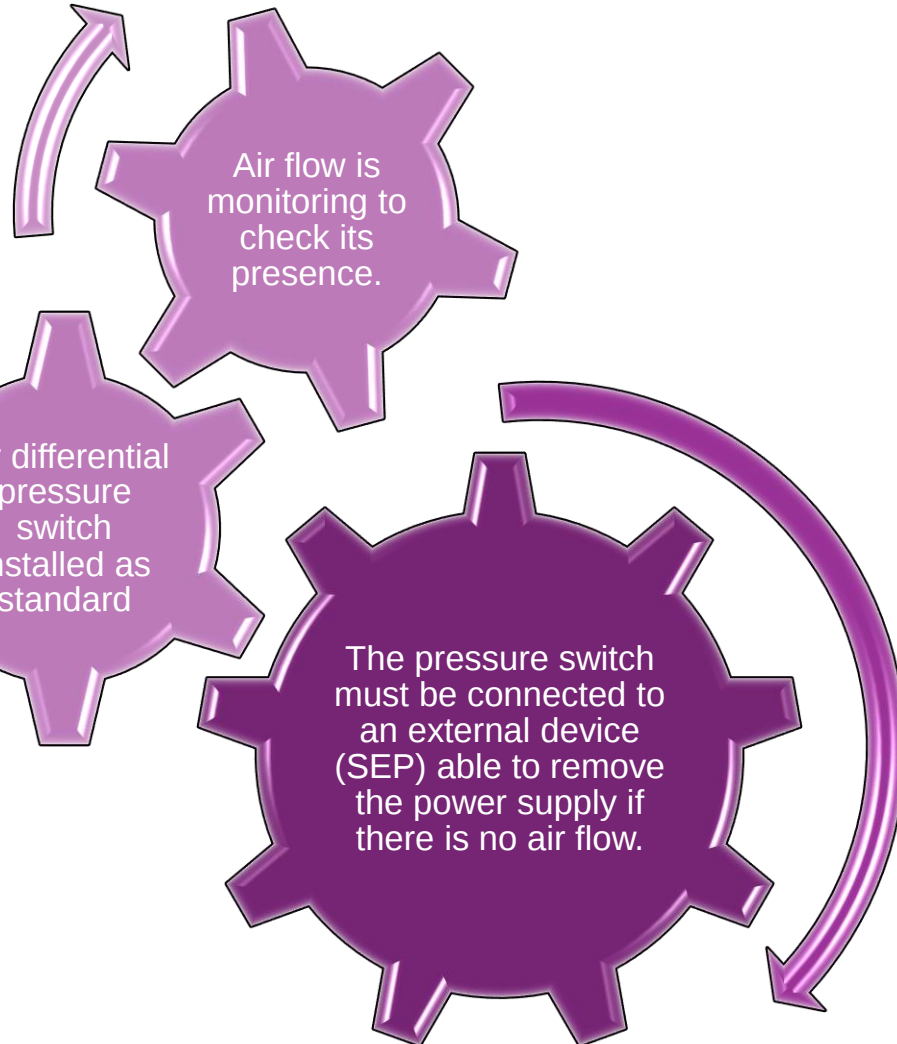


Always switch on

Datatech/Coolbalde BTDX Sky R7

Additional devices and operating functions for R32

B



Datatech/Coolbalde BTDX Sky R7

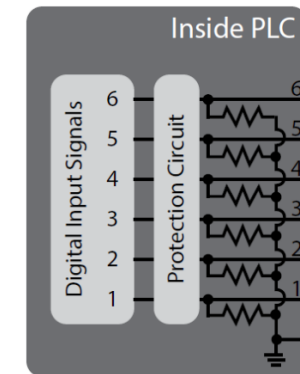
Additional devices and operating functions for R32

C

Digital input to connect
an external refrigerant
detector

The customer can install a refrigerant
leak detector (not provided), that can
activate the leak alarm. In this case
the unit software can be configured to have:

- Only alarm
- Deactivation of all the outputs
- Only ventilation
- Ventilation at maximum speed

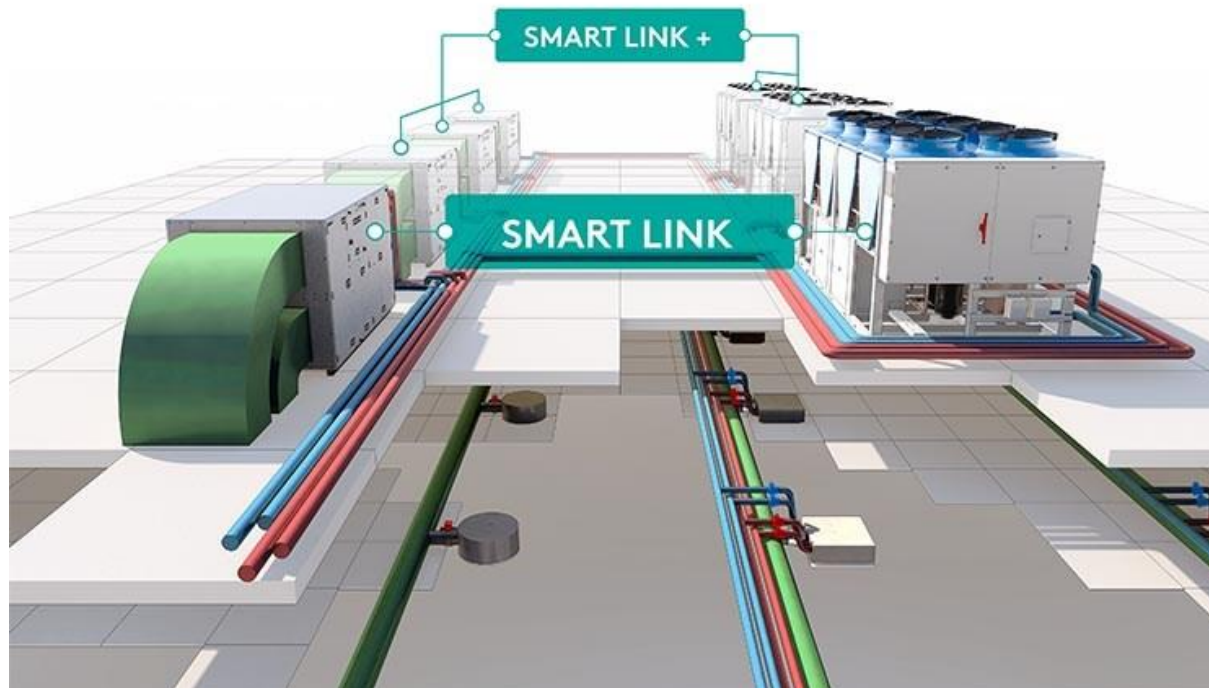


Takeaways

- ❑ Air-to-air split system using R32 refrigerant can be a mid-term solution (up to 2033 for systems over 12 kW and until 2029 for systems under 12 kW) for IEQ and IT Cooling applications
- ❑ EN378-1 prescribes refrigerant charge limitations and minimum area requirements for such systems
- ❑ A proper installation site classification , flammability risk analysis and building area/volume evaluation must be carried out by installation responsible , following EN378 (or local regulations if stricter)
- ❑ Swegon A2L units design and features helps the installer responsible to achieve compliance with EN378-1 requirements

Takeaways

- ❑ If the charge limitations or the installation risk analysis is limiting the application of A2L split system , please remind always that the alternative is to install a Swegon self contained monoblock chiller or heat pump matched with a water/glycol coil in the AHU



Disclaimer

- Always keep in account local/national regulation. Where the refrigerant charge limits or minimum area requirements envisaged by the local regulations in force in the place of unit installation are more restrictive than the requirements laid down in standard EN378, the former shall apply.
- The calculations and contents in this presentation must be considered as indicative and not complete. Reference should always be made to the original version of standard EN378.
- Installation classification and flammability risk analysis is always in charge of the installation responsible.
- Refer always to unit installation manual for refrigerant charge calculations and other installation requirements.

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