



Installation Operation Maintenance

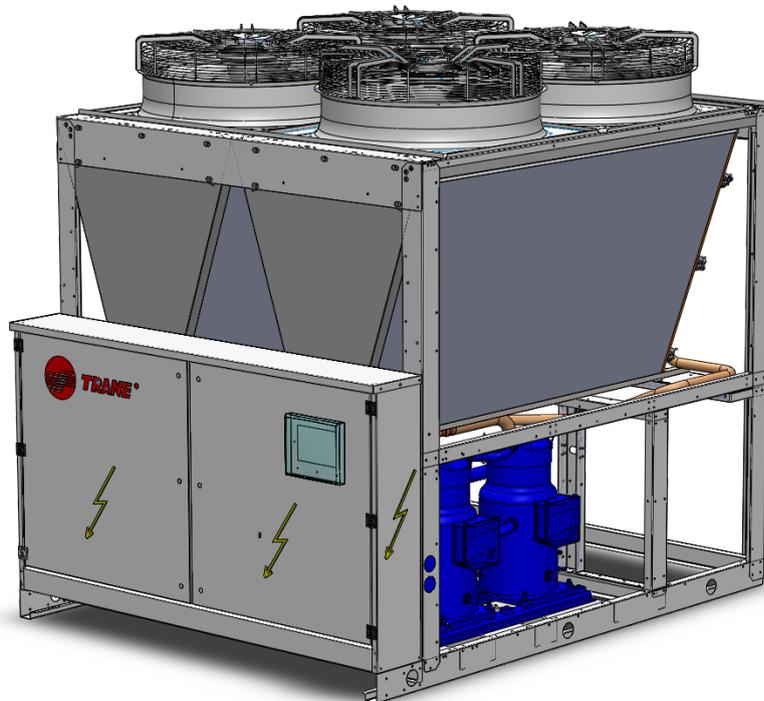
RAUS/RAUX condensing units

Air cooled chillers and heat pumps condensing units with scroll compressors

RAUS 410 – 760 Cooling capacity 143 - 268 kW

RAUX 370 – 660 Cooling capacity 130 - 232 kW

Heating capacity 133 -234 kW



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TRANE
TECHNOLOGIES

Original instructions



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1 OVERVIEW

1.1 FOREWORD

These instructions are given as a guide to good practice in the installation, start-up, operation, and maintenance by the user of RAUS / RAUX units. They do not contain full service procedures necessary for the continued successful operation of this equipment. The services of a qualified technician should be employed through the medium of a maintenance contract with a reputable service company. Read this manual thoroughly before unit start-up.

1.2 WARRANTY

- A. The warranty for Trane machines is 12 months from the date the machine is operated for the first time but no more than 18 months from the date of the invoice. The warranty is reduced to 6 months from the start up date for units running continuously, that is more than 12 hours a day. The date the machine is operated for the first time means the date reported in the "1st start up form" contained into the "machine log book". This form should be filled in and sent, within 8 days from the start up, to Trane.
- B. The warranty is valid if all the installation regulations have been adhered to (both those which may have come from Trane and those coming from current practice), if the "1st start up form" has been filled in and sent to the Trane after sales department.
- C. The warranty is subject to any faults or defects being reported within eight days from their discovery. The warranty will only be applied if and when the purchaser suspends use of the equipment as soon as a defect has been found. Replacement items are to be considered always ex TRANE factory. Labour costs to replace failed items either under warranty or not, will be not of TRANE care.
- D. The warranty is valid if the first running of the machine is carried out by a Trane authorised assistance centre.
- E. The warranty is subject to regular maintenance of the unit which is appropriately indicated in the "machine log book" located inside the electrical panel.
- F. The warranty is automatically over in case of payments not fulfilled, non-performance of the contract and even if the units show tampering without TRANE writing approvals.
- G. Non observance of the above mentioned rules and of all the indications written on this manual, will cause the immediate loss of warranty, getting free TRANE from any responsibility for the unit and any damages to persons or things.

1.3 RECEIVING THE UNIT

On receiving the unit, it is up to the customer to check that there is no obvious damage or pieces missing. If this is so, an immediate complaint must be made to the carrier for damage or for not-delivery and the Receiving Card to be found inside the unit electrical panel must be filled in. Photographic evidence must be provided for macroscopic damage. The card must be sent to Trane within 8 days of receiving the goods: if it is not sent back or delayed, the complaint will not be accepted.

1.4 FACTORY INSPECTION

Trane units are inspected into the factory, in appropriate areas, in accordance with internal procedures. Each performance test carried out on the unit is possible only if the same conditions are reproduced and maintained (charge consistency, constant temperature and evaporation - condensation and recovery capacity, quality and tolerance of the measuring instruments etc.) in the test rooms.

The inspection conditions are those indicated by the customer in the ordering phase: if not otherwise specified, reference should be made to the nominal performance indicated in the technical bulletin in force at the date of the Confirmation of the Order.

2 SAFETY REGULATIONS

All Trane units are designed, built and inspected in compliance with Pressure Equipment Directive (PED97/23/EC or 2014/68/EU and Machinery Directive 2006/42/EC).

2.1 ACCESS TO DANGEROUS AREA

The access to the unit dangerous areas is usually obstructed through protection panels, which are removable, by using a tool. Axial fans are protected with accident prevention grilles.

For all the units which allow access to the cooling piping without security gratings (optional) or closing panelling, the following precautions must be taken:

- mark the areas with contact risks.
- apply warning signs.

The danger zone must be of a suitable size to avoid any contact, even accidental contact.

Trane declines any responsibility for damage to things and unauthorized personnel in case of absence of clear and static limiting systems of the risk areas and of the relevant warning and danger signs.



2.2 GENERAL PRECAUTIONS

The operator must only intervene on the unit commands; he or she must not open any panels except for the one which gives access to the command module.

The installer must only intervene on the connections between the plant and the machine; he or she must not open any machine panels nor carry out any commands.

The following precautions should be made when approaching or working on the unit:

- Do not wear jewelry, baggy clothes or any other accessory which can get caught up.
- Use appropriate protection (gloves, glasses etc.) when using an open flame (welding) or compressed air.
- If the unit is located in a closed environment, wear hearing protection.
- Before disconnecting, removing tubes, filters, joints or other line parts intercept the connection tubes, empty them until the pressure reaches that of the atmosphere.
- Do not use your hands to check for possible pressure losses.
- Always use tools which are in good condition; make sure the instructions have been fully understood before using them.
- Make sure that any tools, electrical cables or other loose objects have been removed before closing the unit and starting it up again.

2.3 PRECAUTIONS AGAINST RISKS DUE TO THE REFRIGERANT

Refer to refrigerant safety data sheet.

2.4 PRECAUTIONS AGAINST RESIDUAL RISKS

Prevention from risks due to the command system

- make sure the instructions for use have been understood before carrying out any work on the control panel.
- always keep the instruction manual close at hand when working on the control panel.
- start up the unit only after having certified that it is correctly connected to the plant.
- inform the technician promptly of any alarms which appear on the unit.
- do not reset the alarms to manual restart without having first identified the cause and removed it.

2.5 PREVENTION AGAINST RESIDUAL MECHANICAL RISKS

- install the unit in accordance with the provisions of the following manual.
- carry out all the maintenance operations provided for by this manual regularly.
- wear a protective helmet before entering inside the unit.
- before opening a machine panel make sure that it is firmly connected by means of a hinge.
- do not touch the air condensation batteries without having first put on protective gloves.
- do not remove the protections to the moving parts while the unit is running.
- before restarting the unit make sure that the moving part protections are in the correct position.

2.6 PREVENTION AGAINST RESIDUAL ELECTRICAL RISKS

- connect the unit to the mains in accordance with the provisions of this manual.
- carry out all maintenance operations regularly.
- before opening the control panel or access any electrical component installed on the unit disconnect the unit from the mains by means of the main switch.
- check that the unit has been earthen correctly before starting it up.
- control all the electrical connections and the connection cables paying particular attention to the state of isolation; replace the cables which are clearly worn or damaged.
- carry out periodic checks of the wiring inside the panel.
- do not use cables with an inappropriate section or flying connections not even for a limited period or in an emergency.

2.7 PREVENTION AGAINST RESIDUAL RISKS OF A DIFFERENT NATURE

• the residual risks due to pressure are mainly coming from a failure of the safety devices. To prevent them it is necessary to check and replace them when required.

• **the RAUS units are equipped with a high pressure safety valve which may relieve high pressure and high temperature refrigerant in close vicinity of the unit in case of an abnormal overpressure event. In order to prevent harm to people who might find themselves close to the unit, the installer should convey the escaped refrigerant by means of piping. The safety valve installed in the unit is equipped with a threaded connection that makes conveying easier. No safety valve is installed on RAUX units.**

If a piping aimed at conveying refrigerant from safety valves, as described above, has not been installed by the installer, in order to protect from safety devices exhausting it is not allowed to remove the protections while the unit is in operation and to approach the unit without wearing the right protections. In case of accidental contact with refrigerant due to the safety valves exhaust it is necessary to follow the above indicated.

- carry out the plant connections to the unit by following the indications reported on the following manual and on the panels of

the unit itself.

- if a part is disassembled, make sure that it is correctly reassembled before restarting the unit.
- do not touch the discharge line of the compressor, the compressor itself or any other tube or component which is inside the machine without putting on protective gloves.
- keep a fire extinguisher which is able to put out fires on electrical equipment near the machine.
- in the event of fire either if it originates on the unit or near it make sure the power supply to the unit is promptly cut and that any person who might be near the unit at that moment is moved to a secure location
- on units installed inside, connect the refrigerant circuit shut off valve to a network of tubes which are able to lead the possible spillage of refrigerating fluid outside.
- eliminate any fluid loss inside or outside the unit.
- collect the discharge liquid and clean up any possible oil leakage.
- periodically clean the compressor casing of the accumulated dirt deposits.
- do not keep inflammable liquids near the unit.
- do not dispose of the refrigerant fluid and the lubricating oil in the environment.
- welding should only be carried out on empty tubes; do not approach the tubes containing refrigerant fluid with flames or other sources of heat.
- do not bend or strike tubes containing pressurized fluids.

2.8 PRECAUTIONS TO BE OBSERVED DURING MAINTENANCE OPERATIONS

Only authorised technicians may carry out maintenance operations. Before carrying out any maintenance the following must be performed:

- isolate the unit from the mains electricity by using the external knife switch.
- place a notice on the external knife switch which says “do not use - maintenance in progress”.
- make sure that any possible on-off commands are disabled.
- use appropriate safety equipment (helmet, isolating gloves, protective glasses, safety shoes etc.).

If measurements or controls must be carried out which require the machine to be running the following observations must be followed:

- operate with the electrical panel open for as short a time as is possible.
- close the electrical panel as soon as the individual measurement or control has been carried out.
- for units which are located outside, do not carry out interventions in dangerous atmospheric conditions such as rain, snow, fog etc.

The following precautions should also be taken at all times:

- never dispose of fluids contained in the refrigerant circuit into the environment.
- when replacing the electronic card always use appropriate equipment (extractor, anti-static bracelet, etc.).
- if a compressor, the condensation batteries or any other heavy part is to be replaced, make sure that the lifting equipment matches the weight to be lifted.
- if the unit has an independent compressor compartment, do not open the ventilator compartment without having first isolated the machine using the knife switch on the side of the panel and only after having placed a sign which says “do not use - maintenance in progress”.
- if modifications must be carried out to the cooling, hydraulic or electrical circuit of the unit, as well as to its command logic, contact Trane.
- if particularly complicated assembly or disassembly operations are to be carried out contact Trane.
- always use original spare parts bought directly from Trane or from official dealers of the companies reported in the list of recommended spare parts.
- if the unit is to be moved after a year of being in the site or if it has to be dismantled contact Trane.

VERY IMPORTANT

No refrigerant high pressure safety valve is installed on RAUX (RAUS mounts a refrigerant safety valve instead).

The unit fail safe is assured by the cut-out of the electrical power supply to the coils of the compressors contactors. The cut-out action is carried out by the electrical contact of the unit high pressure switch (regarding its position in the refrigerant circuit of RAUX refer to the par.2 INSTALLATION DIAGRAM AND PLACING OF THE LIQUID RECEIVER).

No Shrader valve is installed in the port the unit high pressure switch is plugged into.

This implies that following instruction must be observed:

DO NOT PULL OUT THE HIGH PRESSURE SWITCHES HP IF THE UNIT IS NOT COMPLETELY VOID OF REFRIGERANT. FAILURE TO FOLLOW THIS INSTRUCTION COULD RESULT IN DEATH OR SERIOUS INJURY

2.9 MANUAL ALARM RESET

If there is an alarm the unit must not be manually reset before having located and eliminated the cause of the fault. Repeated manual resets may cause the warranty to be void.



3 OPERATING LIMITS

3.1 STORAGE

The units can be stored within the following environmental conditions:

- Min ambient temperature : -10°C
- Max ambient temperature : 53°C
- Max relative humidity : 95% not condensable

CAUTION: The storage in a very high humidity space (condensation) can damage electronic components.

3.2 OPERATING LIMITS

RAUS / RAUX unit operation is permitted within the limits indicated in the diagram provided in 3.3.

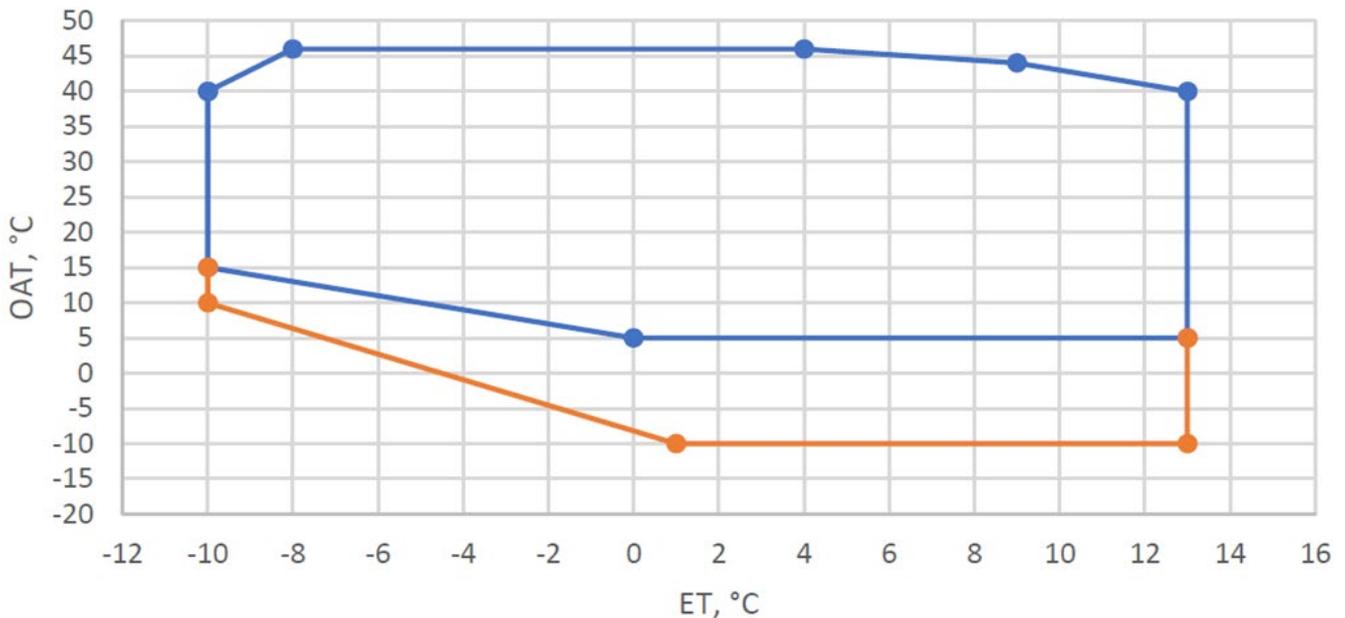
CAUTION: The operation outside the limits specified may cause the activation of the protections and disrupt the operation of the unit and, in extreme cases, damage the unit.

In case of doubt, consult the factory.

These operating limits apply to unit operating at full load.

3.3 OPERATING RANGE

RAUS 410-760 – COOLING MODE

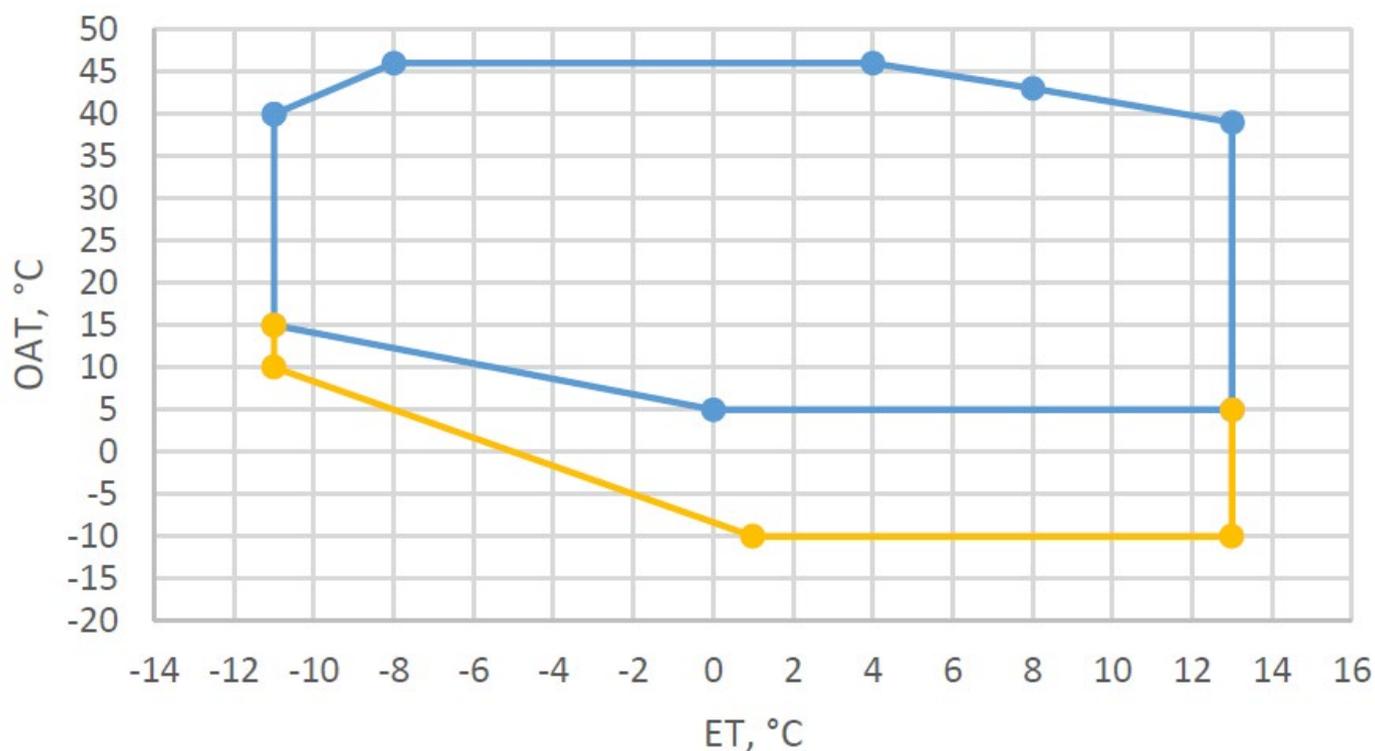


OAT = Outdoor Air Temperature [°C]

ET = Evaporating Temperature [°C]

----- = Low air temperature kit needed

RAUX 370-660 – CHILLER MODE

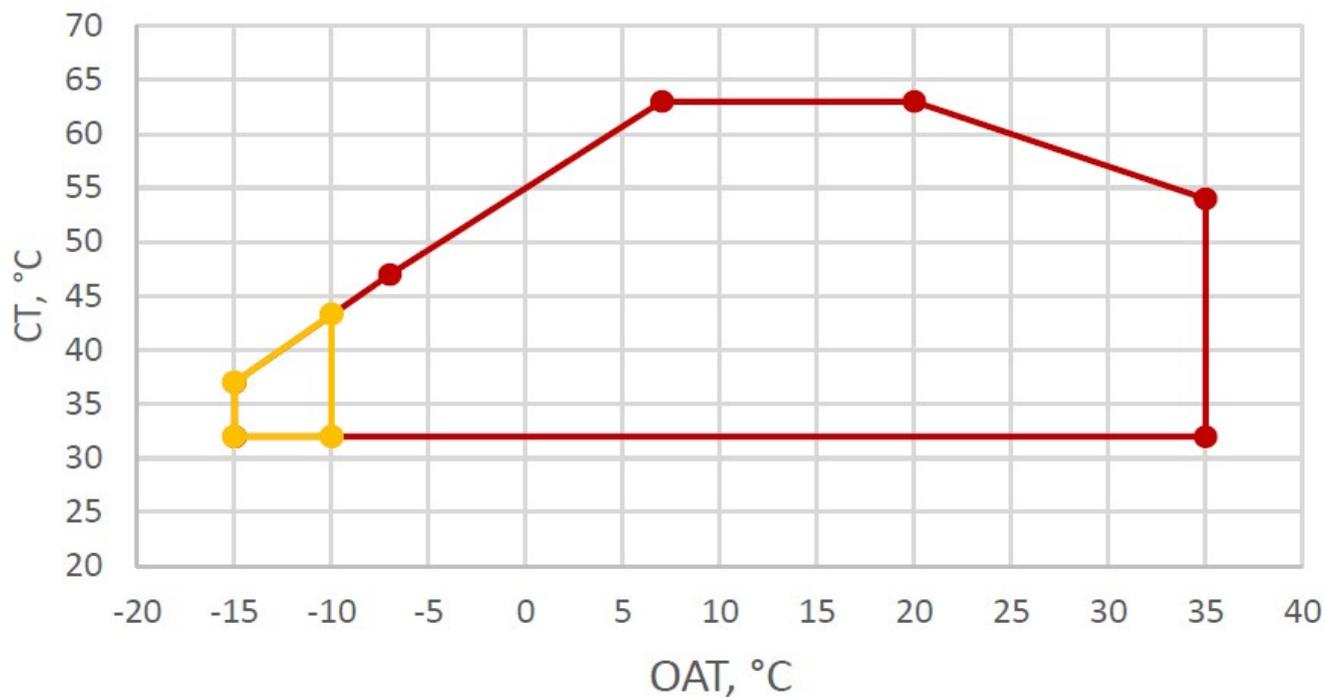


OAT = Outdoor Air Temperature [°C]

ET = Evaporating Temperature [°C]

----- = Low air temperature kit needed (down to -10°C)

RAUX 370 -660 – HEAT PUMP MODE



OAT = Outdoor Air Temperature [°C]

CT = Condensing Temperature [°C]

----- = Low air temperature kit needed (down to -15°C)

4 INSTALLATION

4.1 MOVING AND POSITIONING THE UNIT

The units have been designed to be lifted from above by means of eyebolts and holes in the base members. Use retractor bars to keep the lifting wires or chains away from the unit.

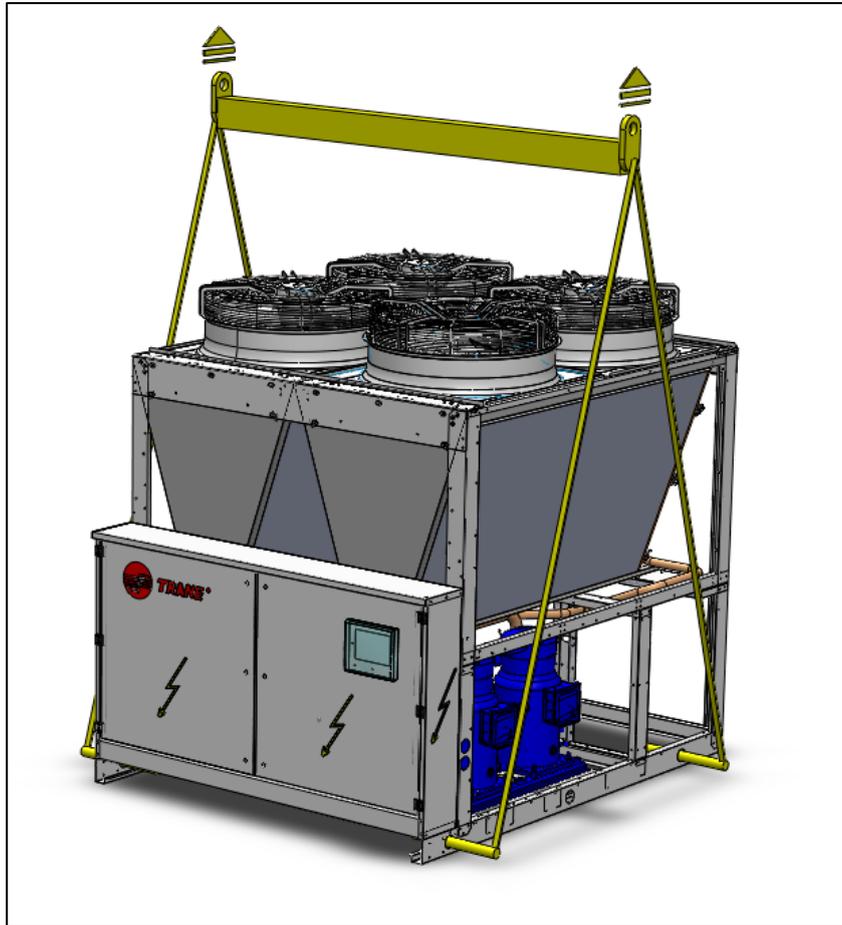


Figure 1 Correct lifting procedure

Lifting procedures provided with the unit have to be respected.

CAUTION

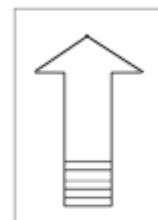
Do not use forklift trucks to lift the unit from below. If equipment for lifting from above is not available, using rollers may move the unit. The surface on which the unit is placed must be flat and strong enough to withstand the weight of the unit while running. In order to reduce the transmission of vibrations to the supporting structures, fit shock absorbers in every fastening point. Rubber shock absorbers are recommended for units installed on the ground, spring shock absorbers for units installed on roofs. Open spaces around the unit must be provided for in order to allow for the passage of necessary airflow and in order to allow normal maintenance to be carried out (as shown on general catalogues).

IMPORTANT: Make sure that during transport the RAUS / RAUX unit ALWAYS remains in the correct position!

In example horizontal positioning of the unit can lead to irreversible damage to the compressors. Damage arising from incorrect transport will not be under warranty by the manufacturer.

Immediately report an incorrect receipt of goods.

An arrow positioned upward indicates the vertical position of the unit.



4.2 MINIMUM SPACE REQUIREMENTS

Dimensional drawing shall be respected to avoid:

- Noise
- Incorrect heat exchange and ventilation
- Difficult maintenance or inaccessibility to components

It is fundamental to respect minimum distances on all RAUS / RAUX units, in order to ensure optimum ventilation for the condenser coils. Limited installation space could reduce the normal air flow, thus significantly reducing the unit performance and considerably increasing consumption of electrical energy.

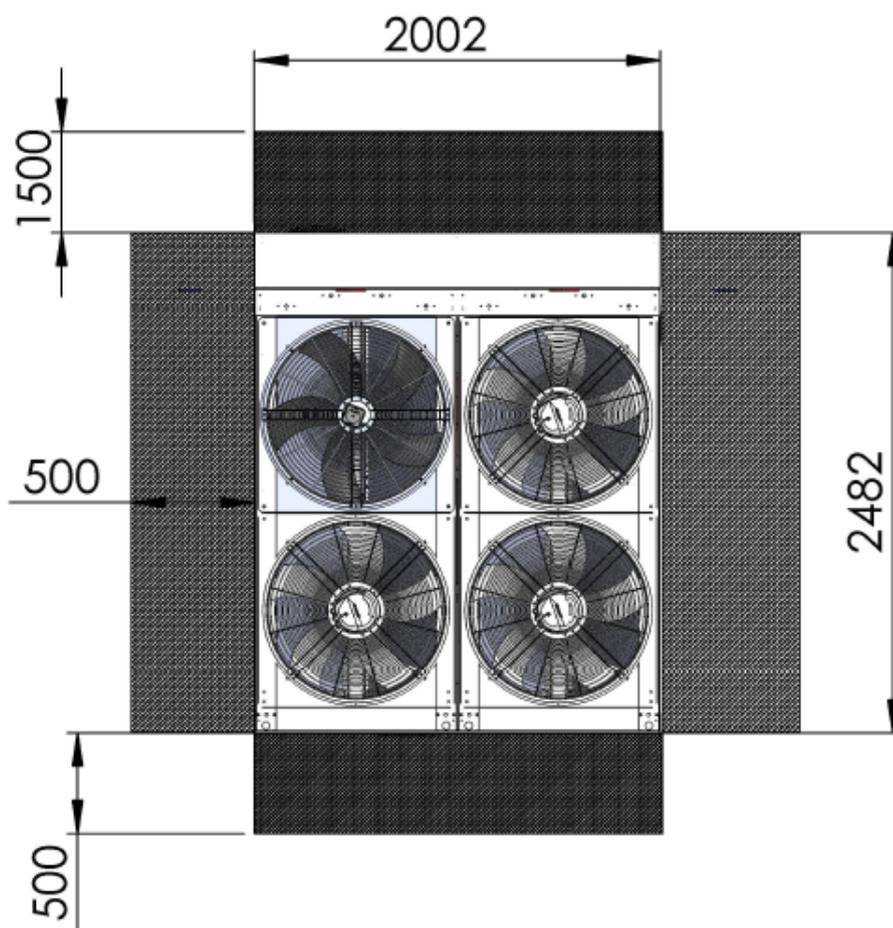


Figure 2 minimum space requirements [mm]

CAUTION: in case two stand-alone units have to be installed side by side, the distance of respect must be doubled.

4.3 PRECAUTIONS FOR DOMINANT WINDS

Avoid obstacles on suction and discharge sides of the units. Respect the safety distances as shown on the units dimensional drawings.

In case of presence of dominant winds in the installation area it is strictly necessary to avoid (for units with horizontal flow fans) that such winds blow in front of the unit (fans discharge side). In case of unit with vertical flow fans it is strictly necessary to avoid installations where the dominant winds could cause rejected hot air to come back to the condensing coils.

4.4 PRECAUTIONS AGAINST DIRECT SUNSHINE

Direct solar radiation can raise the temperature of condensation until it causes the unit shutdown or failure start-up of the same by action of the high pressure switch.

4.5 PRECAUTIONS AGAINST THE PRESENCE OF FIREPLACES AND EXHAUST HOT AIR

Avoid installation of the machines downwind of chimneys, smokestacks and different effluent discharges.



4.6 PRECAUTIONS AGAINST THE PRESENCE OF FOLIAGE AND FOREIGN BODIES

Avoid installing the unit in the immediate vicinity of plants that can prevent proper intake and discharge air.

4.7 CONTROL OF COMPRESSOR FASTENING

The compressors are fitted on shock absorbers. For fixing through spring anti-vibration mounts, it is necessary to remove blockages put to fasten the compressors, as indicated on the label on compressors body.

5 ACOUSTIC PROTECTION

When the sound level must be checked in particular, it is necessary to pay maximum WARNING in isolation from the base of the unit properly applying the anti-vibration mounts (provided optionally). Also, install flexible joints on water connections.

6 ELECTRICAL POWER SUPPLY

The mains power supply characteristics have to match the unit's absorption. The mains power supply tension must correspond to the nominal value $\pm 10\%$, with a maximum difference between the phases of 2%.

All power supply wiring must be sized and selected accordingly by the project engineer in accordance with standard IEC 60364. All wiring must comply with local code.

6.1 POWER CONNECTIONS

Protect the unit electric box power supply circuit with protection devices (not included in the supplied equipment). Connect the line terminals with a three-core cable of a section which is appropriate to the machine absorption. The switch and the fuses like all the power connections must comply with the regulations in force.

6.2 IMBALANCE BETWEEN THE SUPPLY TENSION PHASES

Do not run the electrical motors when the voltage unbalance between the phases is more than 2%. Use the following formula to check:

$$\% \text{ Imbalance} = [(V_x - V_{ave}) \times 100 / V_{ave}]$$

$$V_{ave} = (V_1 + V_2 + V_3) / 3$$

V_x = phase with greatest difference from V_{ave} (without regard to the sign)

IMPORTANT: If the mains voltage has an imbalance of above 2%, contact the company, which distributes the electrical energy. If the unit functions with a unit voltage imbalance between the phases of above 2% the warranty is invalid.

6.3 UNIT VOLTAGE PHASING

It is important that proper rotation of the compressors be established before the unit is started. Proper motor rotation requires confirmation of the electrical phase sequence of the power supply. The motor is internally connected for clockwise rotation with the incoming power supply phases A-B-C.

7 HOW TO SIZE REFRIGERANT LINES

In the dimensioning of refrigerant lines of air conditioning systems equipped with two sections, the designer has to take into account that, due to the pressure loss of the refrigerant circuits, cooling capacity decrease and compressors power input increase may occur. It is also necessary to consider that the fluid changes its state when circulating within the plant.

Another common problem is related to the oil: this, in fact, is highly miscible to the refrigerant and consequently it is easily dragged into the circuit; obviously, it is necessary to make sure that this lubricant is able to entirely come back to the compressor. Finally, the following basic conditions, typical of each refrigerant circuit, must be respected: cleaning of the pipes and total absence of liquid to the compressor's inlet.

In order to avoid all the above mentioned problems, the connection lines must be properly sized.

7.1 DIAMETERS and connection kits

The pipes diameter is one of the most critical feature in sizing the refrigerant lines. The refrigerant speed inside the pipes and the pressure drop depend on the diameter.

Although it is advisable to limit as much as possible the pressure drop (to reduce the loss of cooling capacity) is important to ensure a velocity in the pipe to allow the oil carryover.

Generally the dimensioning of the suction line is made in order to maintain a speed higher than 4 m/s to the minimum load (minimum step of capacity) and lower than 20 m/s at full load.

The tables below show the standard diameters for machines RAUS and RAUX. These diameters shall be considered approximate and must be verified for each installation.

RAUS size	Suction diameter	Liquid diameter	Suction diameter	Liquid diameter
	mm	mm	mm	mm
	Circuit -1		Circuit -2	
410-480	42	22	42	22
550	54	28	42	22
590-760	54	28	54	28

RAUX size	Suction diameter	Liquid diameter	Balancing diameter	Suction diameter	Liquid diameter	Balancing diameter
	mm	mm	mm	mm	mm	mm
	Circuit -1			Circuit -2		
370-460	35	22	22	35	22	22
530	42	28	28	35	22	22
560-660	42	28	28	42	28	28

Connection kits for RAUS and RAUX units

RAUS connection kit includes: solenoid valve, mechanical expansion valve, filter dryer, liquid sight and safety valve.

RAUX connection kit includes: nr.2 check valves, nr.1 mechanical expansion valve, nr.2 safety valves on liquid line.

Additional R410A refrigerant charge for a linear meter of pipe

Diameter (mm)	Gas (Kg/m)	Liquid (Kg/m)
6	0.0014	0.0133
10	0.005	0.051
12	0.008	0.079
16	0.014	0.139
18	0.019	0.182
22	0.029	0.285
28	0.045	0.445
35	0.074	0.729
42	0.111	1.082
54	0.182	1.779
64	0.281	2.721
67	0.289	2.825
76	0.377	3.689

7.2 LENGTH

The length of the suction line produces pressure losses higher than those ones found in the circuit of a machine with a single section. Obviously consequently there is a lower pressure in the intake to the compressor. This may cause, as already mentioned, a decrease of the output power and increase of that absorbed, with consequent reduction of the COP. A similar phenomenon occurs in the discharge line: loss of load forces the compressor to work at a pressure that is higher than the actual condensation, with effects equal to those previously analyzed. In the following table the pressure drops effects on the cooling capacity are shown, expressed in terms of temperature drops [°C] on the suction and discharge lines:

Losses of load (°C)	Power output (%)	Power input (%)
0	100	100
1°C suction	95.7	103.5
1°C discharge	98.4	103.5
2°C suction	92.2	106.6
2°C discharge	96.8	106.6

High pressure drops, caused by considerable lengths, create another type of problem on the liquid line: known as "gas flashing". It consists in the evaporation of part of the refrigerant, due to the heat developed by friction along the line and due to the pressure drops. This may cause a malfunction of the thermostatic valve. A proper sizing of the refrigerant lines will avoid these problems. A simple and rather accurate method has been suggested by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) and will be explained below.

7.3 CALCULATION OF THE EQUIVALENT PRESSURE DROP

For a correct and quick dimensioning of refrigerant lines please refer to the following table, developed for R410A refrigerant.

Cu Tubo - Pipe Dext (mm)	Linea aspirazione - Suction line $\Delta T=0,04$ k/m			Linea di mandata - Discharge line $\Delta T=0,02$ k/m $\Delta P=0,749$ kPa/m		Linea del liquido - Liquid line	
	Temp. di aspirazione satura - Saturated suction temp.			Temperatura di aspirazione satura Saturated suction temperature		Velocità Speed 0,5 m/s	$\Delta T=0,02$ k/m $\Delta P=0,749$ kPa/m
	-20°C	-5°C	+5°C				
	Caduta di pressione corrispondente (kPa/m) Corresponding pressure drop (kPa/m)						
10	0,378	0,572	0,731	-20°C	+5°C	4,14	4,37
12	0,75	1,28	1,76	2,44	2,6	7,08	11,24
14	1,2	2,06	2,83	3,91	4,16	10,02	18,1
16	1,78	3,05	4,19	5,71	6,15	13,46	26,8
18	2,49	4,26	5,85	8,06	8,59	17,41	37,49
22	4,39	7,51	10,31	14,15	15,07	26,66	66,1
28	8,71	14,83	20,34	27,89	29,7	44,57	131
35	15,99	27,22	37,31	51,05	54,37	70,52	240,7
42	26,56	45,17	61,84	84,52	90	103,4	399,3
54	52,81	89,69	122,7	167,2	178,1	174,1	794,2
63	81,38	138,02	188,9	257,1	273,8	240,4	1223,9

Table 1: Cooling capacity corresponding to different tubes diameter referred to different pressure drops or speed values. This table refers to the pressure drop values or speed values (for the liquid line) indicated in the column heading.

If different pressure drops are needed, the cooling capacity shall be corrected with the following formula:

$$P_f = P \times \left[\frac{L_e \times \Delta T}{L_{eff} \times \Delta T_{tab}} \right]^{0,55} \quad [1]$$

Where:

Pf: cooling capacity

P : cooling capacity shown in table 1

Le : equivalent length of the table 1

L_{eff} : actual equivalent length

ΔT : required pressure drop

ΔT_{tab} : pressure drop shown in table 1

The equivalent length can be calculated as follows:

A fictitious length for each curve or branch or concentrated drop shall be added to the real lengths, corresponding to the linear tube length that would give the same pressure drop caused by the curve or by the branch.

Those fictitious lengths are shown in the table 2 and shall be considered effective for fully open valves.

Dext tubo Cu [mm]	Cu Pipe Dext [mm]	10	12	14	16	18	22	28	35	42	54	68
Curva 90° standard	Standard 90° curve	0,38	0,4	0,46	0,48	0,5	0,6	0,8	1	1,2	1,5	1,7
Curva 90° ampio raggio	Large radius 90° curve	0,26	0,3	0,29	0,3	0,3	0,4	0,5	0,7	0,8	1	1,2
Gomito a 90°	90° elbow	0,66	0,7	0,73	0,76	0,8	1	1,2	1,7	1,9	2,5	2,9
Curva a 45°	45° curve	0,2	0,2	0,22	0,24	0,2	0,3	0,4	0,5	0,6	0,8	0,97
Gomito a 45°	45° elbow	0,3	0,3	0,36	0,4	0,4	0,5	0,6	0,9	1	1,4	1,6
Curva a 180°	180° curve	0,67	0,7	0,73	0,76	0,8	1	1,2	1,7	1,9	2,5	2,9
Raccordi cambio direzione	Direction change connectors	0,77	0,8	0,87	0,91	0,9	1,2	1,5	2,1	2,4	3	3,5
Pass. diretto flusso senza riduz.	Direct pass. of flow without reduc.	0,26	0,3	0,29	0,3	0,3	0,4	0,5	0,7	0,8	1	1,2
Pass. diretto flusso riduz. 1/4	Direct passage of reduction flow 1/4	0,33	0,4	0,39	0,43	0,4	0,6	0,7	0,9	1,1	1,4	1,7
Pass. diretto flusso riduz. 1/2	Direct passage of reduction flow 1/2	0,38	0,4	0,46	0,48	0,5	0,6	0,8	1	1,2	1,5	1,8
Allargamento brusco d/D= 1/4	Sudden expansion d/D= 1/4	0,36	0,4	0,48	0,54	0,64	0,8	0,1	1,4	1,8	2,4	3
Allargamento brusco d/D= 1/2	Sudden expansion d/D= 1/2	0,2	0,2	0,28	0,33	0,36	0,5	0,6	0,9	1,1	1,5	1,9
Allargamento brusco d/D= 3/4	Sudden expansion d/D= 3/4	0,07	0,04	0,1	0,12	0,13	0,2	0,2	0,3	0,4	0,5	0,61
Restrizione brusca d/D= 1/2	Sudden restriction d/D= 1/2	0,18	0,2	0,24	0,27	0,3	0,4	0,5	0,7	0,9	1,2	1,5
Restrizione brusca d/D= 2/3	Sudden restriction d/D= 2/3	0,12	0,2	0,18	0,21	0,3	0,3	0,4	0,5	0,7	0,9	1,2
Restrizione brusca d/D= 1/3	Sudden restriction d/D= 1/3	0,07	0,1	0,1	0,12	0,13	0,2	0,2	0,3	0,4	0,5	0,61
Arresto brusco ingresso	Sudden inlet stop	0,41	0,5	0,5	0,54	0,68	0,9	1,1	1,6	2	2,7	3,6
Arresto brusco uscita	Sudden outlet stop	0,21	0,2	0,27	0,3	0,34	0,4	0,5	0,8	1	1,3	1,7
Protezione tubo ingresso	Inlet pipe protection	0,4	0,5	0,5	0,54	0,68	0,9	1,1	1,6	2	2,7	3,6
Protezione tubo uscita	Outlet pipe protection	0,28	0,3	0,4	0,46	0,53	0,7	0,82	1,3	1,5	2,1	2,6
Rubinetto/Valv. ritegno dritti	Straight cock/check valve	4,8	5,1	5,3	5,4	5,8	6,6	8,7	11,4	12,6	16,5	20,7
Rubinetto inclinato a 60°	Cock at 60° inclination	2,2	2,4	2,5	2,7	2,9	2,3	4,6	6,1	7,3	9,1	10,7
Rubinetto inclinato a 45°	Cock at 45° inclination	1,6	1,8	2	2,1	2,3	2,7	3,6	4,6	5,4	7,3	8,7
Rubinetto/Valv. ritegno a squadra	Right angled cock/check valve	1,6	1,8	2	2,1	2,3	2,7	3,6	4,6	5,4	7,3	8,7
Saracinesca	Gate valve	0,16	0,18	0,2	0,21	0,23	0,27	0,3	0,46	0,54	0,7	0,85
Valvola a sfera dritta	Straight ball valve	1,3	1,5	1,7	1,8	2	2,4	3,6	4,2	4,8	6,1	7,6

Table 2: Equivalent lengths (in meters) for concentrated drops.

The table1 is referred to a condensation temperature of 40°C.

In case of different condensation temperatures the following correcting values shall be applied to the cooling capacity.

Cond. Temp (°C)	20	30	40	50
K suction line	1.18	1.1	1	0.91
K discharge line	0.8	0.88	1	1.11

Table 2.a: Cooling capacity of the correction factors in function of the condensing temperature.

Using the table 1 and the suggested correction factors it is possible to choose the proper diameter in accordance to the requested cooling capacity and the evaluated pressure drops.

Once the choice is taken a check shall be made by calculating the real pressure drop using the following formula.

$$\Delta T = \Delta T_{tab} \times \frac{L_{eq}}{L_c} \times \left[\frac{P_f}{P} \right]^{1,5} \quad [2]$$

with symbols having the same meaning as in formula [1]

In order to verify if the selected diameter could be correct the following maximum pressure drops shall be considered according to ASHRAE:

Liquid line: $\Delta P_{max} = 0,5 \div 1$ K

Suction line: $\Delta P_{max} = 1$ K

Discharge line: $\Delta P_{max} = 1$ K

Example:

How to choose the proper tube diameter.

Input data:

Equivalent length calculated: $L_{eq}=60$ m

Saturated suction temperature: $T_{as}=5^\circ\text{C}$

Condensing temperature: $T_c=50^\circ\text{C}$

Cooling capacity at the evaporator: $P_f=30$ kW

Since the values of cooling capacity indicated in Table 1 are relative to pressure drop values equal to 0.02 K / m , first check the



pressure drops that would occur on the line using the diameter corresponding to the cooling capacity of the unit. The equivalent length is about 60 meters, then with a pressure drops of 0.02 K / m the total pressure drops are equal to: $T = 60 \times 0,02 = 1.2$ K. These pressure drops are higher than the maximum specified by ASHRAE. To comply with the recommended value (K1) it is necessary to reduce the pressure drops length down to 0.016 K / m, using the formula [1] . Refer to Table 1 and to search in the discharge line column (with suction temperature equal to 5 ° C) a cooling capacity close to the unit one.

$P = 29.7$ kW at line with $\Delta_{ext} = 28$ mm.

This capacity is relative to a condensing temperature of 40 ° C. To obtain the corresponding 50 ° C capacity, this value shall be multiplied to a factor shown in the table 2a: (discharge line, $T_c = 50$ ° C) \rightarrow factor = 1.11.

The cooling capacity delivered by the line with $\Delta_{ext} = 28$ mm (corresponding to pressure drops of 0.02 k/m) is therefore $P = 29,7 \times 1,11 = 32.97$ kW.

In conclusion, the data we need to use the formula [1] are the following:

$$\Delta T = 0,016 \times 60 = 0,96 \text{ K}$$

$$\Delta T_{tab} = 0,02 \text{ K}$$

$$L_e = 1 \text{ m}$$

$$L_{eff} = 60 \text{ m}$$

$$P = 32,97 \text{ kW}$$

As a consequence:

$$P_f = 32,97 \times \left[\frac{1}{60} \times \frac{0,96}{0,02} \right]^{0,55} = 29,16 \text{ kW} < 30 \text{ kW}$$

The above value represents the cooling capacity for a line with $\Delta_{ext} = 28$ mm, at $T_{as} = 5^\circ\text{C}$ e $T_c = 50^\circ\text{C}$ and with a corresponding pressure drop equal to 0,016 K/m.

Since this capacity is lower than the cooling capacity supplied by the unit (30 kW), the pipe diameter will be undersized.

The $\Delta_{ext} = 35$ mm will then be chosen. In order to verify if the choice is correct, the total pressure drop must be calculated again by using the formula [2]. Consequently, having chosen $\Delta_{ext} = 35$ mm only the P value will change, as follows:

$$P = 54,37 \times 1,11 = 60,35 \text{ kW}$$

And then:

$$\Delta T = 0,02 \times \frac{60}{1} \times \left[\frac{30}{60,35} \right]^{1,8} = 0,34 \text{ K}$$

As shown, the new total pressure drop is much smaller than the maximum value suggested by ASHRAE.

It should be noted that it's important to verify that the compressor oil return on the suction line is ensured.

A small oil amount tends to escape towards the refrigerant circuit, and therefore it is fundamental that even this small oil amount could flow through the pipes reaching the compressor through the suction line. In this section, the oil can flow by gravity if the pipe is oriented downward otherwise it is carried by the refrigerant if the pipe is perfectly horizontal or even upward oriented.

To ensure a correct oil flowing the refrigerant speed shall not be lower than the minimum allowed value. This, however, shall also be possible if the is working at partial load due to a reduced power demand from the plant.

In such cases, very common for unit of big capacity, it is necessary to size the plant according to the minimum compressor capacity, and not in accordance to the full load capacity.

In Tables 3 and 4, the allowed capacities at partial load condition are shown, both for the suction and discharge lines.

Temperatura satura di evaporazione (°C) Saturated evaporation temperature (°C)	Temperatura di aspirazione del gas (°C) Gas suction temperature (°C)	Tubo rame, diametro esterno (mm) - Copper pipe, External diameter (mm)									
		12	14	16	18	22	28	35	42	54	68
-20	-15	0,287	0,447	0,646	0,885	1,508	2,867	5,087	8,213	15,748	23,703
	-5	0,273	0,425	0,614	0,841	1,433	2,724	4,834	7,804	14,963	22,522
	5	0,264	0,411	0,595	0,815	1,388	2,638	4,68	7,555	14,487	21,805
-5	0	0,389	0,605	0,874	1,198	2,041	3,879	6,883	11,112	21,306	32,070
	10	0,369	0,574	0,829	1,136	1,935	3,678	6,526	10,535	20,2	30,405
	20	0,354	0,559	0,797	1,092	1,861	3,537	6,275	10,131	19,425	28,238
5	10	0,47	0,731	1,057	1,449	2,468	4,692	8,325	13,441	25,771	28,791
	20	0,440	0,684	0,99	1,356	2,311	4,393	7,794	12,582	24,126	36,314
	30	0,422	0,666	0,949	1,301	2,217	4,213	7,467	12,069	23,414	34,831

Table 3: Minimum capacity (kW) ensuring the oil flowing in vertical sections of the suction line (R410a refrigerant).

The cooling capacity shown in table 3 refer to 40°C of condensing temperature: in case of different temperature values of the liquid line, the capacities must be adjusted according to the following factors:

Liquid temperature (°C)	30	40	50
Correction factor	1.08	0.91	0.82

Table 3.a: Correction factors for different liquid temperature.

Temperatura satura di mandata (°C) Saturated discharge temperature (°C)	Temperatura di mandata del gas (°C) Discharge temperature of the gas (°C)	Tubo rame, diametro esterno (mm) - Copper pipe, External diameter (mm)									
		12	14	16	18	22	28	35	42	54	68
30	70	0,596	0,927	1,34	1,836	3,127	5,945	10,547	17,028	32,649	49,143
	80	0,579	0,901	1,303	1,785	3,040	5,779	10,254	16,554	31,74	47,775
	90	0,565	0,878	1,27	1,74	2,964	5,635	9,998	16,14	30,948	46,582
40	80	0,618	0,96	1,389	1,903	3,242	6,163	10,934	17,653	33,847	50,946
	90	0,601	0,935	1,353	1,853	3,157	6,001	10,647	17,189	32,959	49,609
	100	0,584	0,908	1,314	1,8	3,067	5,83	10,343	16,690	32,018	48,193
50	90	0,63	0,981	1,418	1,943	3,31	6,291	11,162	18,020	34,552	52
	100	0,611	0,951	1,375	1,884	3,209	6,1	10,823	17,473	33,503	50,428
	110	0,595	0,926	1,339	1,834	3,125	5,941	10,54	17,016	32,627	49,019

Table 4: Minimum capacity (kW) ensuring the oil flowing in vertical sections of the discharge line (R410a).

In this case also, the cooling capacity shown in table 4 refers to a saturated evaporating temperature equal to -5°C: for different temperature values the capacity must be adjusted according to the following factors:

Saturated suction temperature (°C)	-20	+5
Correction factor	0.96	1.02

Table 4.a: Correction factors for different suction temperature

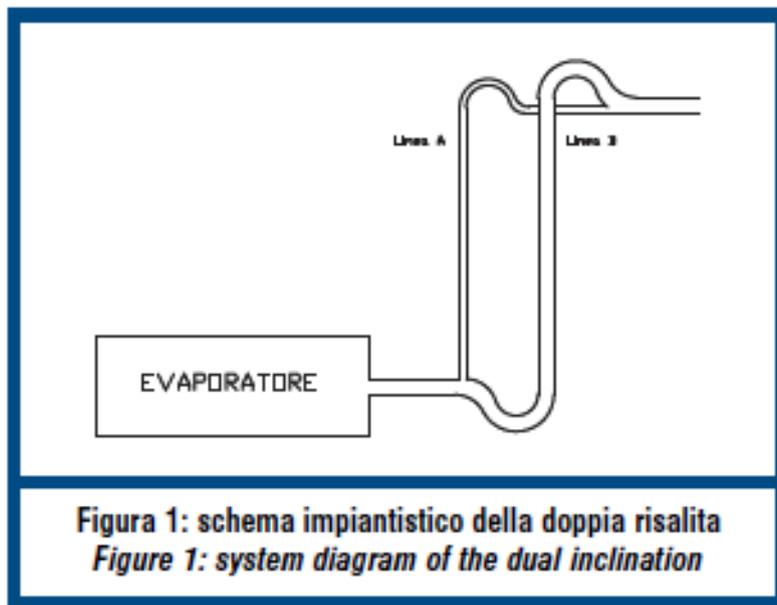
It might be guessed that in order to guarantee the proper speed ensuring the correct oil flow, if the compressor is working at partial loads, the diameter shall be reduced, therefore a too much high speed is obtained when the compressor is working at full load. This is cause of excessive pressure drops.

Thus, the refrigerant line sizing, results often in a problem of balance between two opposite needs. In some cases (especially when the suction line is upward oriented), this balance cannot be easily reached, and therefore it is necessary to use a precaution on the plant, known as a "dual inclination".

The dual inclination consist in installing two parallel lines, one of each (marked as "A" in fig. 1) is sized in order to allow the oil return at the minimum capacity, the other one (marked as "B") is sized to ensure that the sum of the two sections is at least equal to that of a single line dimensioned in accordance to the maximum cooling capacity.

Between the two vertical sections a sump is realized. The sump is sized in order to guarantee that at minimum loads, it will be filled with oil closing the entrance to the line "B".

The sump, however, must not contain excessive amounts of oil, but it must have a minimum volumetric capacity. When the cooling capacity grows, the greater flow creates a higher pressure allowing to overcome the oil cap and therefore also the line "B" works.

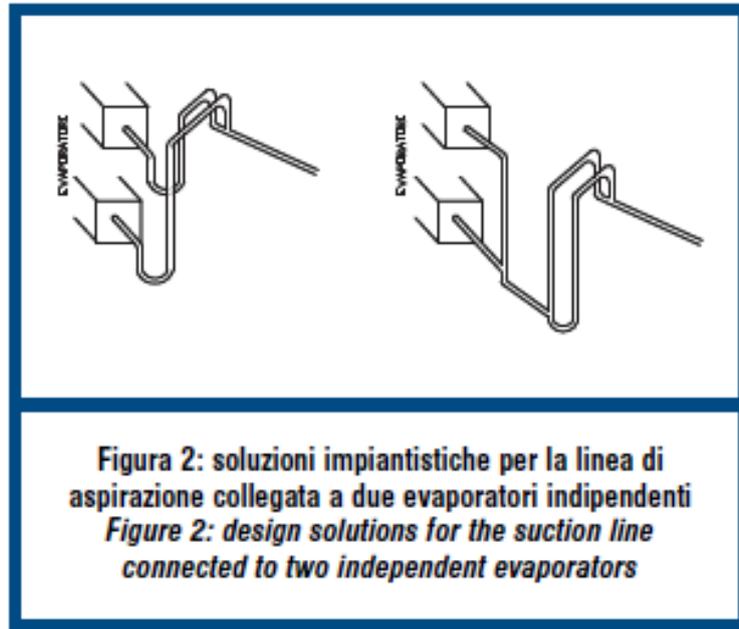


There are two other important precautions to be taken into account in making suction lines an oil trap 6 meters shall be created or a small downward line inclination shall be installed in case of horizontal sections, to ensure a better oil flow.

If the circuit is equipped with two evaporators in parallel, one independent from each other, and one of the two evaporators is not working, oil accumulation must be avoided anyway.

If the two evaporators are installed at the same level a downward line on both evaporators outlet shall be created, before joining the common section.

If the two evaporators are installed at different levels there are two possible solutions shown in figure2.



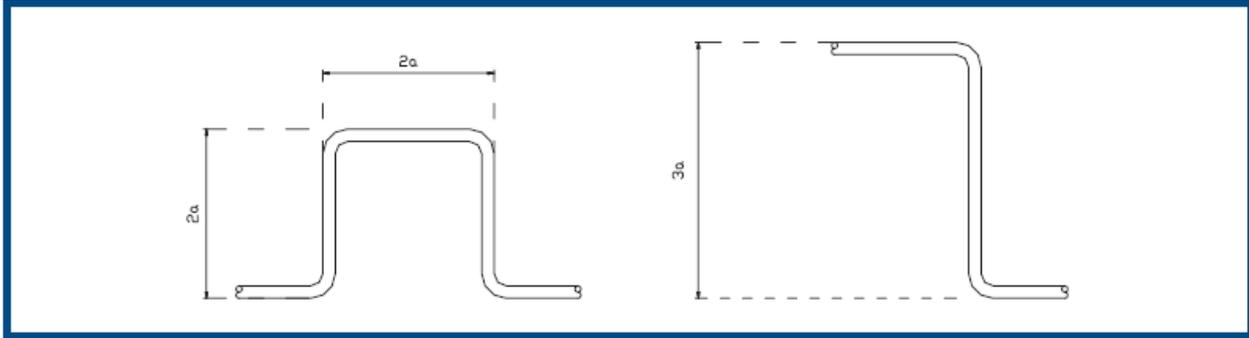
On the discharge line, there is the same problem due to the oil flow on the suction line. The solution to the problem is the same. In this case, the most important issue could be the oil drop towards the compressor. This issue can be solved using check valves and making oil taps if the condenser is mounted at a higher level than the compressor. On the liquid line, it is important to avoid that non liquid refrigerant reaches the thermostatic valve. This purpose is achieved by giving to the fluid a high subcooling in the condenser, but a proper sized liquid receiver shall be installed upstream from the line in the case of high lengths (over 20 meters). If the liquid temperature is lower than the outdoor temperature (it may happen for water cooled units) the line shall be properly insulated.

7.4 PRECAUTIONS FOR REFRIGERANT LINE SIZING

- Suction line must always be insulated to avoid condensate formation.
- The liquid line must be insulated if the outdoor temperature is higher than the liquid temperature. (approximately 5°C less than the condensing temperature)
- The discharge line must be insulated only to prevent from burning danger (the temperature can reach up to 100°C)
- Special couplings or U-shaped or L-shaped sections can be used to compensate the copper pipe expansions. The expansion of the pipe can be estimated using the following table:

Temperature (°C)	-20	0	25	50	75	100	125
Expansion (mm/mt)	0	0.4	0.7	1.1	1.5	1.9	2.3

These special couplings or U-shaped or L-shaped sections used to compensate the pipe expansion can be sized according to the following sketch:

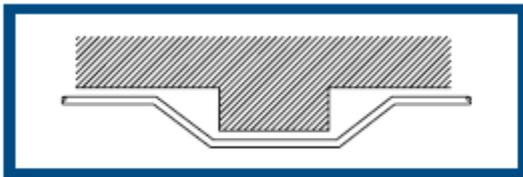


Diametro tubo rame (mm) Copper pipe diameter (mm)	Lunghezza tratto a (mm) riferita a dilatazione lineare (mm) - Length of section a (mm) referred to linear expansion (mm)							
	10	20	30	40	50	60	80	100
16	25	29	36	45	50	58	66	74
18	25	30	38	46	52	60	68	75
22	26	32	41	48	56	62	71	79
28	28	37	45	52	61	65	76	86
36	30	40	48	56	65	70	85	95
42	32	42	51	60	69	77	91	103
54	36	45	57	66	77	87	101	114
68	39	49	59	69	79	89	107	121

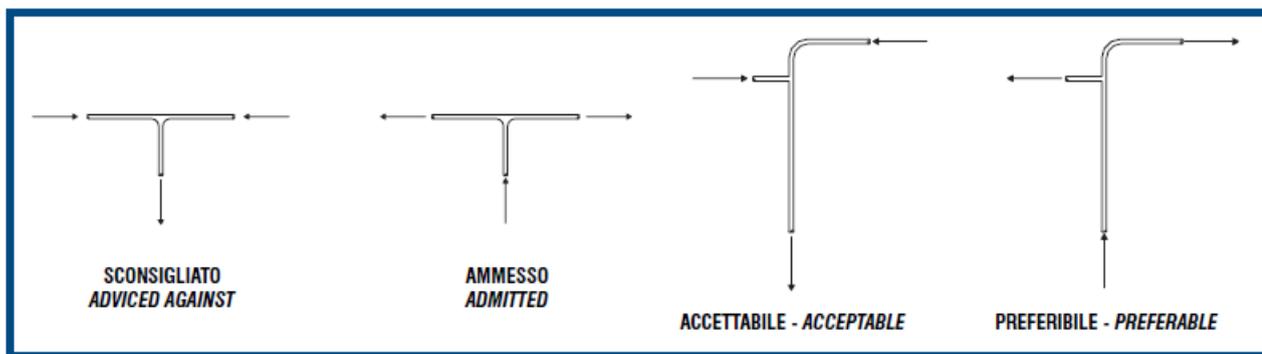
Since this type of components may cause significant pressure drops, their use must be carefully evaluated. Supports shall be installed to support the pipes weight and shall be spaced according to the following prescriptions:

Pipe diameter (mm)	14-18	22-28	35-54	63
Max distance between the supports (m)	2	2.5	3	3.5

Curves and joints cause pressure drops. Large-radius curves are strongly recommended; in case of barriers to overcome 45° curves are recommended if compared to 90°.



T joint shall be made in accordance with the following prescriptions:



• The vibration and noise reduction is very important, and can be carried out by appropriate devices such as: resilient joints (strongly recommended for diameters higher than 50 mm), proper insulation to separate the pipe from the wall (if the pipe passes through the wall), flexible anchors.

• Pipe placing:

The installation of too many curves is not recommended, because each curve cause an increase rectilinear section. Moreover, the curves must be shaped with a large curvature radius. Be extremely careful to not reduce the pipe section because it could obstruct the normal flow of refrigerant, with consequent overwork for the compressor. The presence of too many curves in the plant could create friction and vibration, causing at the connection points pipes and vents slackening or breakage.

• Difference in height:

The difference in height recommended by the manufacturer shall be respected between the evaporating unit and the condensing units, otherwise cooling capacity, oil return and lubrication problems may occur.

• Flare connections

A good flare connection shall not be characterized by flash, especially in the conical contact section of the tap or of the connection and shall be able to work without friction.

The ideal space between folder and pipe union shall be approximately 5 mm; during tightening it is recommended to apply a drop of oil to ease locking. Be careful not to apply the oil in the contact or sealing area with the pipe union, as the oil coating will tend to dry out.

8 LIQUID RECEIVER

The refrigerant charge of the unit depends from the heat exchanger capacity. For a reversible heat pump the heat exchangers work as condenser or as evaporator, in accordance to the cycle. The liquid receivers are installed on the refrigerant circuit and allow to store the charge difference between the two cycles.

The placement of the liquid receiver shall be evaluated depending on the capacity of the heat exchangers of the plant and those installed on board of the unit.

For example:

Capacity of the heat exchanger on board: 10 liters

Capacity of the remote heat exchanger: 6 liters

During chiller operating mode the heat exchanger on board works as a condenser, while the remote one works as evaporator.

Viceversa during heat pump mode.

The difference between the capacity of the two heat exchangers results in a refrigerant charge difference between the two cycles, it is therefore necessary to have a liquid receiver which capacity shall be properly sized to store the excess of refrigerant when a smaller refrigerant charge is required.

8.1 LIQUID RECEIVER SIZING

Here below an evaluation method for the liquid receiver sizing is shown. The described method is proposed to give an approximate indication for the selection of the proper liquid receiver. The volume values obtained may change depending on the specific plant requirements and shall therefore be evaluated in the plant design.

$$V_{\text{Receiver}} = 0.4 \times (V_1 - V_2)$$

V1: volume of the unit's heat exchanger (please contact Trane to obtain this information)

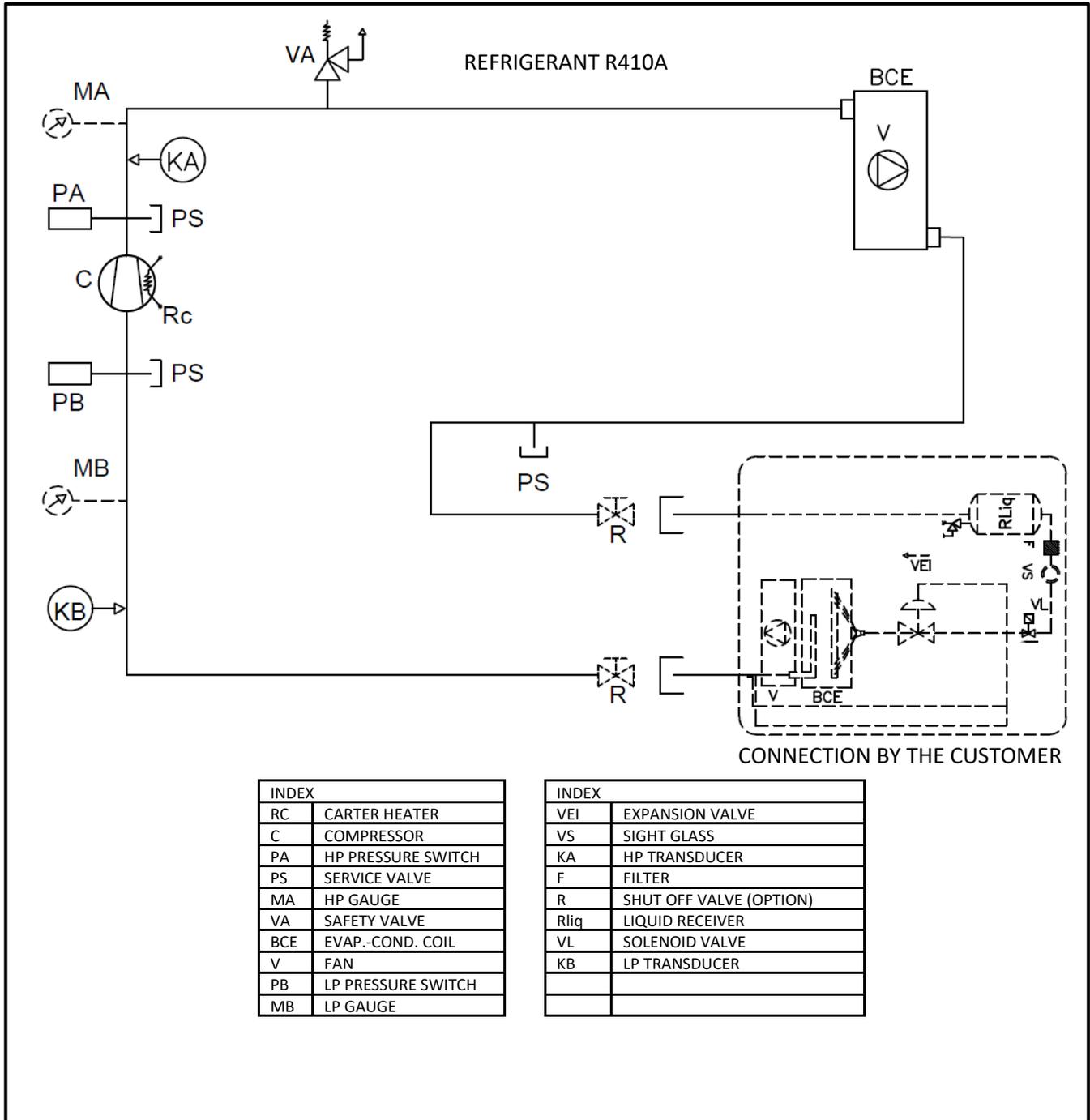
V2: Volume of the remote heat exchanger.

If **V receiver** has positive sign, the receiver shall be placed so as to be filled in heat pump mode and discharged in chiller, otherwise it shall be placed so as to be filled in chiller mode and emptied in the heat pump.

In addition, the liquid receiver capacity shall be sized in accordance to the total refrigerant charge of the plant, in order to store the entire amount of refrigerant in the plant in case maintenance.

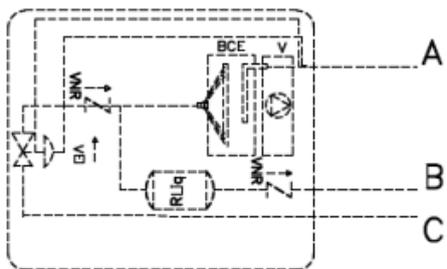
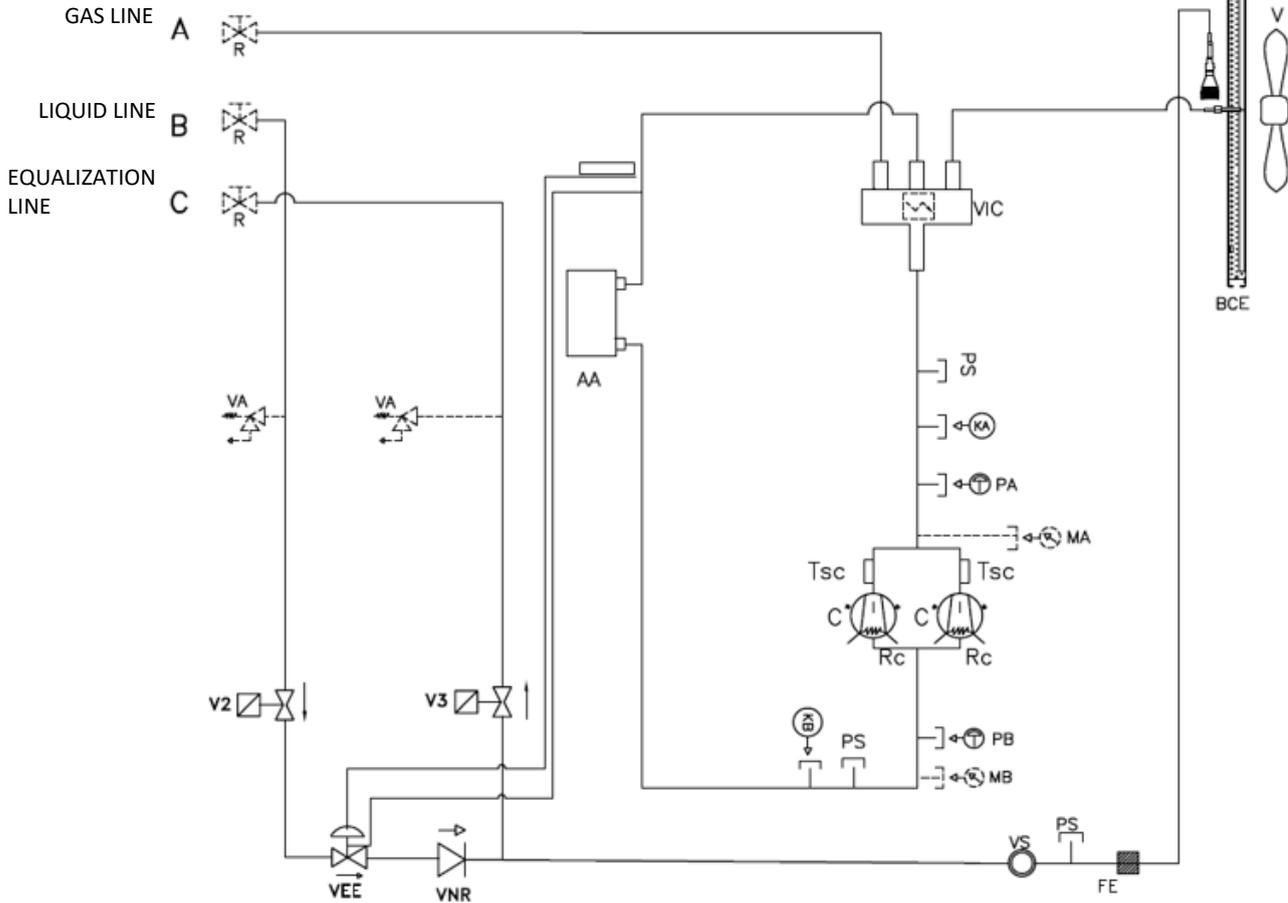
8.2 INSTALLATION DIAGRAM AND PLACING OF THE LIQUID RECEIVER

RAUS 410 - 760

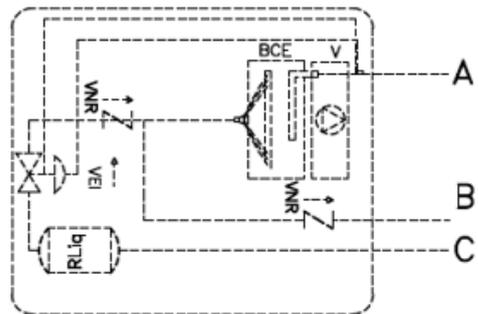


RAUX 370-660

REFRIGERANT R410A



Liquid receiver in heat pump mode
CONNECTION BY THE CUSTOMER



Liquid receiver in chiller mode
CONNECTION BY THE CUSTOMER

INDEX	
RC	CARTER HEATER
C	COMPRESSOR
PA	HP PRESSURE SWITCH
PS	SERVICE VALVE
MA	HP GAUGE
VNR	CHECK VALVE
BCE	EVAP.-COND. COIL
V	FAN
PB	LP PRESSURE SWITCH
MB	LP GAUGE
VIC	CYCLE INVERSION VALVE
VEE	ELECTRONIC EXPANSION VALVE

INDEX	
VEI	MECHANICAL EXPANSION VALVE
VS	SIGHT GLASS
KA	HP TRANSDUCER
FE	FILTER
R	SHUT OFF VALVE (OPTION)
Rliq	LIQUID RECEIVER
V2-V3	CIRCUIT VALVE
KB	LP TRANSDUCER
VA	LIQUID SAFETY VALVE (OPTION)
AA	ACCUMULATOR
TSC	COMPRESSOR DISCHARGE TEMPERATURE
Tair	EXTERNAL AIR TEMPERATURE PROBE



As mentioned in the previous paragraph, the liquid receiver location for RAUX versions shall be evaluated in accordance to the refrigerant charge delta of the two cycles. If the higher refrigerant charge is required for the chiller mode the liquid receiver shall be placed in a location that ensure the proper filling during the operation in heat pump mode and the proper emptiness during chiller mode.

In case of excess refrigerant charge in heat pump mode, the liquid receiver shall be placed in a location that ensure the proper filling during the operation in chiller mode and the proper emptiness during heat pump mode.

IMPORTANT

The choice of the liquid receiver capacity and its placing is the responsibility of the designer of the plant.

9 REMOTE TERMINALS CONTROL AND EXPANSION VALVE

The units can be connected to hydronics or direct expansion terminals. In both case sit is necessary to make sure that terminals pumps and fans are switched on before the compressors is switched on and they have to be switched off after the compressor is switched off.

The expansion valve for the cooling operating mode shall be placed next to the terminal.

10 ELECTRICAL PANEL

When reviewing this manual keep in mind.

- All field-installed wiring must be in accordance with local regulations, CE directives and guidelines. Be sure to satisfy proper equipment grounding requirements according CE
- The standardized values - Maximum Amps –Maximum kWatts are displayed on unit nameplate.
- All field-installed wiring must be checked for proper terminations, and for possible shorts or grounds.

Ensure total protection against the possible penetration of water into the connection point.

All the cables and the terminals are univocally numbered according to the electrical scheme in order to avoid possible misinterpretation. The identification system of the cables connected to the components allow also an easy and intuitive recognition of the component. Each component of the electrical panel is provided with an identification plate according to what is shown on the electrical scheme. All the connections to the electrical panel are made from the bottom and are equipped with cover preventing from break. The electrical panel supply is 400V/3ph+n/50Hz suitable for TN-S system and no additional power supply is necessary. If the unit is powered by a TN-C, TT or IT power supply system the Trane catalogue option “power supply without neutral 400V/3ph/50Hz” must have been ordered and implemented in the unit’s electrical cabinet. The entrance for the power cables is provided on the bottom of the box where a dismountable flange suitable for the purpose is provided.

The control circuit is powered with 24 VAC. Each unit is provided with auxiliary transformer control circuit 230/24V. It requires no additional power cable for the control equipment.

The circuit has an electric resistance installed in the compressor in order to keep warm the oil and thus avoid the transmigration of the refrigerant in its interior. Obviously the operation of the electrical resistors is ensured as long as the unit is power supplied.

The unit is equipped with an alarm relay, which changes state every time an alarm occurs in one of the cooling circuits. Connect the terminals as per the wiring diagram on the unit - terminal “X” - a visual or audible alarm or any external supervision system.

BMS to monitor its operation is allowed. See the wiring of the unit for wiring.

IMPORTANT The electrical cabinet is mounted on the lower part of the unit front side. It would be advisable to evaluate, before installing the unit, whether the electrical cabinet would rather be higher jointly and severally with the whole unit. In this case, the unit has to be installed higher by means of an adequate basement so that the cable entry can be at a proper height from the ground according to the electrical power supply design.

WARNING To avoid corrosion, overheating or general damage, at terminal connections, unit is designed for copper conductors only. In case of aluminum conductors an intermediate connection box must be added. In case of aluminum cable bi material connecting device is mandatory. Cable routing inside control panel should be made case by case by installer.

WARNING Hazardous Voltage with Capacitor! Disconnect all electric power, including remote disconnects and discharge all motor start/run and capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized.

For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer’s literature for allowable waiting periods for discharges capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

After disconnecting input power, wait five (5) minutes for units which are equipped with EC fans and wait twenty (20) minutes for units which are equipped with variable frequency drive (0V DC) before touching any internal components. Failure to follow these instructions could result in death or serious injury.



11 OPERATOR RESPONSABILITIES

It is important that the operator is properly trained and familiar with the equipment before working on the unit. In addition to reading this manual, the operator must study the manual operation of the microprocessor and the wiring diagram to understand the sequence of start-up, operation, shutdown sequences, and the criterion of operation of all safety devices. During the initial start-up of the unit an authorized technician is available to answer any questions and educate on the proper functioning. We recommend the operator to maintain a record of the operating data for each unit installed and all maintenance activities and periodic service. If the operator observes abnormal or unusual operating conditions, consult the authorized service technician.

12 START-UP PRELIMINARY PROCEDURES

12.1 STARTING CHECK

With the general switch open, check that the electrical connections are tightly clamped. Check for any possible refrigerant leaks. Check that the electrical data on the label correspond to those of the mains supply. Check that the thermal charge available is appropriate for starting.

12.2 REFRIGERANT SEALS CONTROL

RAUS and RAUX units are shipped void of refrigerant, pressed with nitrogen and with pipes plugged (shut-off valves are an option).

If the system, after charging it, were not under pressure, blow refrigerants (vapour) into it until pressure is reached and look for leakage.

After having eliminated the leakage, the system has to be dehydrated with a vacuum pump up to at least 1mm Hg - absolute pressure (1 Torr or 133.3 Pa). This is the minimum recommended value to dehydrate the plant.

Danger Do not use the compressor to vacuum the system.

12.3 REFRIGERANT CHARGE CHECK

When the unit is working and bubbles can be seen through the peephole with the compressor running with a full charge and steadily, it means that the refrigerant charge is insufficient.

13 CHECK LIST – MANDATORY OPERATION CONTROL BEFORE START-UP

DATE		N.	
UNIT			

CUSTOMER:	SITE:
	ADDRESS:
	POSTCODE:
	COUNTRY:

THE INTENDED PURPOSE OF RAUS / RAUX UNITS IS NOT FOR INDUSTRIAL PROCESS APPLICATION. PLEASE CONTACT TRANE TECHNICAL DEPARTMENT IN CASE OF INDUSTRIAL PROCESS APPLICATION.

GENERAL

		COMPLIANCE	
		YES	NO
1	<p>THE UNIT DISPLAYS DENTS OR DAMAGES ON THE EXTERNAL CASING OCCURRED DURING THE TRANSPORTATION OR POSITIONING.</p> <p>IF ANY, SPECIFY BELOW:</p> <p>WARNING: PLEASE BE AWARE THAT RELEVANT DAMAGES CAUSED BY THE QUOTED CIRCUMSTANCES MAY RESULT IN THE CALL-OFF OF THE WARRANTY.</p>		
2	<p>THE UNIT HAS BEEN INSTALLED IN ACCORDANCE WITH THE MINIMUM DISTANCE PROVIDED IN THE DIMENSIONAL DRAWING AND TECHNICAL DOCUMENTATION PROVIDED.</p>		
3	<p>THE UNIT IS INSTALLED NEXT TO THE: PHOTOVOLTAIC SYSTEM, ELECTRONIC TRANSMITTERS, ANTENNAS OR SIMILAR DEVICES.</p>		
4	<p>THE UNIT IS POSITIONED ON A PERFECTLY FLAT (NOT INCLINED) SURFACE.</p>		
5	<p>ANTI-VIBRATIONS DAMPERS HAVE BEEN INSTALLED BETWEEN THE UNIT AND THE FLOOR.</p>		
6	<p>THE UNIT DISPLAYS DEFECTS OR DAMAGES RESULTING FROM MODIFICATIONS OR CHANGES (UNIT TAMPERING / UNAUTHORIZED MODIFICATIONS TO THE REFRIGERANT CIRCUIT OR THE HYDRAULIC CIRCUIT OR THE ELECTRICAL PANEL OR CHANGES TO THE UNIT OPERATING PARAMETERS) MADE BY A THIRD PERSON WITHOUT A WRITTEN AUTHORIZATION ISSUED BY TRANE. THE UNIT SHALL BE CONFORM TO TRANE WIRING DIAGRAMS AND TECHNICAL DOCUMENTATION) IN CASE OF RELEVANT DIFFERENCE BETWEEN THE UNIT AND TRANE STANDARD CONFIGURATION PLEASE CONTACT TRANE.</p> <p>WARNING: PLEASE BE AWARE THAT RELEVANT DAMAGES CAUSED BY THE QUOTED CIRCUMSTANCES MAY RESULT IN THE CALL-OFF OF THE WARRANTY.</p>		
7	<p>THE UNIT HAS BEEN INSTALLED VERY CLOSE TO A MARINE ENVIRONMENT OR AN AGGRESSIVE INSTALLATION ENVIRONMENT (HIGHLY CORROSIVE CHEMICAL AGENT).</p> <p>WARNING: PLEASE BE AWARE THAT RELEVANT DAMAGES CAUSED BY THE QUOTED CIRCUMSTANCES MAY RESULT IN THE CALL-OFF OF THE WARRANTY.</p>		
8	<p>SPOTTED PRESENCE OF MOLD, MUSHROOMS, BACTERIA, MICROBIAL OF ANY TYPE.</p>		
9	<p>THE UNIT DISPLAYS DAMAGES CAUSED BY: FLOODS, LIGHTNING, FIRE, ANY ACCIDENT BEYOND TRANE CONTROL.</p>		



ELECTRIC AND ELECTRONIC

		COMPLIANCE	
		YES	NO
10	THE UNIT IS ELECTRICALLY POWERED AND ALL THE RELEVANT ELECTRICAL WIRES ARE PROPERLY CONNECTED.		
11	ELECTRICAL SUPPLY HAS BEEN INSTALLED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED IN THE NAME PLATE AND IN THE TECHNICAL DOCUMENTATION. (ELECTRICAL POWER SUPPLY: 230V/400V +/- 10% - MAXIMUM "% OF PHASE IMBALANCE: +/- 2%) . IT IS RECOMMENDABLE TO CHECK BY USING A TESTER THE VOLTAGE VALUE (BETWEEN PHASES AND BETWEEN PHASE AND NEUTRAL)		
12	PHASES ARE CONNECTED IN THE PROPER SEQUENCE.		
13	ELECTRICAL CABLES SIZE ARE CONFORM TO FLA MAX VALUE.		
14	BOTH EXTERNAL AND INTERNAL ELECTRICAL WIRES ARE WELL TIGHTENED.		
15	THE COMPRESSOR CRANCKCASE HEATERS HAVE BEEN POWERED AND HEATED AT LEAST 8 HOURS BEFORE THE START-UP		
16	AN ELECTRONIC SUPERVISOR (OR ANY ADDITIONAL CONTROLLER) HAS BEEN INSTALLED.		
17	THE CONNECTION WIRES ARE SHIELDED.		
18	REMOTE CONTROL DEVICES OR INTERFACES ARE CONNECTED TO THE ELECTRICAL PANEL IN CONFORMITY WITH TRANE WIRING DIAGRAMS		
19	ELECTRONIC DEVICES ARE INTACT AND DON'T DISPLAY ANY DAMAGE.		
20	THE ELECTRICAL ABSORPTION IS STANDARD.		

REFRIGERANT CIRCUIT

		COMPLIANCE	
		YES	NO
21	ALL CONNECTIONS ON THE REFRIGERANT CIRCUITS ARE WELL TIGHTENED.		
22	THE ELECTRONIC LEAKAGE DETECTOR OR THE PRESSURE GAUGE LEVEL INSTALLED ON THE REFRIGERANT CIRCUIT HAVE DETECTED ANY LEAKAGE. IF ANY, SPECIFY BELOW:		
23	THE COMPRESSOR OIL INDICATOR LIGHT POINTS THE MAXIMUM LEVEL.		
24	THE FILTER INDICATOR LIGHT ON THE LIQUID LINE IS GREEN. WARNING: THE YELLOW INDICATOR LIGHT INDICATES PRESENCE OF MOISTURE IN THE CIRCUIT. IN THIS CASE PLEASE CONTACT TRANE.		

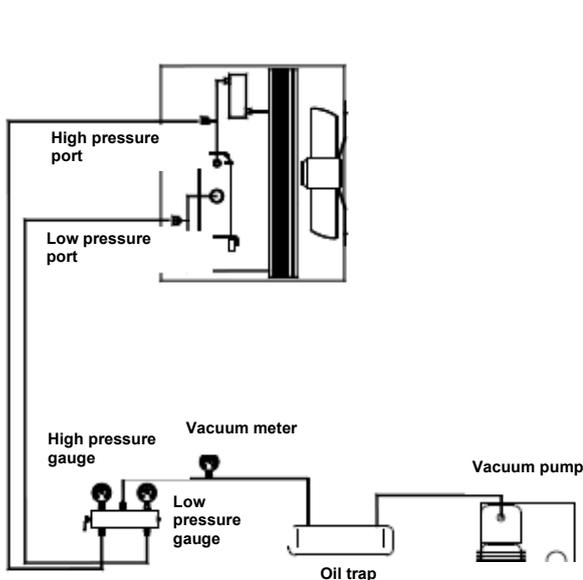
DATE:	<u>AUTHORIZED SERVICE:</u> <u>NAME AND SIGNATURE</u>	<u>CUSTOMER:</u> <u>NAME AND SIGNATURE</u>
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13.1 REFRIGERANT CHARGE

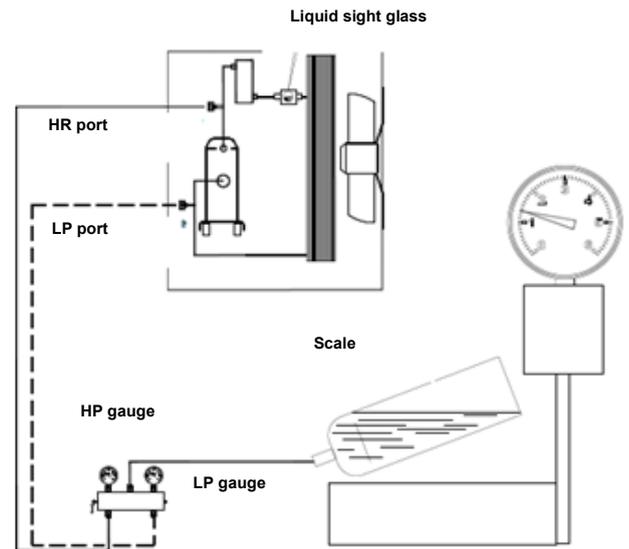
13.1.1 Refrigerant replacement procedure with unit stopped and in vacuum (refrigerant charge in the liquid phase)

Open the shut off valve as far as possible so that it closes the service coupling. Connect the refrigerant cylinder to the service coupling without tightening the coupling. Half close the liquid shut off valve. If the circuit has been dehydrated and is in vacuum, charge the liquid by turning the cylinder upside down. Weigh and charge the appropriate quantity. Open the valve completely. Start up the unit and leave it running at full charge for some minutes. Check that the indicator is clear with no bubbles. Make sure that the transparency condition without bubbles is due to the liquid and not to the vapour. Correct functioning of the unit allows for overheating of 4 - 7° C and sub cooling of 4 - 8°C. Values of overheating which are too high may be caused by a lack of refrigerant, whereas high sub cooling values may mean an excess of charge. After intervention on the charge, it is appropriate to check that the unit runs within the declared values: with unit steadily running on a full charge, measure the temperature of the suction line downstream of the thermostatic valve bulb; read the balance pressure to the evaporator on the low pressure manometer and the corresponding saturation temperature. Overheating is equal to the difference between the temperatures measured in this way. Then measure the temperature of the liquid line coming out of the condenser and read the balance pressure to the condenser on the high -pressure manometer and the corresponding saturation temperature. The sub cooling is the difference between these temperatures.

Danger While refrigerant is being added do not exclude any control system and let the water circulate in the evaporator to avoid the formation of ice.



Refrigerant circuit diagram connection to vacuum pump



Refrigerant charge in the liquid phase

13.1.2 Refrigerant replacement procedure with unit running (refrigerant charge in the vapour phase)

Caution: charge vapour only. Do not charge liquid because it may damage the compressor.

Connect the refrigerant cylinder to the service valve without tightening the coupling. Drain the connection piping and tighten the coupling. Charge the circuit until the indicator indicates liquid without bubbles. Now the unit has the required charge. Make sure not to over charge the circuit. Charging more than necessary leads to a higher delivery pressure, greater power consumption and possible damage to the compressor.

The symptoms of a low refrigerant charge are:

Low evaporation pressure.

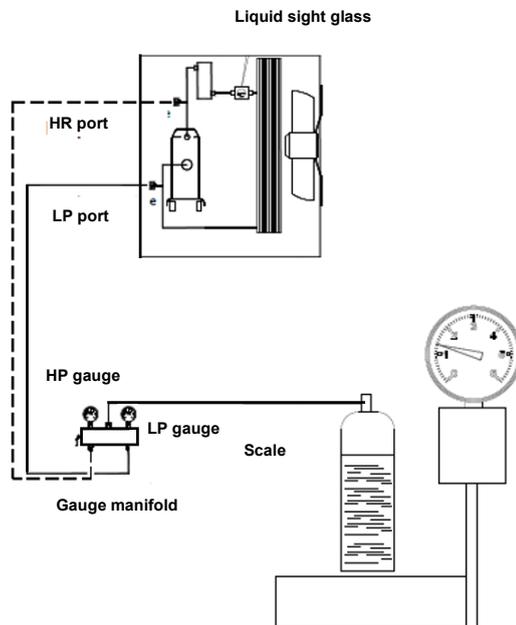
High value of superheating.

Low value of sub cooling.

In this case, add refrigerant R410A. The system is provided with a charging port between the expansion valve and the evaporator. Charge refrigerant until conditions return to work normal. Remember to replace the cap closing the valve at the end.

IMPORTANT!

If the unit has not been provided with integrated pump on board, do not turn off the external pump before 3 minutes have elapsed after turning off the last compressor. The early shutdown of the pump causes a water flow alarm failure.



Refrigerant charge in the vapour phase

14 MAINTENANCE

Maintenance operations are fundamental in order to keep the units running properly, from both a purely functional and an energetic point of view.

Every unit comes with a logbook, in which the user or the person delegated to machine maintenance can keep all the required notes, in order to keep a historical log of the Trane unit.

A lack of notes in the logbook could be considered proof of careless maintenance.

14.1 GENERAL

IMPORTANT!

Beyond the cadences of checks recommended in the following, in order to keep the unit at optimum levels of performance and efficiency and prevent incipient failures, we recommend periodic visits of inspection and control of the unit by qualified personnel.

In particular, we recommend:

4 annual visits to units that operate about 365 days / year (quarterly)

2 visits per year for units with seasonal operation about 180 days / year (one at the start of the season and another one at mid-season)

1 annual visit for units with seasonal operation of about 90 days / year (starting seasonal)

It's important that during the initial start-up and periodically during operation routine checks are carried out. Among them we must also check the suction and condensation as well as the sight glass located on the liquid line.

Check through the microprocessor installed on the unit if the unit is working within normal parameters of superheating and sub cooling. It is suggested to record on a weekly basis all the operating parameters of the unit. The collection of these data will be very useful to technicians, in case technical assistance is requested.

Compressor Maintenance IMPORTANT!

This inspection must be performed by qualified and trained personnel.

The analysis of vibration is a great tool for checking the mechanical conditions of the compressor.

It is recommended to check the value of the vibration immediately after starting and periodically on an annual basis.

Compressor Electrical Connections

It is very important that all the compressors are wired correctly for proper rotation. These compressors will not tolerate reverse rotation. Verify correct rotation/phasing using a rotation meter.

If wired incorrectly the compressor will make excessive noise, will not pump and will draw about half the normal current. It will also become very hot if allowed to run for an extended period.

NOTICE: Do not "bump" the compressor to check rotation as incorrect rotation could cause compressor motor failure in as little as 4 to 5 seconds!

Improper rotation of the compressors is indicated by a compressor module trip, noisy operation, no pressure difference on manifold gauges and low amp draw.

Compressor Replacement

If the chiller suffers a failed compressor, use these steps for replacement:

Each compressor has lifting eyes. Both lifting eyes must be used to lift the failed compressor.

After a mechanical failure of a compressor, it is necessary to change the oil in the remaining compressor and also replace the liquid line filter drier. After an electrical failure of a compressor, it will also be necessary to change the oil in the remaining compressor, replace the filters driers and add a suction filter drier with clean-up cores.

Change filters and oil until the oil no longer test acidic.

Make sure that a heater is correctly installed on the compressor. The heater helps prevent dry starts.

Note: Do not alter the refrigerant piping in any way as this can affect compressor lubrication.

Refrigerant System Open Time

The RAUS / RAUX units use POE oil and therefore refrigerant system open time must be kept to a minimum. The following procedure is recommended:

Leave a new compressor sealed until it is ready to be installed in the unit. Maximum system open time is dependent upon ambient conditions, but do not exceed one hour open time.

Plug the open refrigerant line to minimize moisture absorption. Always change the liquid line filter drier.

Do not leave POE oil containers open to the atmosphere. Always keep them sealed.



14.2 STANDARD CONTROLS

It is mandatory to clean regularly the coils for a proper unit operation. Pollution and other residual material clearing helps extend the life of the coils and the whole unit

Operations description	Recommended basis
Compressors oil level check	monthly
Inlet temperature check (overheating)	monthly
Fans and compressors motors electrical input check	monthly
Power supply and auxiliary power voltage check	monthly
Refrigerant charge check through sight glass	monthly
Compressors carter heaters operation check	monthly
Tightening all electrical connections	monthly
Coils cleanliness	monthly
Compressors and liquid circuit solenoid valve check	semiannual
Fans and compressors contactors state check	quarterly
Motor and fan bearing noise check	semiannual
Pressure vessels conditions check	yearly

14.3 MICROCHANNEL CONDENSER COIL – CLEANING PROCEDURES (MOUNTED ONLY ON RAUS 160-400)

It is mandatory to clean regularly the coils for a proper unit operation. Eliminate pollution and other residual material help to extend the life of the coils and the unit

CAUTION! Equipment Damage! Do not use coil cleaning agents to clean uncoated RAUS coils. Use clean water only. Use of coil cleaning agents on uncoated RAUS coils could cause damage to coils.

- Regular coil maintenance, including annual cleaning enhances the unit operating efficiency by minimizing compressor head pressure and amperage draw. The condenser coil should be cleaned at least once each quarter or more if the unit is located in a “dirty” or corrosive environment. Cleaning with cleansers or detergents is strongly discouraged due to the all-aluminum construction; straight water should prove sufficient, if not please contact Trane. Any breach in the tubes can result in refrigerant leaks

IMPORTANT: *Only in extreme cases should any type of chemical cleaner or detergent be used on microchannel coils. If it becomes absolutely necessary because water alone did not clean the coil, specify a cleaner that is:*

- A is pH neutral cleaner.
- An alkaline cleaner that is no higher than 8 on the pH scale.
- An acidic cleaner that is no lower than 6 on the pH scale.
- Does not contain any hydrofluoric acids.

Be sure to follow the instructions provided with any cleaner chosen. Keep in mind that it is still MANDATORY that the coils are thoroughly rinsed with water after the application of the cleaner even if the instructions specify a “No Rinse” cleaner. Cleaners or detergents that are left on the coil due to improper rinsing will significantly increase the possibility of corrosion damage on the microchannel coil.

Note: Quarterly cleaning is essential to extend the life of an E-coated coil and is required to maintain warranty coverage. Failure to clean an E-coated coil will void the warranty and may result in reduced efficiency and durability in the environment.

WARNING! Hazardous Voltage!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/ tagout procedures to ensure the power cannot be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

1. Disconnect Power to the unit.
2. Wear proper personal protection equipment such as a face shield, gloves and waterproof clothing.
3. Remove enough panels from the unit to gain safe access to the microchannel coil.

14.4 ORDINARY MAINTENANCE

Activities list	week	Month (note 1)	Year (note 2)
General:			
Data collection operation (Note 3)	X		
Visually inspect the unit for any damage and / or looseness		X	
Verifying the integrity of the thermal insulation			X
Clean and paint where needed			X
Electric:			
Check the correct operation of the equipment on the unit			X
Check the wear of contactors - Replace if necessary			X
Check tightness of all electrical terminals - Tighten if necessary			X
Clean the inside of the electrical panel			X
Visual inspection of the components for signs of overheating		X	
Check the operation of the compressor and the electric resistance		X	
Measurement using a Megger insulation of the compressor motor			X
Refrigerant circuit:			
Perform a test of refrigerant leaks		X	
Check through the sight glass coolant flow - Full Indicator	X		
Check the pressure drop of the filter drier		X	
Carry out the analysis of the vibrations of the compressor			X
Carry out the analysis of the acidity of the oil of the compressor (5)			X
Condensing section:			
Cleaning the condenser coils (Note 4)			X
Check that the fans are tightened			X

Notes:

- 1) The monthly activities include all those weekly.
- 2) The annual activity (or earlier in the season), include all activities weekly and monthly.
- 3) The values of the unit should be recorded each day for a high level of observation.
- 4) The coil cleaning may be required more frequently in areas with a high percentage of particles in the air.
- 5) TAN (Total Acid Number):

0.10:	No action
From 0.10 to 0.19:	Repositioning filters antacid and occurs after 1000 hours of operation. Continue to replace the filters until the TAN not falls below 0.10.
> 0.19:	Changing the oil, oil filter and the filter drier, Refer to regular intervals.



15 RECOMMENDED SPARE PARTS

There follows a list of the recommended parts for several years' running. Trane is at your disposal to recommend a personalised list of accessories according to the commissioned order, including the part number of the equipment.

1 YEAR	
COMPONENTS	QUANTITY
fuses	(all)
filter dryers	(all)
solenoid valves	(1 per type)
electronic expansion valves	(1 per type)
pressure switches	(1 per type)
gas gauges	(1 per type)
contactors and relays	(1 per type)
thermal protectors	(1 per type)
carter electric heaters	(1 per type)
check valve	(1 per type)
4-way valve	(1 per type)
safety valve	(1 per type)
sight glass	(1 per type)
fans and engines	(1 per type)

2 YEAR	
COMPONENTS	QUANTITY
fuses	(all)
filter dryers	(all)
solenoid valves	(all)
electronic expansion valves	(all)
pressure switches	(all)
gas gauges	(all)
contactors and relays	(all)
thermal protectors	(all)
carter electric heaters	(all)
check valve	(1 per type)
4-way valve	(1 per type)
safety valve	(1 per type)
sight glass	(1 per type)
fans and engines	(1 per type)
electrical components	(all)
compressors	(1 per type)

5 YEAR	
COMPONENTS	QUANTITY
fuses	(all)
filter dryers	(all)
solenoid valves	(all)
electronic expansion valves	(all)
pressure switches	(all)
gas gauges	(all)
contactors and relays	(all)
thermal protectors	(all)
carter electric heaters	(all)
check valve	(all)
4-way valve	(1 per type)
safety valve	(1 per type)
sight glass	(all)
fans and engines	(all)
electrical components	(all)
compressors	(all)
heat exchanger	(1 per type)

16 TROUBLESHOOTING

Symptom	Who can take corrective action		Probable cause	Possible remedy	
	Cooling	Heating			U = User S = specialised personnel
A The unit does not start	X	X	S	Probe faulty service	Check and replace if necessary.
	X	X	S	Lack of consent of the high or low pressure	See points D-E
	X	X	S	Defective compressor	See point B.
B The compressor does not start	X	X	S	Compressor burnt or seized	Replace the compressor.
	X	X	S	Compressor contactor de-energized	Check the voltage across the coil of the compressor contactor and the continuity of the coil.
	X	X	S	Power circuit open	Investigate the cause of the protection, and check if there are any short circuits in the wiring or in the windings of the motors of pump, fan, compressor and transformer
	X	X	S	Motor thermal protection open	The compressor has operated in critical condition or there is a lack of charge in the circuit: Make sure that working conditions are within the limits of operation. Loss of coolant: see section G.
C The compressor starts up and stops repeatedly	X	X	S	Intervention of the minimum	See point E.
	X	X	S	Compressor contactor defective	Check and replace if necessary.
	X	X	U	Calibration values of the set- point or differential	Modify them as reported in the tables.
	X	X	S	Lack of coolant	See point G
D The compressor does not start because the maximum pressure switch has tripped	X	X	S	Pressure switch out of order	Check and replace.
	X	X	S	Overcharge of refrigerant	Download the excess refrigerant
	X		U	Finned coil clogged, air flow rate is too low	Remove dirt from the coil and obstructions to the air flow
	X		S	Fan not working	See point F.
		X	S	Water pump circulation blocked	Unblock the pump.
		X	X	Water circulation pump and defective	Check and replace if necessary.
	X	X	S	Presence of non condensable gases in the refrigerant circuit	Prime the circuit after it has been downloaded and put under vacuum.
X	X	S	Refrigerant filter clogged	Check and replace.	

Symptom	Cooling	Heating	Who can take corrective action U = User S = specialised personnel	Probable cause	Possible remedy
E The compressor does not start because the minimum pressure switch has tripped	X	X	S	Pressure switch out of order	Check and replace.
	X	X	S	Machine completely void of refrigerant	See point G.
		X	U	Finned coil clogged, airflow rate is too low	Remove dirt from the coil.
	X		U	Water circulation pump blocked	Unlock the pump
	X		S	Water circulation pump blocked and defective	Check the pump and replace if necessary
		X	S	Presence of frost on the evaporator coil	See point N.
		X	S	Evaporator fan not working	See point F.
	X	X	S	Refrigerant filter clogged	Check and replace.
F The fans do not start	X	X	S	Fan contactor de-energized	Check the voltage across the coil of the contactor and the continuity of the coil.
	X	X	S	Lack of output voltage from the control fan speed	Check the contacts, replace if necessary.
	X	X	S	Thermal protection inside the fan	Check the condition of the fan and the air temperature during operation of the unit.
	X	X	S	Fan motor faulty	Check and replace.
	X	X	S	Loose electrical connections	Check and replace.
G Lack of gas	X	X	S	Loss in the refrigerant circuit	Check the cooling circuit using a leak detector after pressurising the circuit to approximately 4 bars. Repair, evacuate and refill.
H Frost in the liquid line downstream from a filter	X	X	S	The filter is clogged	Replace the filter
I The unit works continuously without ever stopping	X	X	S	Lack of refrigerant gas	See item G.
	X	X	U	Incorrect tuning of the operating thermostat	Check and set.
	X	X	S	Excessive thermal load	Reduce the thermal load
	X	X	S	Compressor does not give the thermal output	Check, change or revise
	X	X	S	The liquid filter is clogged	Replace.
L The unit works regularly but with an insufficient capacity	X	X	S	Low refrigerant charge	See point G.
	X	X	S	4-way reversing valve defective	Check the power supply and the coil of the valve and replace the valve

Symptom	Cooling	Heating	Who can take corrective action U = User S = specialised personnel	Probable cause	Possible remedy
M Frost in the compressor intake pipe	X	X	S	Expansion device that is not working properly	Verify and replace.
	X	X	S	Water circulation pump blocked	Unlock the pump.
	X	X	S	Water circulation pump defective	Check the pump and replace if necessary.
	X	X	S	Low refrigerant charge	See point G.
	X	X	S	The liquid filter is clogged	Replace.
N Abnormal noise detected in the system	X	X	S	Compressor noisy	Check and replace if necessary.
	X	X	S	The panel vibrate	Fasten properly.
O The defrosting cycle is never activated		X	S	4-way reversing valve defective	Check the power supply and the coil of the valve and replace the valve.
		X	S	The defrost thermostat is worn out or has an incorrect calibration value	Check and replace if defective or change the calibration value.
P The unit does not start	X		S	Phases of the supply network reversed	Invert two phases.

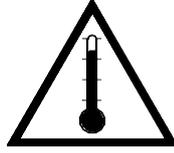
17 IMPROPER USES

The unit is projected and built up to grant the maximum safety in its proximity, as well as to resist to the aggressive environmental conditions. The fans are protected by grilles. Residual risks are indicated with warning labels.

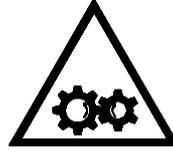
SAFETY SYMBOLS



DANGER:
General danger



DANGER:
Temperature



DANGER:
Moving parts



DANGER:
Cutoff voltage



Trane – by Trane Technologies (NYSE: TT), a global climate innovator – creates comfortable, energy efficient indoor environments through a broad portfolio of heating, ventilating and air conditioning systems and controls, services, parts and supply. For more information, please visit trane.eu or tranetechnologies.com. Trane has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.

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