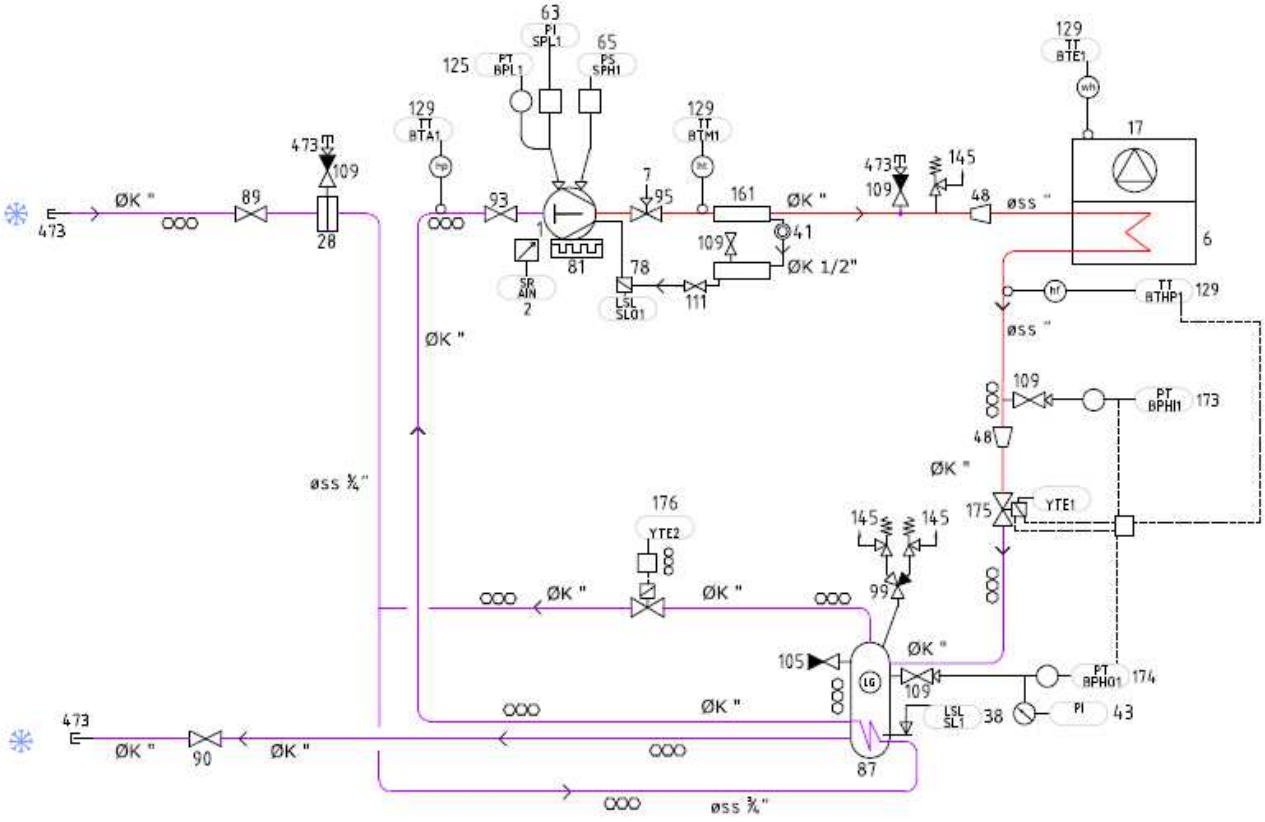
OPERATION INSTRUCTIONS FOR SCM FRIGO CONDENSING UNIT OPERATING WITH R744 (CO2)

Version UMT OEM rev.1.1 date 24/10/2017



CE

1. Introduction

This manual refers to systems for cooling and conserving at medium temperatures circuit, which use R744 (CO_2) as refrigerant and are identified by the mark:

UMT…MTDX – UMT …BTDX

2. Safety issues with CO2 - Safe handling

When the R744 (CO_2) is being handled, a qualified person must be present with the suitable equipment.

CO_2 has no smell or colour and the operator would not be aware if there were any leaks.

The effects of increased CO_2 levels on adults at good health can be summarized:

- normal outdoor level: *350 - 450 ppm*
- acceptable levels: *< 600 ppm*
- Long Term Exposure Limit (8hours): *5000 ppm* (CO2 detector alarm level)
- Short TermExposure Limit (15min): *15,000ppm*
- intoxicating, breathing and pulse rate increase, nausea: *30,000 ppm*
- unconscious, further exposure death: *100.000 ppm*

The machine room must be equipped with CO2 detector which will alarm when the CO2 level reaches 5000ppm.

CO2 is heavier than air, therefore the CO2 detector and any ventilation points have to be placed as low as possible.

Safety valves are necessary in all the parts of the system which can be shut off separately. Due to high liquid thermal coefficient of expansion of CO2, fluid pipes may not be blocked. Each SCM units is protected against overpressure with pressure relief valves according to EN378 and PED.

Given the high pressure that system can reach during operation, special attention must be made to connecting and fine tuning the unit.

Before carrying out any repairs which will involve breaking into the system/soldering or welding all relevant parts must be emptied of CO2.

3. System technical documentation

It is an integral part of this manual and gives individual information for each serial number:

- **The refrigerator diagram**
- **The instruction manuals of the installed components**
- **Electrical diagrams**
- **Dimensional drawings**
- **Control parameters and set points**
- **CE –PED declaration**
- **Labelling on the unit as follow (example):**

CE 0474

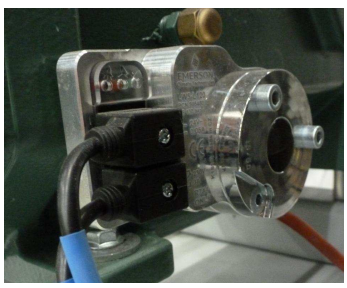
SCM FRIGO S.p.a.
Strada Zona Industriale, 10
35020 Vigorovea di S.Angelo di Piove di Sacco ITALY (PD)

☎ +39 049 9705000
+39 049 9704947

Unit Model	UMT...MTDX	
Serial Number	0P...	
Voltage-Phases-Frequency	400 V / 3 Ph+N / 50 Hz	
Auxiliary circuit voltage	-	V
Max absorbed current	-	A
Max starting current	-	A
Refrigerant type	R744 (CO2)T	
Refrigerant charge each circuit	-	Kg
Manufacturing year	-	
PS - LP 60 BAR	PS - HP 120 BAR; PS - MP 60 BAR	
TS MIN -20°C	TS MAX +140°C	

4. System description

To follow a brief description of the components installed on the unit:

Component	*Remark*
Compressor systems MT compressor is installed on right side of the unit in a separate area adjacent to the gas cooler. Liquid receiver is mounted on the left side of the unit in the gas cooler area . MT compressor is equipped with service valves mounted on the suction and discharge to allow isolation from the refrigeration circuit. The compressor is equipped with an oil level switch installed on the compressor sump and oil sight glass. Compressor is equipped with a discharge pressure relief valves operating at 160 bar & individual high pressure switches operating at 110 bar. **Operation** The system operates at the following pressures: MT discharge pressure : operating between 45-95 bar. Receiver pressure : operating between 35-40 bar. MT suction pressure : operating between 25-30bar. **High pressure valve (HPV)** The high pressure valve is made up of one Carel ExV. This valve regulates the pressure inside the gas cooler to maintain an optimum COP during transcritical operation and degree of sub-cooling	 Unit  MT Compressor  Compressor oil level switch

during subcritical operation. It receives the signal from the EVD driver.
In case of power failure the valve is shut down by a module (ULTRACAP) connected to the EVD on the electrical board.
For more info: see instruction manual of EVD and ExV.

Medium pressure valve (MPV)
The receiver pressure is maintained at constant pressure by venting vapour from the top of the receiver into the MT suction. The flow of this vapour is managed by a Carel ExV valve. The valve is located behind the gas cooler close to the liquid receiver.

High pressure and medium pressure valve controller
Both the high and medium pressure valves are controlled by a Carel EVD EVO (Twin) controller mounted inside the electrical panel.

Suction filter dryer:
Each unit is equipped with filter dryer on the suction line. The core is factory installed and should be replaced as necessary to ensure system drying during operation (see maintenance instructions)

Oil separator:
The oil separator present on the discharge line as also a function of silencer in order to decrease the discharge pipe pulsations.
The oil return to compressor is provided by a flexible pipe with an internal volume of 0.5 liters.

Danfoss high pressure valve arrangement

Danfoss CCM valve

MT suction filter strainer

5. Installation of the system

5.1 Control of the unit tightness

After the pressure tests, the unit is shipped pressurised with nitrogen at 10 bar.
Before making any connections or breaking into the system all parts must be carefully vented to atmospheric pressure.

5.2 Unloading and positioning of the unit

The refrigerators have lifting points clearly marked by yellow arrows.
The units may be lifted by sufficiently strong cranes.
The sling must not provoke any transversal stress to the machine structure, which must be carefully protected from rubbing by the lifting cables.
All safety devices must be used, including the constant use of block-release devices, well balanced load on the forklift truck, restricted load and everything else prescribed by current safety regulations and standards. When the machine is unloaded from the lorry, it is advisable to place it straight on its final base, which must be perfectly flat and stable; if that is not possible, the units must be stored on perfectly flat, stable and even surfaces. The base must be stable and strong enough to support the weight of the unit, perfectly flat and parallel with the floor, constructed to avoid any water stagnating. Rubber vibration dampers should be placed between the machine and the base.

5.3 Gas cooler

The unit gas cooler is connected to the unit.
There must not be any obstacles to the free flow circulation, therefore:

- The intake openings must be completely free
- There must not be any obstacles or dirt on the battery and it must be cleaned periodically (especially after the spring and autumn, when leaves and pollen could block the battery).
- The space above must be completely free, including of any tree branches overhanging it.

5.4 Risk Assessment

Prior to installation, risk assessment on the installation site has to be carried out. This assessment forms the documentation basis towards municipal emergency service.
Moreover, the risk assessment describes the safety approaches performed to minimize possible risk.
This could be setting-up of gas detectors or mounting of increased ventilation as well as zone classification of the area. Ventilation has to be dimensioned according to EN378-3.

5.5 Safety on the system

Safety valves and pressure switch are installed on the unit accordingly to EN 378.
For each part of the system pressure relief valves are installed with the following settings:

Liquid receiver…….. 60 bar

The system is equipped with pressure switches according to EN-378.

5.6 Assembling of pipes to users

Suitable heavy gauge copper pipe for design pressure systems up to 60 bar or k65 copper alloy must be use to connect the unit to the system.

Action	Remarks
Vent nitrogen from the system	Valve 89, 90, 90B shall be close when compressor pack is empty.
Finish all copper pipes connecting fixtures	All pipes in the shops are finished and only connection to compressor pack is missing.
Cut-off end plate from pipes to compressor system and start soldering	Avoid metal residual in the system. It is important to keep the system clean.
Leakage detection and pressure testing fixture services	Strength test at 1.1xPS with Nitrogen is required according to EN 378 (suction 1.1x60 bar; liquid 1.1x60 bar). Shut cabinet expansion valves .
Vent nitrogen and open the valves	Valves 89A, 90, 90B must be opened after the test.

5.7 Electrical connection

The unit is supplied with electrical panel for unit and gas cooler management.

Make the electric connections to the unit following the enclosed wiring diagram. Special attention must be paid to the EN 60204, EN60335, EN 378 safety standards and to national regulations.
The choice of materials, dimensions, installation and testing procedures must conform to national legislation in force. More info on electrical diagram and SCM installation manual.
The feed voltage must not fluctuate by more than ±5% with respect to the rated level 400V.
Imbalance between phases must be less than 5%.
Specification of the electrical connections:

- Main Supply 400V /1ph + N / 50 Hz
- Short circuit level 10 kA
- All high voltage components are marked Siemens or Telemecanique
- Max surrounding temperature 38°C
- Outdoor installation

6 Preliminary procedures before commissioning

6.1 Check compressor & common alarm circuits for functionality and activation points.

Check correct connection of all transformers.

Check correct phase connection and presence of protection panels.

Open the inverter box and check inverter connections according to the wiring diagram.

Check pressure switch and timer settings (see setting list attached).

Ensure all compressor overloads and MCBs are switched off until all voltage checks are completed and results are satisfactory.

Feed the electrical board: check correct working of components (instruments, compressor status/alarm indication panel, lights, etc.).

Check electrical supply to the EVD/CCMT/CCM is on.

Check the inverter settings according to the compressor nameplate; the ABB inverter shows the following masks (group 99):

Group 99: START-UP DATA	
9901	LANGUAGE
9902	APPLICATION MACRO
9904	MOTOR CTRL MODE
9905	MOTOR NOM VOLT
9906	MOTOR NOM CURR
9907	MOTOR NOM FREQ
9908	MOTOR NOM SPEED
9909	MOTOR NOM POWER

Test all oil and pressure switch safety function by manually tripping the device. The correct alarm should light on the alarm indication panel.

Check all probe and transducer readings and calibrate where necessary. Ensure all displays are configured to the correct readings.

6.2 Check oil charge and temperature.

Oil is present in the oil crank case; check the oil level is between max and min level as indicated on the compressor body; check oil temperature and the functionality of the crankcase heater for the compressor. Oil temperature on the crankcase shall be at least 20K above the ambient temperature prior to start the compressor.

6.3 Pump down procedure

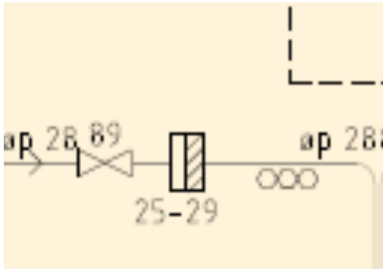
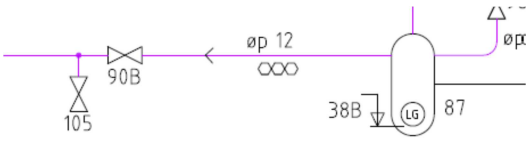
Action	Remarks
Pump down procedure: Pump down to receiver will be carried out in case of service to the system . Cut-off liquid delivery to cabinets to empty the liquid line.	It is recommended to lower suction set points on the pack controllers to limit the amount of refrigerant which will be vented when components are accessed. Close valve 90B Allow MT compressor to stop at pump down settings (see controller parameter).
Cutting off medium pressure valve	Cabinet expansion valve can be close
Switch off compressors	On front panel put the compressor switches to "OFF"
Close High pressure side Most of the system charge is now restricted in the receiver.	Close valve 90. The system is now ready for service; remember to empty the area to be serviced.
Start after pump down:	
Switch on compressors	On front panel put the compressor switches to "auto "
Open high pressure side	Open valve 90. Make sure that High pressure valve is operating.
Slowly open medium pressure valve	During this operation compressors starts. Slowly open valve 90B.
Open liquid line	
Progressively put in operation the LT cabinets and IT cabinets	Expansion valves on the cabinet back in operation.

6.4 Evacuation and filling of the system (with oil and CO2)

Exchange / assembly of filter dryer

The system is supplied with suction filter strainer and liquid filter dryer already installed on the unit.

For filter replacement see Appendix: Maintenance.

Action	Remark
IT Suction Filter/Filter dryer Replacement: Carry out pump down procedure as listed above. 	Remove housing end plate, replace gasket and filter. Refit housing end plate and evacuate circuit down to 0.5 torr. Remove gauge manifold. Open compressor service valves. Open valve . Return plant to normal running conditions as in pump down procedure.
Filling the system with CO2: If system pressure is <5 bar CO2 vapour must be used to increase the system to 10 bar minimum. Refrigerant from liquid withdrawal bottles must only be added to the liquid receiver or liquid line. Access points are available on both the liquid receiver and liquid line drier assembly. In cold ambient temperatures it may be necessary to reduce the liquid pressure. This can be done by either 1 of the 2 following methods, 1/ closing valve 90B and allowing the pack to pump down. Alternatively this can be done by lowering the liquid pressure set point inside the PRack -EVD controller (please refer to controller operating instructions). If this method is to be utilised attention must be given to the MT suction set point to ensure an adequate differential is maintained.	During the preliminary vapour charge all of the system must be open including the cabinet expansion valves. Connect a suitably rated pressure line between the refrigerant bottle and valve 105 mounted on the end plate of the liquid drier housing. Open both refrigerant bottle and valve 105. Once charging has completed close valve 105 and remove charging line. 

7 Test and inspection before start-up

7.1 Preliminary controls according to EN 60204-1, visual controls

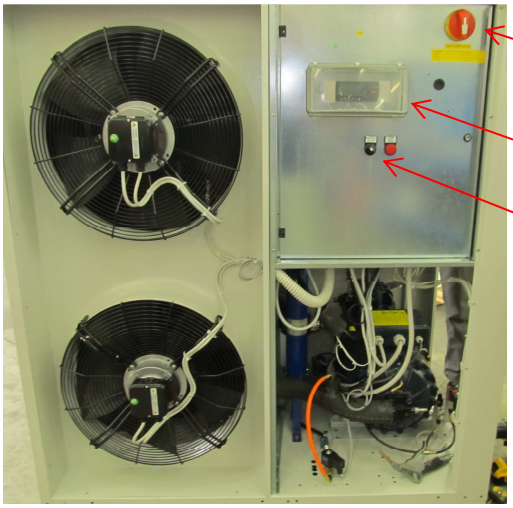
1. General PE terminal present and identified.
2. All other terminals clearly identified, with the ground symbol or two-colour yellow-green lead.
3. Terminals for exclusive connection to the equipotential connections.
4. Only one lead connected to each terminal.
5. Yellow/green insulation on the ground lead.
6. No live leads with yellow or green insulation.
7. No pipes or raceways used as lead protections.
8. No fuses, switches or circuit breakers on the equipotential protection circuit.
9. Lead sizes conform to the minimum sizes given by current standards.
10. Check the electric connections have been made correctly. Especially the phase connections: open the box with the compressor terminal block, the connections must conform to the diagram given in the compressor electric box – depending on whether it is a direct or part winding compressor – and the wiring diagram for the unit.

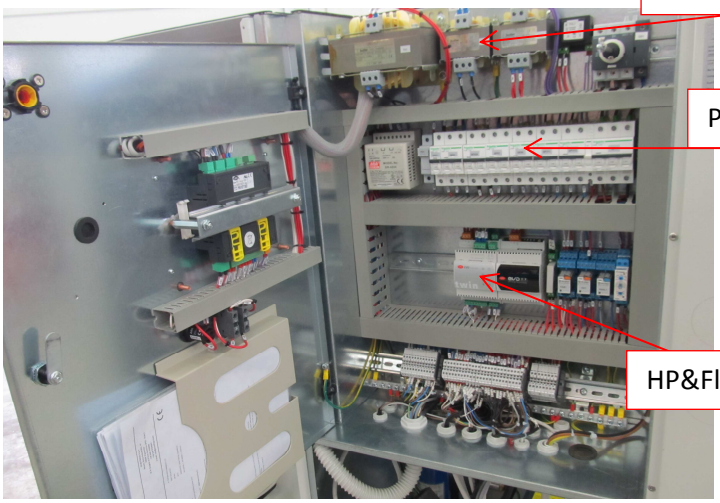
7.2 Management of the system. Configuration of the controllers

Unit is equipped with the following controllers:

- PRack (for CO2 transcritical) to manage:
  - MT compressors staging according to suction pressure
  - Gas cooler fans according to ΔT between gas cooler air inlet temperature and CO2 gas cooler outlet temperature
  - Liquid injection system referencing discharge temperature
  - Collect all the alarms coming from HT side of the unit
- EVD EVO TWIN to manage:
  - Gas cooler pressure according to CO2 gas cooler outlet temperature
  - Receiver pressure according to fixed set point (35-38 bar)

Refer to electrical diagram and controller configuration list, attached to this manual, to check the configuration .





7.3 Inspection of the gas cooler

The fans reach the specified flow rate by rotating in a specific direction as indicated on the unit. Check and, if necessary, invert the phases to ensure the correct direction of rotation.
The air flow must never be obstructed.
Cooling air must never be contaminated; avoid intake from pollutant industrial facilities or from manure yards/slurry or intensive cattle breeding centres, sources of ammonia pollutants.
Refer to specific OEM manual of the component.

7.4 Grounding

The unit must be connected to the ground line, using the terminal provided by the constructor before the unit is turned on for the first time after installation. The customer is responsible for the connections and perfectly efficient grounding in conformity with current legislation in force and for periodically checking the state of the same.

8 Commissioning of the system

The unit leaves the factory without being filled with refrigerant.
Compressor have being pre-charged oil types showed in the table below.
The customer is responsible for complete filling of refrigerant and filling of servicing oil.
The instruction given herein are a reminder of the best method to protect the unit, which could be seriously damaged in the event it is not filled correctly.

8.1 Type of oil and refrigerant

R744 (CO2) refrigerant must be used.
R744 refrigerant with a purity level of 4.5 or equivalent and with a maximum residual umidity 5 ppm shall be used.
Use the following oil to fill the system:

R744 (CO2) Booster system	POE	85 cst	BSE 85K Fuchs C85 E

8.2 Electrical data

Ensure all compressor, gas cooler, medium pressure valve, high pressure valve and resilience unit controls are correct. Record all compressors and fan start and run amperages. Compare with compressor/fan manufactures guide lines and adjust over load setting to suit.
Note: MT machines must be set to ensure no "nuisance" trips during summer operating conditions.

8.3 CONTROLLING THE OIL CIRCUIT

Record all additions of refrigerant and oil. Periodically check the oil level on the oil sump on the compressor.
Check the operation of the compressor oil level switch. The compressor must be switched off in case of low oil level detection.
Oil changing is not normally necessary; oil has to be replaced approximately every 3 years or 10.000 operating hours.

8.4 CONTROLLING COMPRESSOR NOISE LEVELS AND VIBRATIONS

Check the entire plant, especially the piping and capillary pipes, for any unusual vibrations. If required take additional safety measures.
Heavy vibrations could cause the pipes to break and refrigerant and oil leaks onto the plant components.

9 ENVIRONMENT PROTECTION – MAINTENANCE – DISPOSAL

Lubricant oils are governed by very strict legislation, forbidding disposal in the environment. It is compulsory for them to be recovered.
Pay special attention to this when disposing of any cooling plants.

9.1 REPAIRS TO COOLER CIRCUITS BY A QUALIFIED OPERATOR

ALL THE PIPES, BENDS AND FITTINGS MUST BE CERTIFIED ACCORDING TO PED DIRECTIVE 2014/68/UE AND NATIONAL REGULATIONS.
ALL WELDING AND BRASING PROCESS MUST BE PERFORMED BY SPECIALISED AND CERTIFIED OPERATORS ACCORDING TO PED DIRECTIVE AND NATIONAL REGULATIONS.

In certain cases, and always when welding or brazing is required, the refrigerant and oil must be emptied from the circuit. If the refrigerant and oil cannot be recycled, it must be returned to the retailer or to an authorised waste collection centre.

10 DISPOSING OF THE UNITS IN THE SYSTEM

When the system is disposed of, the following must be applied:

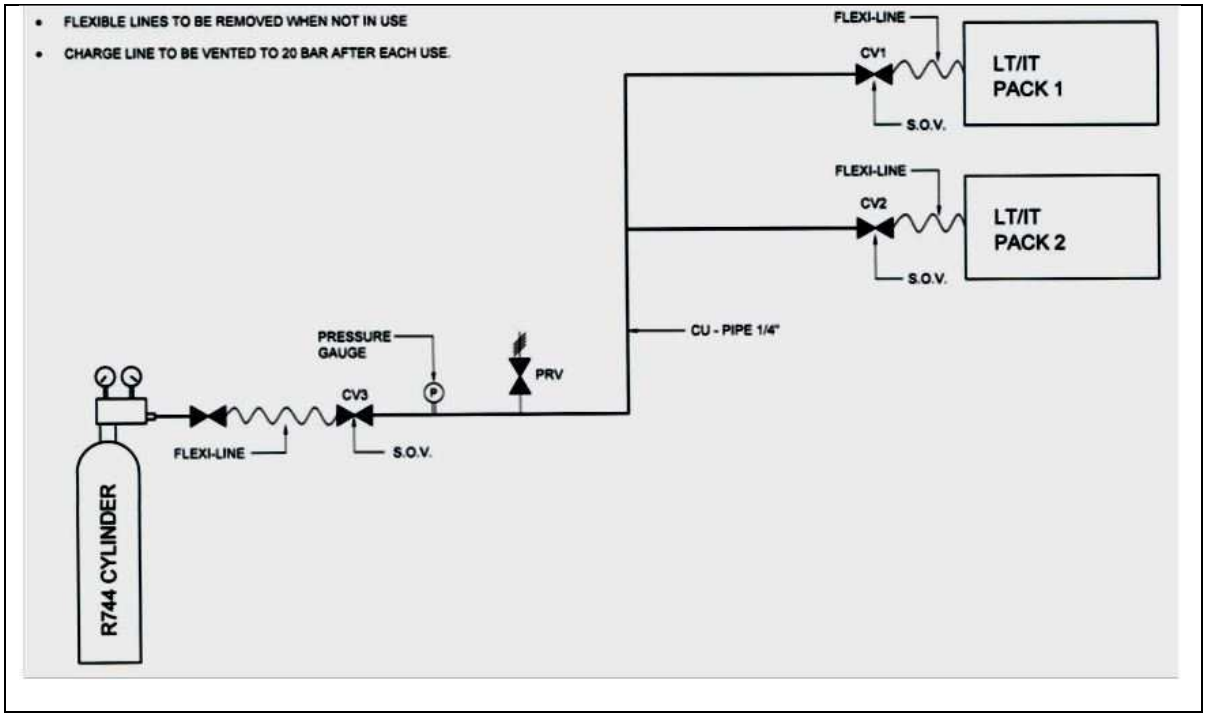
1. All the refrigerant fluid collected using adequate equipment, and consigned to authorised centres for recycling or disposal.
2. The same goes for the lubricant oil in the circuit, especially in the compressor crankcase, and the filter cartridges that are impregnated with oil.
3. Sort the components by material, i.e. iron and steel, copper and electric leads, electric motors and motorised compressors, sound proofing panels in synthetic foam and heat insulation. The sorted materials must then be sent to an authorised waste collection centre for recycling.

11 Maintenance

Note; after all maintenance procedures all effected circuit must be leak checked, all valve caps must be replaced.

11.1 Charge Line Operation

Action	Remark
Ensure valves CV1, CV2. CV3 and pack valve 107F are closed before commencing works.	
Check charge line pressure is >5 barg.	If pressure is <10 bar pressurise charge line by connecting CV1 or CV2 (dependant on Pack to be charged) to suction strainer housing via valve 107A. Open both 107A and CV1 or CV2 until a pressure >10 bar is achieved.
Connect charging hose between CV1 or CV2 liquid drier valve 107F and suction strainer housing 107A.	You will need to use 3 connection hoses and a tee piece for this.
Using pressure in charge line purge charge hose up to valves 107F & 107A, control purge with valve CV1……..tighten connection.	In cold ambient temperatures it may be necessary to reduce the liquid pressure. This can be done by either 1 of the 2 following methods, 1/ closing valve 90C and allowing the pack to pump down. Alternatively this can be done by lowering the liquid pressure set point inside the Carel EVD controller (please refer to controller operating instructions). If this method is to be utilised attention must be given to the IT suction set point to ensure an adequate differential is maintained.
Fully open valve 107E and CV1.	
Go to CV3 Location	
Connect bottle to CV3	
Purge connection with pressure from charge line, control purge with CV3……..tighten connection.	
Open bottle and charge system. Some charge line may have a pressure relief valve fitted, in these cases charge line inlet pressure must be regulated and maintained below the pressure relief valve limit.	


FLEXIBLE LINES TO BE REMOVED WHEN NOT IN USE
CHARGE LINE TO BE VENTED TO 20 BAR AFTER EACH USE.
FLEXI-LINE
CV1
S.O.V.
LT/IT
PACK 1
FLEXI-LINE
CV2
S.O.V.
LT/IT
PACK 2
CU - PIPE 1/4"
PRESSURE
GAUGE
PRV
CV3
FLEXI-LINE
S.O.V.
R744 CYLINDER

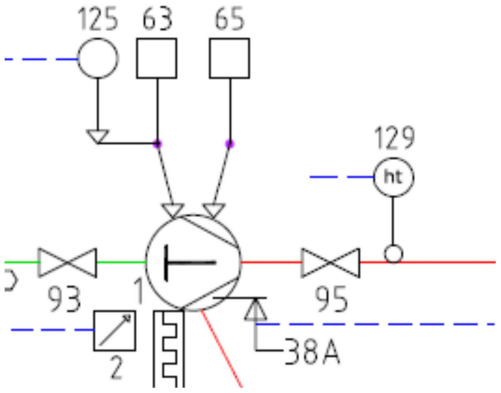
11.2 Disconnect procedure

Action	Remark
Shut off bottle and pump down pack by closing pack valve 90C for 15mins	
Close liquid drier valve 107F and open 107A to drain any remaining liquid into the suction line.	
Open pack valve 90C.	
Close CV1 or CV2 and vent pressure between charge line and 107A&107F immediately but slowly. Leave venting for 5 minutes.	
Examine charging hose for signs of expansion or frosting,	If signs of frosting are present do not touch hose and leave in a vented position until frost has melted.
If no signs are present disconnect hose and replace service caps on valve CV1 or CV2 and valve 107F and 107A.	
Go to CV3 location.	
Close CV3 and vent pressure immediately but slowly.	Leave venting for 5 minutes.
Examine charging hose for signs of expansion or frosting.	If signs of frosting are present do not touch hose and leave in a vented position until frost has melted.
After charge hose has been disconnected vent charge line pressure to 20 barg.	

11.3 Compressor mechanical isolation and reinstatement;

Note: all compressor service valves have their final unique code matched with the compressor number. EG, compressor 1 valves all end with the prefix 'A', compressor 2 with 'B' etc.

For the purpose of these guidance notes compressor number 1 will be used.

Action	Remark
Compressor mechanical isolation and reinstatement; Isolate compressor power, safety & crank case heater circuits before commencing any service/maintenance procedure  Attach a suitable rated pressure line and gauge to the service port on suction service valve 93. Close (front seat) suction service valve 93. Close (front seat) discharge service valve 95. Immediately vent pressure from compressor body by 'cracking off' compressor high pressure switch line at compressor attachment.	Particular notice should be paid to the operating temperature of the compressor discharge line whilst undertaking any service/maintenance activity. Attach a suitable rated pressure line and gauge to the service port on suction service valve 93 Close suction service valve 93 Close discharge service valve 95 and immediately “crack off” compressor HP switch connection ½ turn to vent pressure. DO NOT fully remove this line until the gauge attached to suction service valve 93A is at 0 bar and pressure has stopped venting. Once the gauge attached to suction service valve 93A is reading 0 bar fully remove compressor high pressure switch line and gauge from compressor. Once service/maintenance activities have been completed the compressor must be evacuated to 1 Torr. Switch on compressor crank case heater only whilst evacuation is taking place. Evacuate compressor via the service attachment on suction service valve 93 and high pressure switch line attachment onto compressor body. Isolate vac pump and Torr gauge

The oil in the system is very hydroscopic and should not be exposed to atmosphere unnecessarily.	Break the vacuum to a pressure of 0.5 bar by slowly opening suction service valve 93A. Remove vac line attached to compressor high pressure switch attachment and reattach compressor high pressure switch line. Pressurise compressor to 1 bar and purge high pressure switch line at switch attachment. Fully open (back seat) suction service valve 93A and remove gauge line and gauge. Fully open (back seat) discharge service valve 95. Leak test all effected components. Check oil level in compressor before reinstating power.

11.4 Recommended Annual Check

This check should be carried out in conjunction with the customers' requirements. If the customers' requirements surpass that of this check all actions should be carried and recorded.

Compressor Check inclusive of inverter	
Prior to annual check all compressors should be inspected. Any unusual sounds or vibrations should be corrected	• Check all electrical components and switch gear with an infrared thermometer. Investigate and correct any anomalies. Check all terminals of tightness. • Check compressor foot bolts and washers • Investigate and rectify and signs of oil • Check functionality of oil regulator and alarm circuits. Where necessary check oil pump-compressor sump pressure differential to manufacturers specification • Record compressor running amperages
Pressure vessels & Headers	
All vessels should be inspected as per local laws and customers' requirements	• Inspect insulation for damage and repair as necessary • Investigate for any signs of corrosion • Check all manometers, valves and mechanical connections for functionality and refrigerant tightness
Gas coolers	
Whilst an annual check must be carried out it is recommended that gas coolers should be check/cleaned every spring and autumn to assist efficient operation of the pack	• Check gas cooler finning for fouling and signs of corrosion, correct and clean as necessary • Check rotation of fans, where applicable check speed control signal at fan • Check all terminals with infrared thermometer and correct any anomalies • Check fan overload settings
Oil system	
The oil system should be checked in its entirety. Oil samples should be taken every year to check for contamination	• Check pressure drop across separator filter and replace as per manufacturers guidelines • Check oil mechanical strainer and clean/replace as necessary • Check oil system for signs of oil seepage and repair where necessary

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Registro Imprese n. 04342820281
Cod. Fisc e P. IVA n. 0434282028
R.E.A. PD 382005

	• Check oil drain solenoid timer is set as per commissioning documentation • Check oil pressure/suction pressure differential
Liquid drier	
Check moisture indication in liquid line sight glass. If the indicator is showing the presence of moisture the liquid drier must be changed	• Liquid drier should be changed after service operation has broken into the system or every 2 years
Suction filters	
Suction filters should be check for pressure drops	• If there is a pressure drop across either suction filter this should be replaced
Pressure switches	
All pressure switches must be checked to ensure correct operation of pack safety functions	• Test (and adjust if necessary) each pressure switch to ensure activation and reset at correct pressure as per commissioning documentation • Switches must be tested with nitrogen • Functionality of the electrical circuits must be verified at this point • All PRVs must be tested for refrigerant tightness and replaced as per manufacturers guidelines or customers' requirements
Plantroom ventilation	
Plantroom ventilation has 3 activation functions- Thermostat, gas detection or manual run mode	• Check ventilation fan runs when control switch is set to manual run • Check ventilation fan controls on thermostat function-adjust set points as necessary. Check positioning and calibration of control probe • Activate leak detection alarm and check ventilation fan runs (seek advice from the leak detection manufacturers)
Controls systems	
Both primary and where applicable back-up control systems must be check in their entirety including any and all mechanical valves.	• Check set point for all controllers and inverters are as per commissioning documentation • Check operation of CCMT & CCM/ETS

	valves • Check calibration and positioning of all temperature probes and pressure transducers • Check alarm logs for present and past alarms investigate and correct as necessary • Check inputs and outputs are as commissioned • Check all timers are set as per commissioning document • Check operation of blackout/AKV shutdown function • Check component on electrical board with infrared thermometer and investigate any anomalies
Pack general	
A general inspection should be carried out	• Carry out a full system leak test • Repair any missing or broken insulation on both hot and cold services • Check functionality of all electrical isolators • Check functionality of pack anti-vibration mounts • Check all pipework and supports • Check resilience unit operates in both manual and auto modes • Check communications to alarm monitoring systems and verify alarm output (customer specific) • Repair pack lighting as applicable • Ensure all valve caps and electrical guards are present