EMICON
AIR CONDITIONING AND INDUSTRIAL APPLICATION

CLIMATE DESIGN

R A C

AIR COOLED WATER CHILLERS
WITH
TURBOCOR COMPRESSORS
(OIL FREE)

USE AND MAINTENANCE MANUAL

1. INTRODUCTION

1.1. FOREWORD

The present handbook, originally written in Italian, was completed in accordance with the European legislation. It contains all the necessary information for carrying out without any risk transportation, installation, start-up, operation, setting, maintenance and dismantling of the unit.

All people authorized to operate with the unit, in particular, all technicians assigned to the unit maintenance, must know all information and instructions contained in this handbook and all its attachments.

In the event of non-compliance with the instructions contained in this manual regarding the installation, start-up, operation, setting, maintenance and dismantling of the unit, it could be unsafe for people, could damage objects and environment.

Should you have any doubt on the correct under standing of these instructions, please contact the Manufacturer in order to get further clarifications.

The unit has to be installed, handled, subjected to maintenance, repaired and dismantling in compliance with local technical standards.

1.2. Safety marks

The following safety marks are used in this manual to draw attention to all useful information in order to avoid any dangerous situations which could be unsafe and harmful for people, could damage equipment and environment or besides breaking the unit.

It means operation not allowed, because it could compromise the functionality of the unit.

It means a warning about important information for correct unit utilization.

It means a danger to people, things or environment.

It means an electrical danger or risk to people, things or environment.

1.3. Referring standards

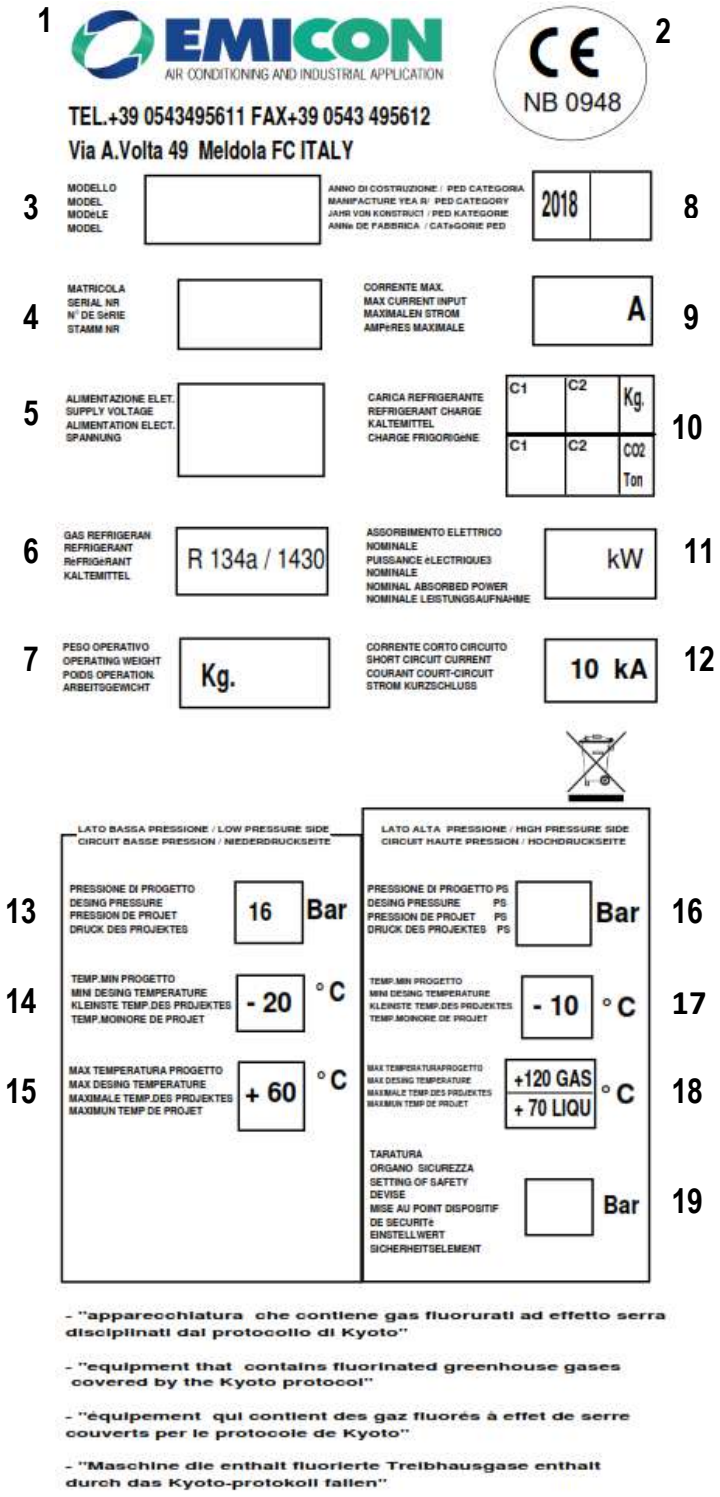
The unit of this handbook is designed and manufactured, unless the order has a different agreement, in compliance with the relevant European Directives and in particular, they meet the "Essential Safety Requirements" as set out in the following directives:

- 97/23/CE (PED),
- 2004/108/CE (Electromagnetic Compatibility),
- 2006/42/CE (Machinery Directive),
- 2006/95/CE (Low Voltage Directive).

As a matter of fact, the unit is certified by the Manufacturer and provided together with the CE Declaration of Conformity which is attached to the chapter n°8 of the present Manual and on the Identification tag of each unit.

1.4. Identification tag

The data for the identification of the unit are marked on a permanent tag attached inside the unit, close to the electrical panel. As shown in Figure 1.1, the identification tag contains the information unit in conformity with the European regulations.



1	Manufacturer's name and address
2	CE mark and the Notified Organization identification number which released the PED certification
3	Model
4	Serial number
5	Supply voltage
6	Refrigerant
7	Operating weight
8	Manufacture year / PED category
9	Max current input
10	Refrigerant charge
11	Nominal absorbed power
12	Short circuit current
13	Design pressure
14	Min. design temperature
15	Max design temperature
16	Design pressure
17	Min. design temperature
18	Max. deign temperature
19	Setting of safety device

1.5. Warranty

The manufacturer warrants the Unit according to what stated on his general sales terms or according to what else explicitly agreed.

This manual provide detailed information on the proper receiving, handling, rigging, site installation requirements and maintenance of the equipment. All requirements must to be followed to ensure that your RAC (air cooled water chillers with turbocor compressors) will perform properly. Failure to follow these instructions can significantly impact the chiller's performance and reliability. The Manufacturer Warranty is void in case the guidance of this manual has not been carefully respected.

The manufacturer refuses all responsibility for any damage to people, animals, things or environment, caused by incorrect installation, maintenance or setting or misuse of the machine. It is considered as "misuse" of the machine any use not explicitly allowed in this manual.

On the first start-up, it is necessary duly fill in the relevant report attached to this manual and send a copy to Emicon A.C. (Customer Service), in order to make the warranty valid.

1.6. Readers of the Manual

This manual and all its attachments are supplied with the described unit.

The Manual must be kept by the machine's owner or by the person in charge to care for the machine, in a proper place. To this end, a plastic bag where to store the manual has been placed inside of the electric panel board of the machine, so that it can be always easily accessible for consultation and at the same time, it can be preserved in a good state.

All people authorized to operate with the unit, in particular, all technicians assigned to the maintenance and to charge the chiller with liquid refrigerant, must know all information and instructions contained in this manual.

In case the manual is lost or deteriorated, a new copy must be requested directly to the manufacturer.

1.7. Personnel requirements

Every work necessary on the unit, and especially on the refrigerant circuit, must to be to carried out from qualified and trained personnel. During such jobs workpeople must use the Personal Protective Equipment (PPE) and to be trained to use the refrigerant gas conforming to the norms in force for safety subject during the work, in regard to the place and the time where the job is done.

Maintenance and repair works require personnel with specific skills (as welders, electricians, programmer, etc), must to be run under supervisor.

The technician will work on the unit must to know:

- The directives, rules in accordance with the local current legislation concerning refrigeration gas;
- How to manage the refrigerant gas and Personal Protective Equipment necessary;
- Rules on safety and protection of the environment.

To keep these skills, the personnel have to take regularly refresher training.

1.8. Dangerous areas

In the unit can be dangerous areas such as:

- Components subject to electric voltage,
- Mechanism in movement,
- Overheated surfaces,
- Sharp edge,
- Components contain liquid at high pressure.

The unit is closed by case panel, in this way the unit is not accessible from outside in order to keep the personnel safe from these parts. . Only qualified and trained personnel can remove the covering panels.

The dangerous areas are adequately indicated with marks if they don't have any protection device.

1.9. Preventing electrostatic discharge when working with with electrical components on the DTC compressor

1.9.1. Purpose

Notify customers and technicians of the requirements to use correct procedures to prevent Electrostatic Discharge (ESD) when working with electrical components on the DTC compressor. This ensures that customers are aware of possible damage to static sensitive PCBs and devices if the procedures are not followed.

1.9.2. Handling electrostatic sensitive devices

Active electronic components are susceptible to damage when exposed to static electrical charges. Voltages as high as 1000 VAC may be encountered under some circumstances. Damage to these components may lead to outright failure or reduction in service life. Since the presence of static charges is not always evident, it is essential that service personnel follow static control procedures at all times when handling sensitive electronic components.

This section outlines static control precautions that must be followed when providing service support in the field. Preferably, service support personnel should create a safe, static-free environment.

Service personnel must use a commercially available service kit for handling static-sensitive devices. The kit typically includes:

- Ground cord Assembly
- Alligator clip
- Grounding wrist strap

- Wrist strap tester

If a safe, static control environment cannot be created for a specific reason, the operator will ensure that ESDS items and personnel are at the same electrical potential as the equipment before touching the module and will not carry the module without its electrostatic discharge (ESD) protective bag.

The electronic modules should only be removed from the ESD protective bag at the last moment, just before installation when the operator is ready to do the replacement. The operator should avoid touching any components or connectors on the module and should hold the module by its edge or enclosure, as applicable. To start follow these procedures.

1.9.3. Electrical isolation of the compressor

This equipment contains hazardous voltages that can cause serious injury or death. Only qualified and trained personnel should work on DTC compressors.

Always wear appropriately rated safety equipment when working around equipment and/or components energized with high voltage. Faulty components can explode and cause serious injury or death.

Before replacing the spare part, you must isolate the compressor power by completing the following steps:

1) Turn off the mains input power to the compressor;
2) Secure/lock-out/tag-out the mains disconnect to ensure no accidental or unauthorized re-application of the mains input power can occur.

Removing the mains input cover will expose you to a high voltage hazard of up to 640VAC. Ensure the mains input power is turned off and locked out before removing it.

Do not allow the mains input or top covers to touch any components during their removal.

In particular, be careful with the CE type covers because they are coated on the outside for the purpose of being conductive. The painted covers only apply to TT300P and TT300C.

3) Remove the Mains Input cover. See Figure 1.

Figure 1 Mains Input Cover

The mains input fast-acting fuses are installed in the power panel for all compressor models except the TT300.

4) Using an appropriately rated multimeter (set for AC voltage measurements) and leads, on the line side of the mains input fast-acting fuses, place the red (+) multimeter lead on the phase 1 mains input terminal and the black (-) multimeter lead on the compressor main housing and record the result. The measured value should be 0.0VAC. If the measured voltage is not the expected value, determine the source of the voltage and turn it off, otherwise proceed with the next step.

5) Repeat step 4 for the remaining phases.

6) Remove the top cover.

Removing the top cover will expose you to a high voltage hazard of up to 1000VDC, wait at least 15 minutes to allow the DC capacitors to discharge and ensure there is no mains input voltage present before removing it.

1.9.4. ESD Protection / Grounding Instructions

All parts that are susceptible to damage by Electrostatic Discharge (ESD) will be marked using the following label. Please follow the instructions below to ensure safety and to protect the parts from ESD damage.

1) Using an appropriately rated multimeter (set for DC voltage measurements) and leads, place the red (+) multimeter lead on the positive (+) SCR DC bus bar and the black (-) multimeter lead on the negative (-) SCR DC bus bar and record the result. The measured value should be below 5VDC. If the measured value does not correspond to the expected DC bus voltage, then wait at least 5 minutes and repeat this step until 5VDC or less is measured.

2) Clip the ESD strap ground clip to the compressor ground post. See blue arrow in Figure 2.

3) If you need to remove the Soft-Start, clip the ESD strap ground clip to the Mains Plate. See green arrow in Figure 2.

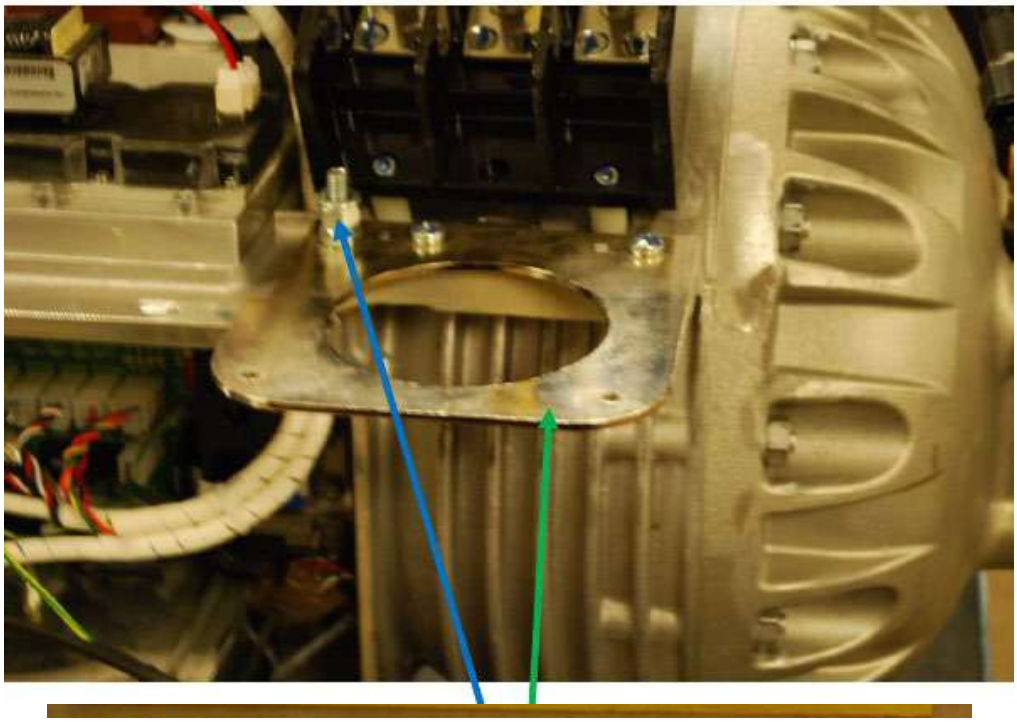


Figure 2 Mains Plate, round

4) If you only need to remove the Service Side cover, clip the ESD strap ground to the cover screw hole that is part of the compressor housing. See yellow arrows in Figure 3.

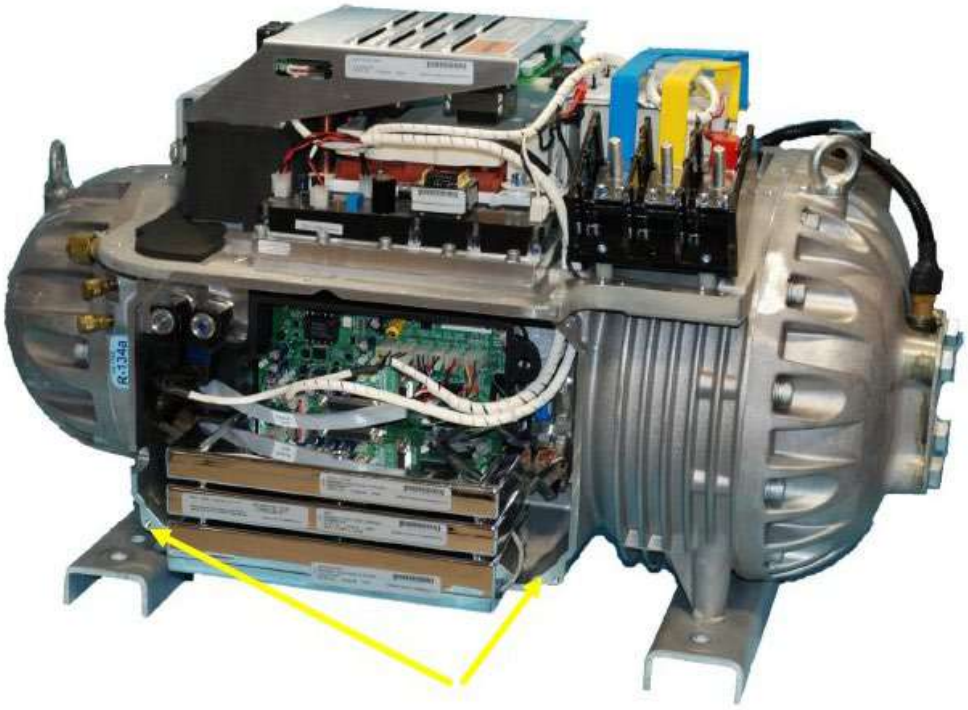


Figure 3: Compressor Grounding Points

1.10. Use

The unit is a monobloc water chiller with air condenser. The purpose of the unit starts with the evaporator, which contains the liquid refrigerant. The refrigerant radiates out cold to the surrounding tubes that are filled with water. The water is chilled and pumped through the circuit, absorbing heat from whatever items the chiller is meant to cool. When the water has finally reached a high enough temperature, it radiates the heat back at the refrigerant in the evaporator, causing it to turn into vapour. The vapour passes through the pipe into the compressor, which compresses the vapour putting it under high pressure and heat. This superheated vaporized refrigerant is then pumped through the condenser by axial fans. The vapour gives off its heat into the surrounding air and then condenses back into a liquid. The liquid flows back into the evaporator to repeat the chilling process.

1.11. Service rating

The unit can work regularly and realiably even in out-of-specification operational conditions. In this case, however, the machine's performance may be remarkably different from normal, since this depends heavily on working conditions. In particular, the unit's refrigerating capacity may be lower and its current draw may be higher than specified.

However, operating limits must be abided by during unit operation, as indicated in table 1.1.

If you want to operate with the cooled fluid at the outlet of the evaporator at a different temperature than nominal, it is necessary to set the right value for the set point on the microprocessor. Also, if the temperature is lower than design temperature, anti-freeze alarm settings must also be modified (to a value at least 4° higher than the freezing point of the fluid to be cooled).

The tension and frequency of the feeder must fall within the intervals indicated in table 1.2

Table 1.1: Operational working limits

Parameter	Limit value
Minimum temperature of condensation air (without condensation pressure regulator – as an option)	20°C
Minimum temperature of condensation air (with condensation pressure regulator – as an option)	-15°C
Maximum temperature of condensation air	43°C
Minimum temperature of cooled water at the outlet of the evaporator (without adding brine)	4°C
Minimum temperature of cooled fluid at the outlet of the evaporator (with added brine)	2°C
Maximum temperature of cooled fluid at the inlet of the evaporator (during unit operation)	25°C
Maximum temperature of cooled fluid at the inlet of the evaporator (at unit start)	35°C
Minimum transfer rate of cooled fluid in the evaporator	0.9 x nominal rate
Peak transfer rate of cooled fluid in the evaporator	1.1 x nominal rate

Table 1.2: Allowed characteristics for power supply

ELECTRICAL MAGNITUDE	OPERATING RANGE
Power supply voltage (Nominal 400 V – 3ph)	395 - 410 V – 3ph
Power frequency (Nominal 50 Hz)	±5% of nominal value

If the power supply voltage or frequency do not fall within the specified interval, the compressors turn off automatically.

It is forbidden to exceed the limits set out in this paragraph while the unit is in operation without the manufacturer's prior explicit authorisation.

2. Description

2.1. Identification tag

The following figure there are the interpreting key for the initials used to mark the air cooled water chillers with turbocor compressors.

R	A	C	60	2	.U	.Ka
1	*2*	*3*	*4*	*5*	*6*	*7*

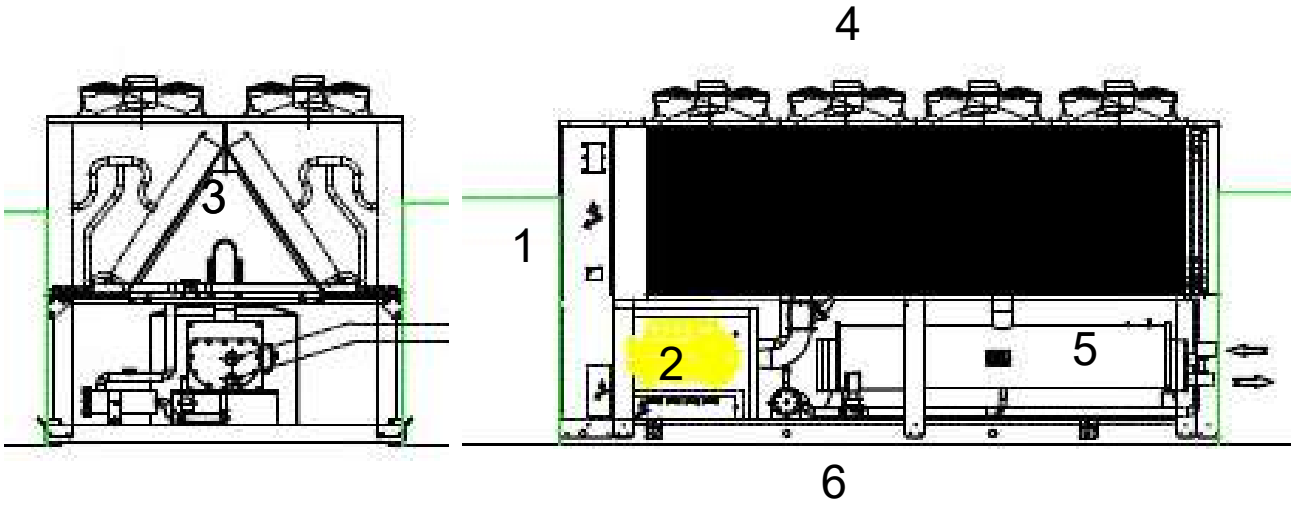
1	R	*Type of unit*	R = Chiller
2	A	*Condenser type*	A = Air
3	C	*Type of compressors*	C = Centrifugals
4	60	*Nominal capacity of chiller*	
5	2	*Number of compressors*	
6	.U	*Sound level*	_ = Standard S = Silenced U = Ultra-silenced X = Extra-silenced
7	.Ka	*Refrigerant type*	Ka = R134a

2.2. Main components

This unit is equipped with one or more two-stage centrifugal compressors, fitted with semi-hermetic design, with integrated control, variable frequency drive. The compressor is provided with radial and axial magnetic bearings to levitate the shaft, thereby eliminating metal-to-metal contact, and thus eliminating friction and the need for oil.

In the next paragraph will show the main characteristic components. The figure 2.1 shows the main parts of the unit.

Figure 2.1: Main components



1	Electrical board	**4**	Condensation axial fans
2	Centrifugal compressors	**5**	Flooded evaporators
3	Condenser with finned coil	**6**	Supporting frame

2.2.1. Structural frame

The modular carpentry of the unit is in galvanized carbon steel profiles and painted with epoxy powder primer of colour RAL 7035.

The structural frame parts are mounted in the way to be a solid chassis, to carry the unit components and to sustain the stress during the handling and unit operation.

All the parts in the unit are easily accessible, to facilitate and to make secure the unit during the operation and maintenance.

2.2.2. Compressors

The compressors fitted in the unit utilize a two-stage, variable-speed, centrifugal compressor design requiring no oil for lubrication.

Compressor is constructed with cast aluminium casing and high-strength thermoplastic electronics enclosures.

The two-stage centrifugal impellers consist of cast and machined aluminium. The motor rotor and impeller assembly shall be the only major moving parts.

The motor is compatible with high-speed variable-frequency operation that affords high-speed efficiency, compactness and soft start capability.

Compressors is designed for use with HFC-134a.

The compressor is provided with radial and axial magnetic bearings to levitate the shaft, thereby eliminating metal-to-metal contact, and thus eliminating friction and the need for oil.

The magnetic bearing system consists of front, rear, and axial bearings. Both the front and the rear bearings are to levitate the shaft at radial and longitudinal directions. Each bearing position shall be sensed by position sensors to provide real-time repositioning of the rotor shaft, controlled by onboard digital electronics.

The compressor is provided with a direct-drive, high-efficiency, permanent-magnet synchronous motor powered by pulse-width-modulating (PWM) voltage supply.

The compressor has a Variable Frequency Drive (VFD) for linear capacity modulation, high part-load efficiency and reduced in-rush starting current. Signals from the compressor controller determines the inverter output frequency, voltage and phase, thereby regulating the motor speed. In case of power failure, the compressor is capable of allowing for a normal de-levitation and shutdown.

Compressor speed is reduced as condensing temperature and/or heat load reduces, optimizing energy performance through the entire range from 100 percent to 30 percent or below, depending on the pressure ratio, of full-load capacity of each compressor given Air Conditioning and Refrigeration Institute (ARI) unloading conditions. Capacity modulates infinitely as motor speed is varied across the range.

Inlet Guide Vanes (IGVs) is built-in to further trim the compressor capacity in conjunction with the variable-speed control to optimize compressor performance at low loads.

The motor cooling is determined by liquid refrigerant which is channelled, at full condenser pressure, from the main liquid line (after the drier filter) to the compressor to cool the electronics, mechanical components.

In case of power failure, the compressor shall be capable of allowing for a normal de-levitation and shutdown.

The compressor includes a microprocessor controller capable of controlling magnetic bearings and speed control. The controller is capable of providing monitoring, including commissioning assistance, energy outputs, operation trends, and fault codes via a ModBus interface.

2.2.3. Evaporator

Flooded shell and tube evaporator with shell in carbon steel operating with refrigerant in shell and water in the copper pipes. This solution allows working with an extremely low temperature superheating gas refrigerant value; consequently it allows to contain the difference between the temperature of the evaporator outlet water and the temperature of evaporation. The combination of these factors improves the heat exchange and as consequently the energy efficiency of the unit.

2.2.4. Evaporator's liquid level

The temperature that is sensed by the Electronic Expansion Valve thermal bulb is the superheat temperature of the refrigerant at the outlet of the evaporator. This is the temperature increase of the refrigerant above the saturation temperature corresponding to the existing evaporator pressures. When the superheat gas temperatures are too low, they suggest to adjust the liquid flow by the Electronic Expansion Valve.

An electronic refrigerant gas level transducer measures the refrigerant into the evaporator, it transfers the date to the unit microprocessor which controls the opening or closing of the Electronic Expansion Valve.

2.2.5. Condenser coil

The air heat exchanger is manufactured with copper tubes and aluminium fins; which are adequately spaced to decrease the thermal contact resistance and having the best heat exchange efficiency.

2.2.6. Axial fans

The axial fans with external rotor, at low rpms, generate the air capacity to the condenser coil. The electric motor fit for the purpose tot o run at variable rotation speed, which allows for controlling condensation by adjusting the speed rotation with voltage steps.

The axial fan with airfoil blades in aluminium alloy is expressly thought and manufactured to maximize the efficiency and to reduce the sound level.

The axial fans are furnished with safety grille.

2.2.7. Cooling circuit

The main components of the refrigerant circuit, above all that mentioned, are:

- Compressor discharge check valve,
- dryer filter,
- sight glass,
- solenoid valve,
- electronic thermostatic valve,
- high pressure safety valve,
- low pressure safety valve,
- compressor discharge shut-off valve
- compressor suction shut-off valve
- liquid line shut-off valve,
- High and low pressure guages,
- high and low pressure switches,
- evaporator temperature probes (inlet and outlet).

2.2.8. Electric board

The unit electric board is built inside a metallic box, meeting the European current legislation. The electric board is IP 54 and it's manufactured to ensure protection for external installation..

The main panel is fitted with a main switch interlocked door. It's completed with:

- contactors,
- thermal and amperometric protectors,
- transformers,
- conductors,
- auxiliary low voltage circuit,
- terminal block,
- electronic card.

2.2.9. Controller

The complete management of the chiller control system is controlled by the electronic microprocessor, Turbocor Compound Capacity Chiller.

The Turbocor Compound Capacity Chiller is dedicated to Chiller systems with one or more Danfoss Turbocor compressors and it allows the management of chiller cooling: Air/Water, Water/Water, one or more refrigerant circuits and totally up to 4 Danfoss Turbocor compressors.

The main microprocessor's functions are as follows:

- chilled inlet or outlet water temperature regulation;
- proportional/integral regulation;
- anti freeze control;
- Danfoss Turbocor compressor management;
- pre-emptive handling of low evaporator or high discharge pressure;
- twin pumps control;
- alarms management;
- setpoint management:
- second setpoint;
- remote setpoint;
- setpoint compensation;
- liquid level control;
- Fan control (step or variable speed);
- Auto/Manual control modes;
- historical alarm list.

The main screen of the Turbocor Compound Capacity Chiller has a LCD display surrounded by soft keys. See the paragraph 7.4

2.2.10. Manufacturer test

The machine is subjected to thorough test and inspection before to leave the factor.

The cooling circuit is tested by pressure tester to confirm that it is without leaks and has the ability to hold the pressure specified by the Manufacturer's Quality System.

The unit is charged with refrigerant R134A only when the test and inspection give a positive result.

2.3. Centrifugal compressor

The purpose of this paragraph is to identify the parts of the compressor and to provide fundamental knowledge that describe the controller and the energy and signal flow.

2.3.1. Power supply

Turbocor compressors are designed to operate with a power supply that is within a strict tolerance for the values of nominally rated voltage and frequency.

Nameplate AC Voltage	Acceptable Voltage Range
400V (50Hz)	390 - 410 VAC

Nameplate frequency	Acceptable Voltage Range
50Hz	47 - 53 Hz

Even if the compressor is not running the input terminal can be under voltage

The use of wrong values of nominal voltage and / or frequency outside the permitted range can cause malfunctions and / or faults and implies the expiry of the warranty terms offered by Emicon AC. In particular, this applies in any case where is used a nominal voltage of 400 V AC with 380 V AC power supplies.

The AC line power is routed to the Silicon-Controlled Rectifiers (SCR) to convert the AC voltage into DC voltage. The DC bus voltage output from the SCR is about 1.35 times that of the input signal (a bus is a

common electrical connection between multiple electrical devices). The DC bus has a voltage of 460-900 VDC, depending on the value of the AC input voltage. The DC voltage output from the SCR is then fed into the Soft-Start Board for voltage monitoring.

DC capacitors at the SCR output serve as energy storage and filter out the voltage ripple to provide a smooth DC voltage.

The DC capacitors provide the IGBT(Insulated Gate Bipolar Transistor) Inverter with 460-900VDC. The IGBT Inverter converts the DC link voltage into an adjustable frequency and adjustable amplitude, 3-phase simulated AC voltage.

Using both the AC input voltage source and the DC voltage output from the SCRs, the Soft-Start Board generates the in-rush current control signal and outputs pulses of 0-12VDC (with respect to the positive DC bus) to the SCR. This system together with speed variable operation limits the in-rush current at compressor power-up.

2.3.2. Motor drive system

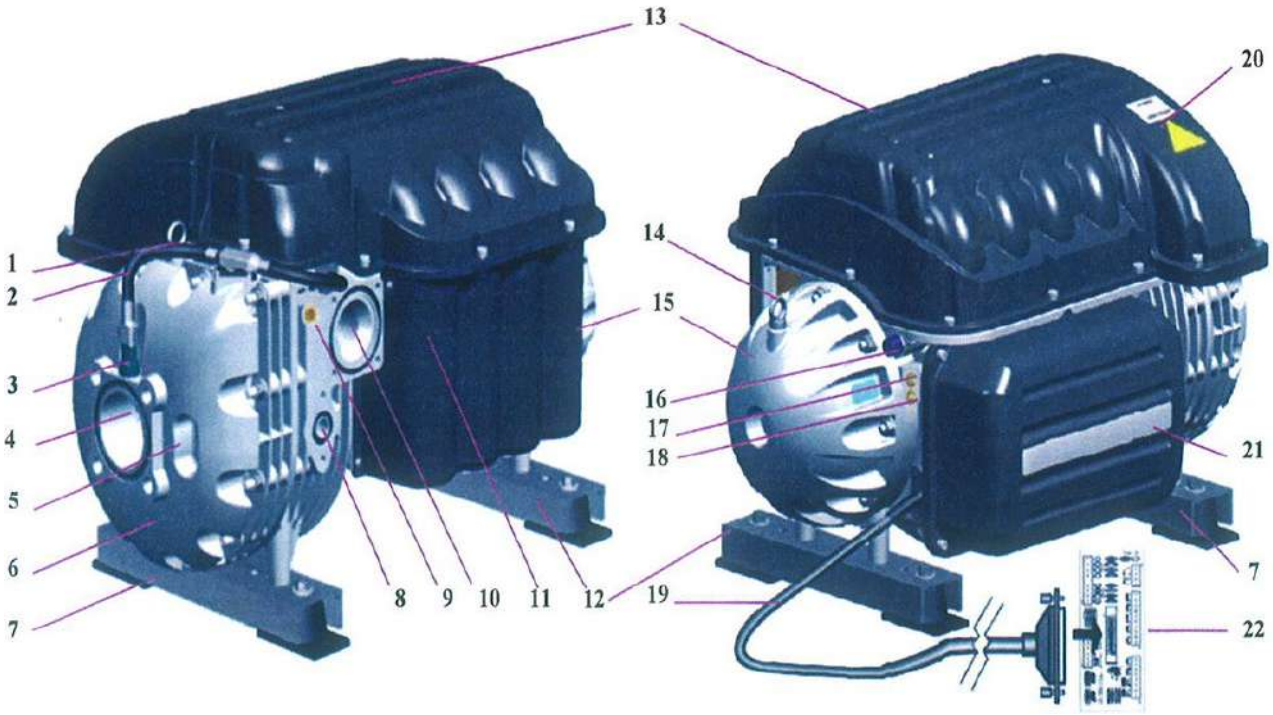
Normally, AC power to the compressor remains on, even when the compressor is in the off state. The compressor motor requires a variable-frequency three-phase source for variable speed operation. The AC line voltage is converted into a DC voltage by a half-controlled, full-wave rectifier. DC link capacitors at the rectifier output serve as energy storage and filter out the voltage ripple to provide a smooth DC voltage. The Insulated-Gate-Bipolar Transistor (IGBT) is an inverter that converts the DC link voltage into an adjustable three-phase AC voltage. Pulse-Width Modulation (PWM) signals from the Bearing-Motor-Compressor Controller control the inverter output frequency and voltage. By modulating the on and off times of the inverter power switches, three-phase variable sinusoidal waveforms are obtained.

If the power should fail while the compressor is running, the motor switches into generator mode thereby sustaining the capacitor charge. The rotor can then spin down safely in a controlled sequence preventing damage to components.

The soft-start controller limits inrush current by progressively increasing the conduction angle of the silicon-controlled rectifiers (SCRs). This technique is used at compressor start-up while the DC link capacitors are charging up.

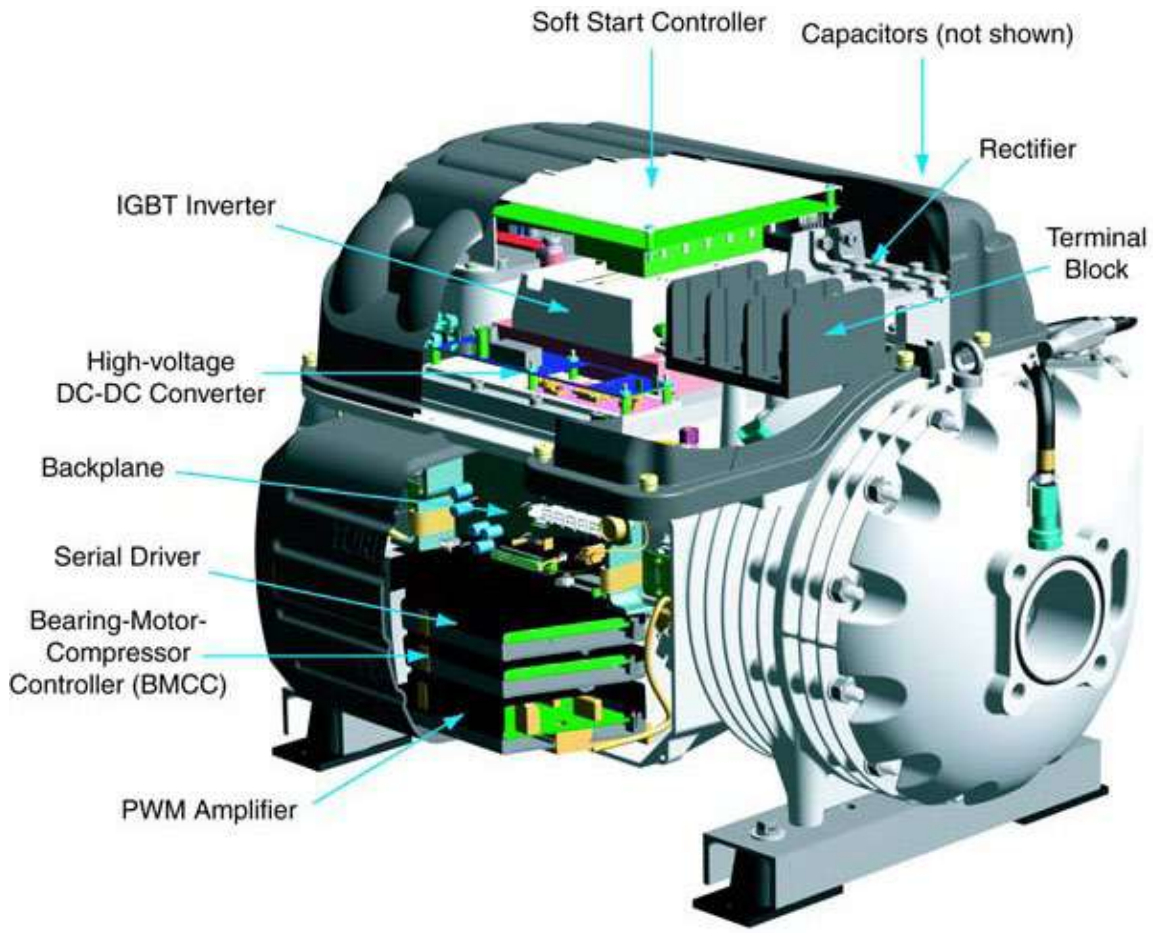
The soft-start function and the variable-speed drive combined, limit the inrush current at start-up.

Figure 2.2: Compressor component identification



No.	Component	No.	Component
1	Lift anchor (front)	**12**	Rear support base
2	Cable harness (sensor)	**13**	Top access cover
3	Suction pressure/temperature sensor	**14**	Lift anchor (rear)
4	Inlet guide vanes (IGV) suction port	**15**	End bell
5	IGV Position indicator	**16**	Motor–cooling connection
6	IGV housing	**17**	Motor–cooling (TT300) and Power electron ics cooling (TT400) Access port #1
7	Front support base	**18**	Motor-cooling Access port#2 (TT400 only)
8	Economizer port	**19**	Compressor I/O board cable
9	Optional pressure regulating port	**20**	Mains input access cover
10	Discharge port	**21**	Service-side access cover
11	Capacitor side access cover	**22**	Compressor I/O board

Figure 2.2: Compressor component location



The Backplane is powered by +24VDC (with respect to 0V) from the High Voltage DC-DC Converter, which also provides the Backplane with High Voltage + (+250VDC with respect to High Voltage-) for the Bearing PWM Amplifier. The Backplane connects the onboard plug-in modules with the power electronics, expansion valves, IGV stepper motor, motor-cooling solenoids, rotor-position sensors, and pressure/temperature sensors. It is a means to transfer control, sensor, and error information between the BMCC and other Compressor components.

The Backplane also serves as the source of power to the parts connected to it. Enfact it provides +15VDC and +24VDC to the Serial Driver. The Serial Driver, in turn, uses +15VDC to control the external expansion valves and the IGV stepper motors. The +24VDC is used by the Serial Driver to control the motor-cooling solenoids.

The Backplane powers the BMCC with +5VDC, +15VDC and -15VDC. The BMCC uses the power source to process current, sensor, and error information.

The Backplane provides the Bearing PWM Amplifier with +5VDC, along with +17VDC and HV+ (both with respect to HV-). The PWM Amplifier uses the energy to supply current to the radial and axial magnetic bearing coils as commanded by the BMCC. In return, the PWM Amplifier passes feedback from the current sensor for the bearing coils and a spare temperature sensor for the heatsink.

The Backplane sends +24VDC and gating signals to the IGBT as per the BMCC. In return, the IGBT Inverter sends current, temperature, error, and DC bus voltage information to the BMCC via the Backplane. With the input gating signals, the IGBT Inverter controls the motor at a variable frequency of 0-750Hz.

2.3.3. Compressor controller

Over current The hardware and software for the compressor controller and the bearing/motor controller physically reside in the Bearing-Motor-Compressor Controller (BMCC) module.

The compressor controller is continuously updated with critical data from external sensors that indicate the compressor's operating status. Under program control, the compressor controller can respond to changing conditions and requirements to ensure optimum system performance.

One of the compressor controller's primary functions is to control the compressor's motor speed and IGV position in order to satisfy load requirements and to avoid surge and choke conditions. However, the majority of capacity control can be achieved via motor speed.

The compressor controller monitors over 60 parameters, including:

- Gas pressure and temperature monitoring
- Line voltage monitoring and phase failure detection
- Motor temperature
- Line currents
- External interlock

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The magnetic bearing system physically supports a rotating shaft while enabling non-contact between the shaft and surrounding stationary surfaces.

A digital bearing controller and motor controller provide the PWM command signals to the bearing amplifier and IGBT inverter, respectively.

The bearing controller also collects shaft position inputs from sensors and uses the feedback to calculate and maintain the desired shaft position.

The compressor controller responds to abnormal conditions by monitoring:

- Surge RPM
- Choke RPM
- Power failure/phase unbalance
- Low/high ambient temperature
- High discharge pressure
- Low suction pressure
- Stop/start short cycle
- Motor cooling circuit failure (over temperature)
- Refrigerant loss
- Power supply

The Compressor I/O Board allows the user to control the Compressor and allows the Compressor to return status and sensor information to the user.

2.4. Unit Technical data

The main technical of the units are shown in the attachments.

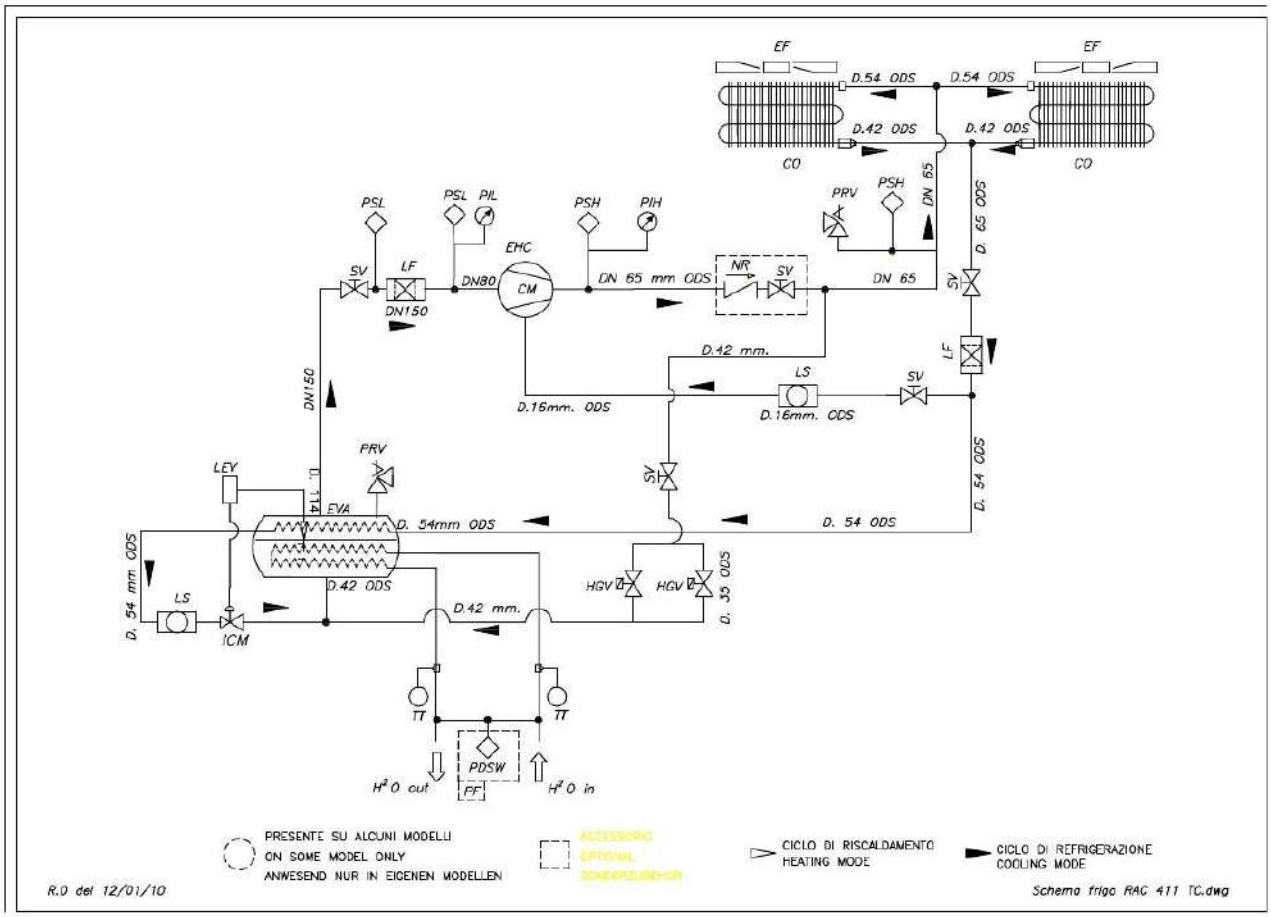
2.5. Cooling circuit

The figure 2.3 shown a typical cooling circuit of the unit.

Cooling circuit keys

CM	Centrifugal compressor	**PIH**	High pressure gauge
CO	Condenser with finned coil	**PIL**	Low pressure gauge
EF	Condensation axial fans	**PRV**	Safety valve
EV	Solenoid valve	**PSH**	High pressure switch for refrigerant gas
FSR	Fan speed regulator	**PSL**	Low pressure switch
HR	Heat recovery	**PT**	Pressure transducer
LF	Dehydrating filter	**SFF**	Heat exchanger
LLT	Refrigerant gas level transducer	**SV**	Shut-off valve
LS	Sight glass	**TT**	Temperature probe
NR	Non-Return valve	**VP**	Flooded evaporator
PDSW	Differential pressure switch	**VT**	Electronic expansion valve

Figure 2.3: Typical Cooling circuit of the unit



2.6. Wiring diagram

The wiring diagram is stored into the plastic bag placed inside of the electric panel board of the machine.

2.7. Dimensional drawings

The dimensional drawings are stored into the plastic bag placed inside of the electric panel board of the machine.

2.8. Main accessories

BT: Electronic device for the continuous voltage control of the condensing pressure through the variation of the axial fan rotation speed for low temperature operation (-15° C).

CF: Insulation of compressors by a cabinet coated with soundproofing material.

ECO: Economizer: to increase the chiller Energy efficiency, growing the liquid sub-cooling in the thermal expansion valve inlet, tank to a refrigerant quantity took immediately after the filter and put in the 2 compressor stage inlet.

GP: Metal protection grille (dismountable) to protect the condenser coil and the cooling circuit.

IH: Connect RS485 serial interface to external supervision systems (the furniture does not include the supervision system and software controller – contact the Manufacturer to verify which communication protocols are available.

PA: Bell shaped vibration supports for insulating the unit, made of base and bell in galvanized steel and natural rubber mixture.

PF: Safety water flow switch installed between the evaporator inlet and outlet. It switch off the unit in case of lack of water flow rate through the evaporator.

PM: Spring type vibration dampers, with damping factor above 90.

PQ: Allowing to display unit parameters by Remote display terminal.

P1: Circulation pump group with standard head composed of expansion vessel, safety valve, hydrometer, pump inlet valve, pump outlet valve and air vent.

P1H: Circulation pump group with high head composed of expansion vessel, safety valve, hydrometer, pump inlet valve, pump outlet valve and air vent.

P2: N°2 circulation pump group installed in parallel composed of expansion vessel, safety valve, hydrometer, pump inlet valve, pump outlet valve and air vent. The pumps run one by one. Automatic switch in case of failure of the working pump. Double pumps runs in master/ slave mode, they invert their status at every stop. In this way the balance the working hours. The pumps are furnished of discharge shut-off valve and check valve.

RM: Condensing coil with pre-painted fins, it is obtained by superficial treatment of the condensing coils with epoxy coating.

RR: Copper/copper condensing coil, it is a special execution of the condensing coils with copper pipe and fins.

VB: The evaporator is insulated externally with thermal insulation and anti condensation cladding, which has 19 mm thick instead 9 mm on the standard model.

RAC series are available in various versions with different pressure sound.

2.9. Refrigerant

The unit is designed to work with gas R134A. It contains no chlorine and it is considered ozone-safe and environment friendly.

The refrigerant Safety data sheet is shown on Chapter 7.