ONS
CONDENSING UNIT

CO_2

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

AIR-COOLED - VERTICAL DISCHARGE CO_2 TRANSCRITICAL CONDENSING UNIT R2

REFPLUS

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1. SAFETY CONSIDERATIONS

Installing, starting up, and servicing equipment can be hazardous due to system pressures, electrical components and equipment location (roofs, elevated structures, etc.). Only trained and qualified installers as well as service technicians should handle, install, start-up and service this R744 CO_2 equipment.

When working on the equipment, observe precautions found in the literature, on the tags, stickers, and labels attached to the equipment.

Follow all safety codes. Wear safety glasses and work gloves. Keep quenched cloths and fire extinguisher nearby when brazing and welding. Use care in handling, rigging, and setting bulky equipment.

Units are factory pressurized with nitrogen at approximately 100 psig. Be careful when opening the circuit. If no pressure is present, check for leaks or loose valves. Work in a well-ventilated location when using refrigerant.

Before carrying out repairs which require breaking into the system soldering or welding, all pertinent components must be emptied of CO_2.

WARNINGS:

Before installation, always check to make sure main power to systems is OFF.
Electrical shock can cause personal injury or death.

Very high pressure CO_2 (R744) can be present in the system.

Only a qualified person with the suitable equipment must handle CO_2 (R744).

CO_2 has no smell or colour. Therefore, the operator would not be aware of any possible leak. Refrigerant gas leak may cause suffocation.

CO_2 is hazardous at high concentration. Levels on healthy adults are summarized here:

CO_2 CONCENTRATION	EXPOSURE
<400 PPM (0.04%)	TYPICAL ATMOSPHERIC LEVEL
<700 PPM (0.07%)	INDOOR ACCEPTABLE LEVEL
1000 PPM (0.1%)	INDOOR TOLERABLE LIMIT
5000P PPM (0.5%)	LONG TERM EXPOSURE IN WORK AREA - 8 HOUR LIMIT
15000 PPM (1.5%)	SHORT TERM EXPOSURE 15 MIN LIMIT
30000 PPM (3%)	INCREASED BREATH AND PULSE RATE AND HEADACHE
40000 PPM (4%)	IMMEDIATELY DANGEROUS TO LIFE OR HEALTH
300000 PPM (30%)	QUICK DEATH

2. INTRODUCTION

These instructions describe the installation, start-up and service of an outdoor, air-cooled CO_2 condensing unit with one or several semi-hermetic compressors for high, medium or low temperature applications.

3. PRODUCT DESCRIPTION

Each CO_2 condensing unit is equipped with a compact autonomous control system that manages the operation of the entire system including compressors, fans, and electronic valves to assure smooth, robust, and safe operation of the system in different climates.

A system wiring diagram is provided along with the unit. It displays the controller and all the components and required protection systems.

The unit is supplied with a VFD that modulates and secures the operation of the first compressor to better adapt the capacity of the unit to the customer's requirements.

High-performance and high-efficiency ECM motors with low-noise fan blades are standard on all models for optimal operation of the unit in all weather conditions. Models with multiple fans are equipped with one variable-speed fan and one or more twin-speed fans.

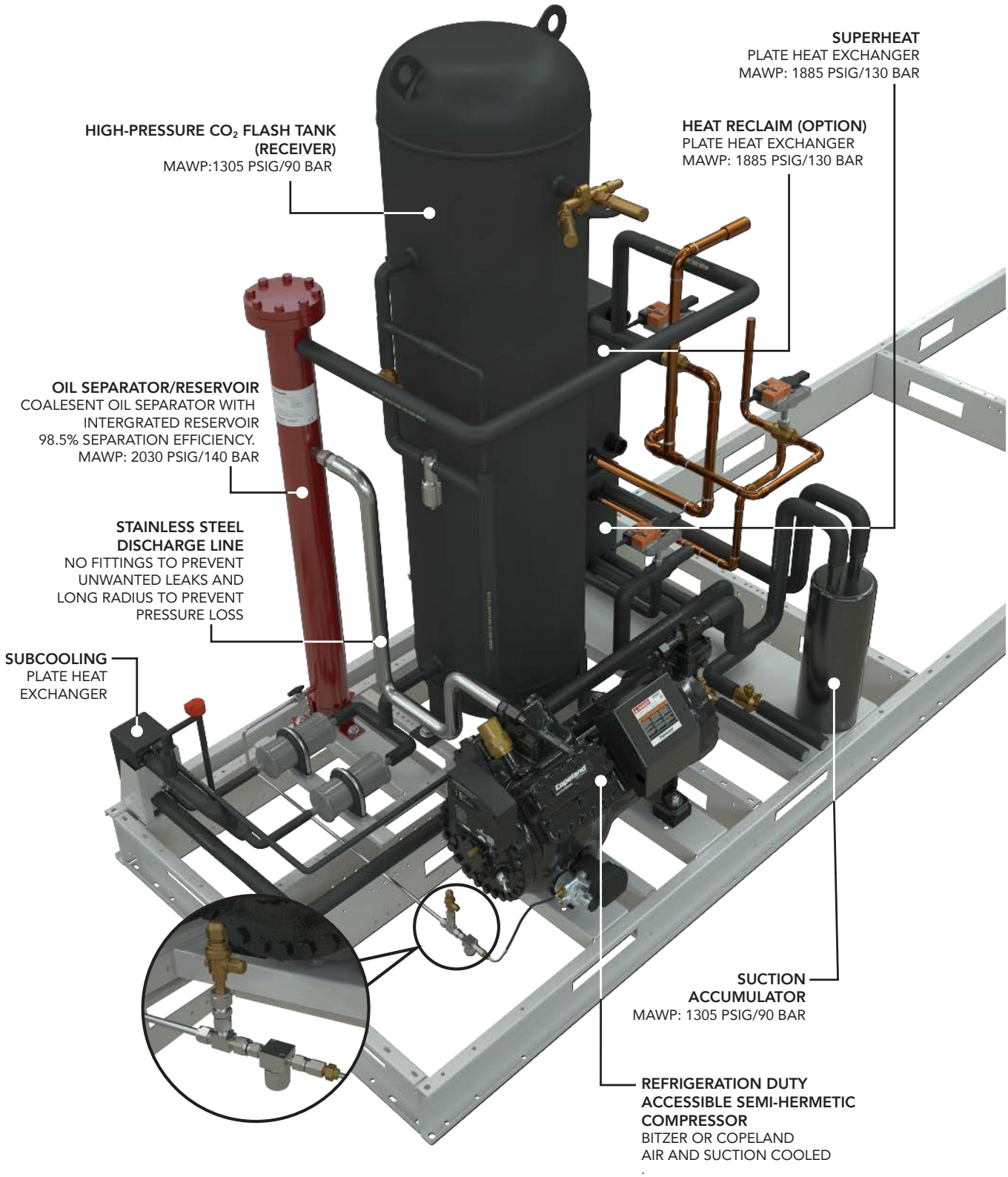
All CO_2 units are designed with 1741 psig/120 bar maximum designed working pressure (MAWP) at the high side and 1305 psig/90 bar at the low side. The supplied CO_2 flash tank/liquid receiver is ASME and CRN certified.

For protection against overpressure, units are supplied with pressure relief valves for both the high and low sides of the system as well as the compressor at corresponding MAWP.

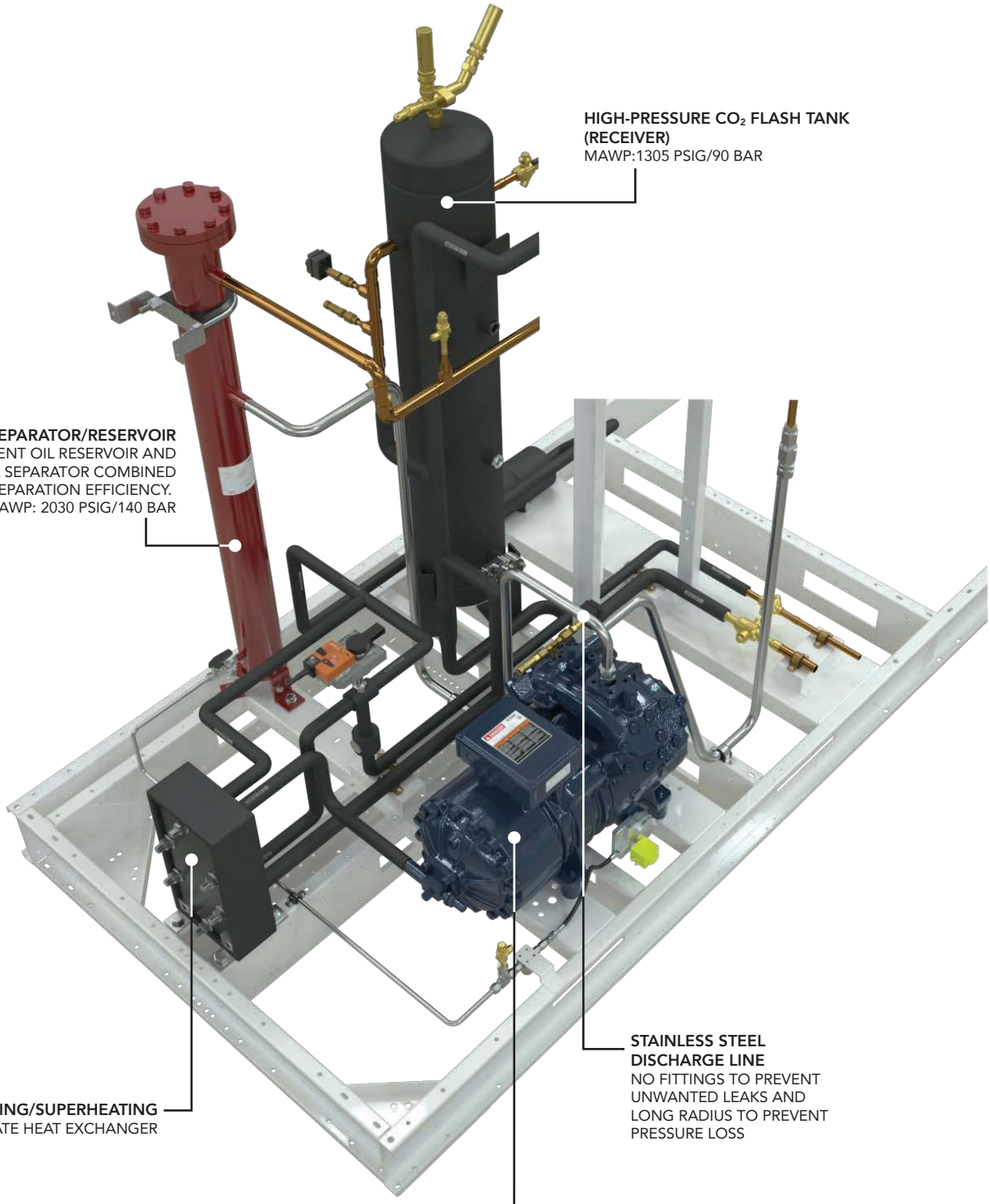
Dual reliefs with changeover valves are standard on large CO_2 flash tanks (with internal volume above 10 ft^3). Otherwise, they are optionally available.

An optional heat exchanger is available for up to 100% heat recovery. It will need a pumping system (a separate unit) for recirculation of a heating fluid (water-PG 50%-50% recommended) in the heating system.

4. MAIN COMPONENTS - MEDIUM & HIGH TEMP. COPELAND OR BITZER COMPRESSOR



4. MAIN COMPONENTS - LOW TEMP. 2-STAGE DORIN COMPRESSOR



HIGH-PRESSURE CO_2 FLASH TANK (RECEIVER)
MAWP:1305 PSIG/90 BAR

OIL SEPARATOR/RESERVOIR
COALESENT OIL RESERVOIR AND OIL SEPARATOR COMBINED
98.5% SEPARATION EFFICIENCY.
MAWP: 2030 PSIG/140 BAR

SUBCOOLING/SUPERHEATING
PLATE HEAT EXCHANGER

STAINLESS STEEL DISCHARGE LINE
NO FITTINGS TO PREVENT UNWANTED LEAKS AND LONG RADIUS TO PREVENT PRESSURE LOSS

REFRIGERATION DUTY ACCESSIBLE SEMI-HERMETIC DORIN 2-STAGE COMPRESSOR
AIR AND SUCTION COOLED
.

5. HANDLING AND RIGGING

Good handling and rigging practices must be followed to protect units from damage. Having proper handling equipment at the job site is most important and it should be planned.

In the US, follow OSHA 1926.251 standard for Rigging Equipment and Material Handling.

In Canada, follow your province's requirements for hoisting and rigging.

Improper rigging of a load or a rigging failure can expose riggers and other workers nearby to a variety of potential hazards.

Always lift units secured to the fork lift to prevent it from slipping off.

Fork Lift – Do not use fork lifts against sheet metal panels or coils. The compressor side of the condensing unit is the heaviest and should be facing the lift truck. Make sure forks extend the entire length of the unit and against a structural part or frame.

Crane – **The center of gravity must be identified before lifting the unit**. Holes are provided to insert bars or hooks for lifting units. Use spreader bars to protect the casing, gas cooler coil, electrical box, piping, and wiring.

Figure 1 shows the ideal rigging of a CO_2 condensing unit. **This rigging method is for reference only**. Rigging procedure will vary from one machine to another and from one site to another.

Equipment handling and rigging should be carried out by a certified rigger.

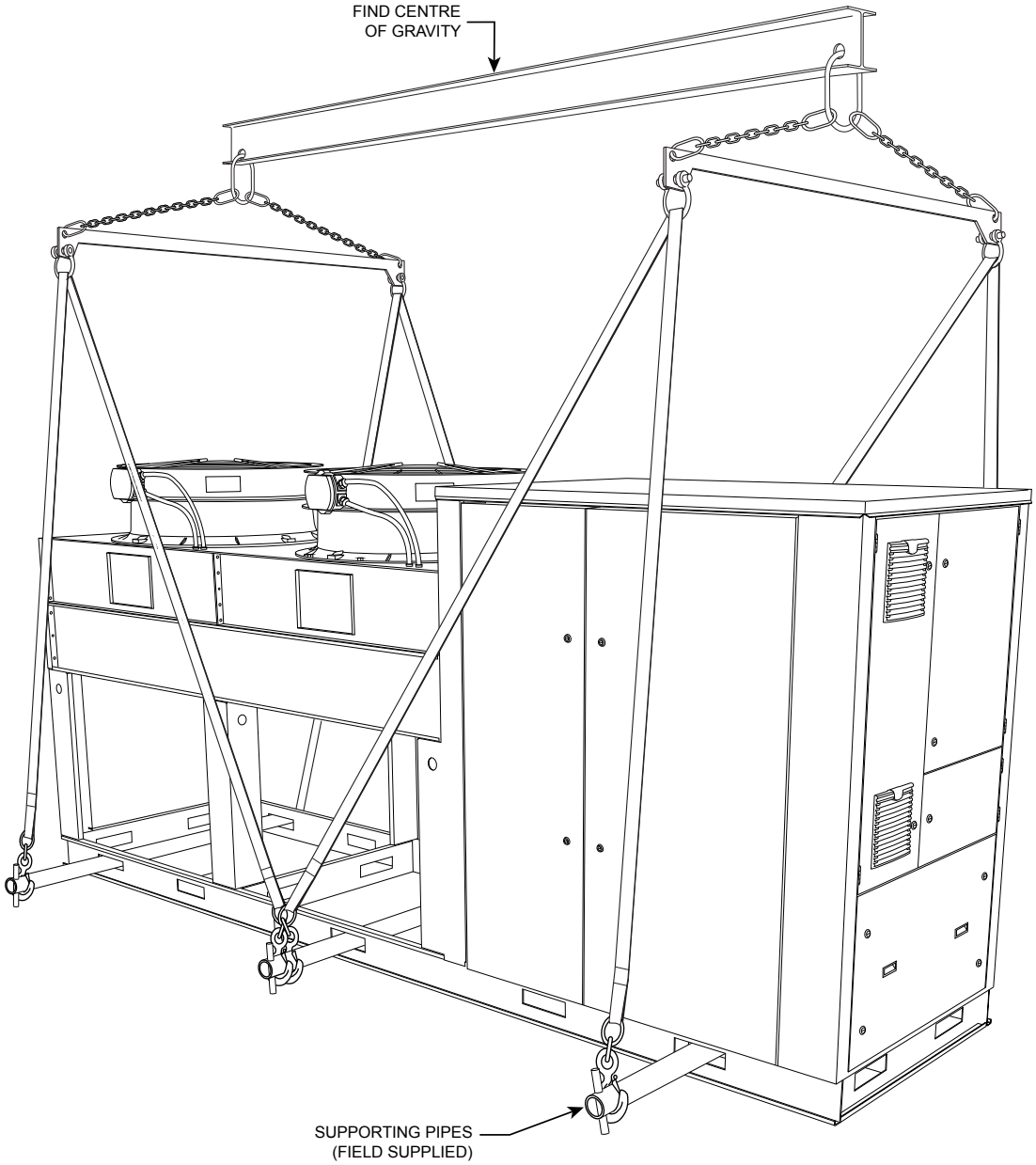


Figure 1 Unit rigging (crane)

6. INSTALLATION

6.1 COMPLETE PRE-INSTALLATION INSPECTION

Check all items against the bill of lading to make sure all crates and boxes have been received. Check unit for possible damage incurred during shipment. Check for concealed damage. If there is any shortage or damage, file a freight claim immediately with the transport company. Do not return damaged equipment to the factory without prior approval. A Return Material Authorization (RMA) must be obtained in advance. **Items returned without an RMA label will be refused**. Verify that the nameplate electrical requirements match the available power supply.

6.2 INSTALLATION LOCATION

These condensing units are designed uniquely for outdoor installation, on the roof or on the ground.

Always check the load capacity of the roof before installing the unit.

Roof-mounted units should be secured with proper size bolts to a steel frame (field supplied) to prevent the unit from shifting or changing position. Rubber pads are recommended to absorb vibration and reduce noise. The frame must be straight and level for proper unit operation.

Units should be mounted above supporting walls, over hallways, storage areas or auxiliary areas that are not sensible to noise and vibrations. **Mount all condensing units where sound level is not an important factor.** They should be mounted away from windows, doors, and other noise sensitive areas.

When selecting the location, be sure to provide enough space for adequate air circulation and avoid air recirculation. Areas with heavy polluted or corrosive vapours must be avoided. Do not locate units where air discharge from one unit will enter the air intake of others. Avoid locating units in restricted spaces where heat can build up and enter gas cooler. Install the unit as close as possible to evaporators and near the power supply. Allow accessibility to the unit for safe maintenance.

If condensing units are mounted on the ground, adequate protection must be provided to avoid damages. A levelled concrete base, at least 6 inches (152 mm) above ground must be provided to protect against ground water. It will also help keep the gas cooler coil clean from grass, dirt and other debris.

Condensing units, piping, coil and disconnect switch **should not** be accessible to unauthorized persons. To shield the equipment from tampering and vandalism and protect people from accidental injury, a safety fence with locked access is recommended. Condensing units accessible to the public often get damages to the coil, piping, fans, or other components. Protect your equipment, your product in storage and yourself from liability. Prevent accidents and losses. The unit should be securely bolted to the base. Vibration absorbing components can be field supplied and installed to reduce noise. Proper piping vibration isolation must be provided.

Figure 2 to Figure 5 show proper mounting arrangements for all ON series condensing units.

Note: For standard units, refer to the technical catalogue dimensions. For non-standard units, refer to the approval drawings or to the actual unit on the job site.

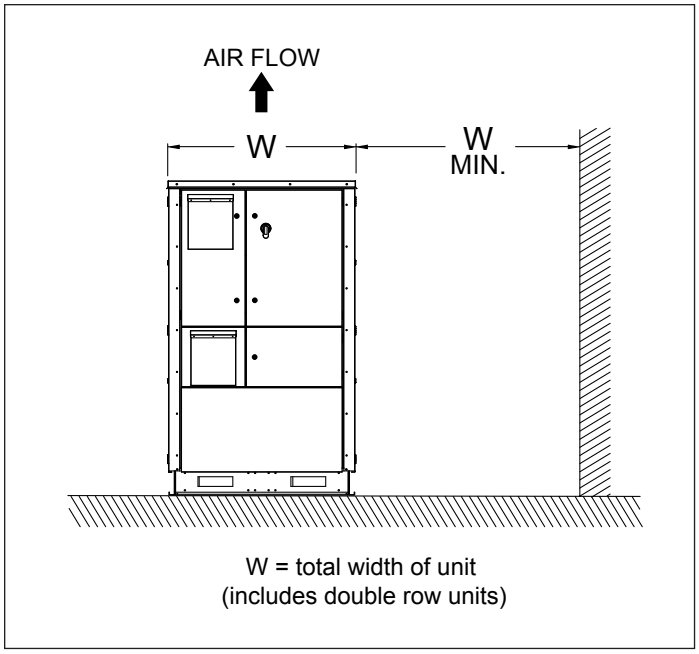


Figure 2 Proper mounting arrangement - distance to wall

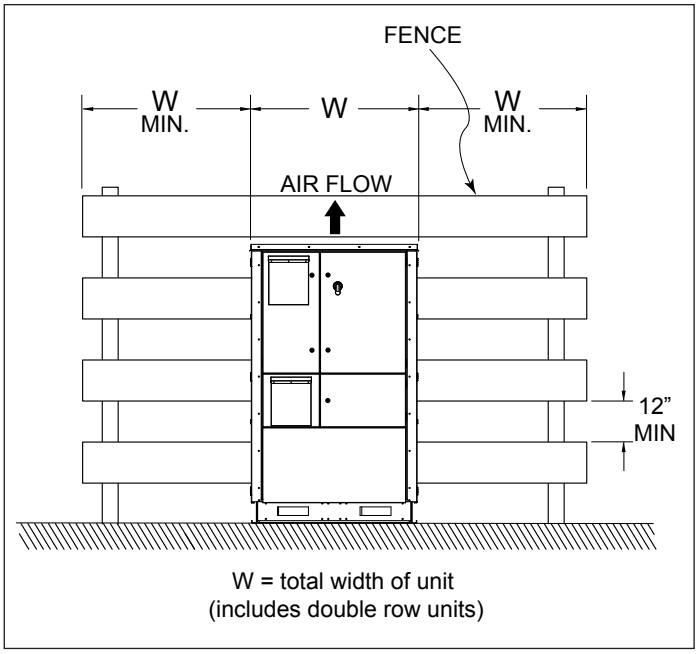


Figure 4 Proper mounting arrangement

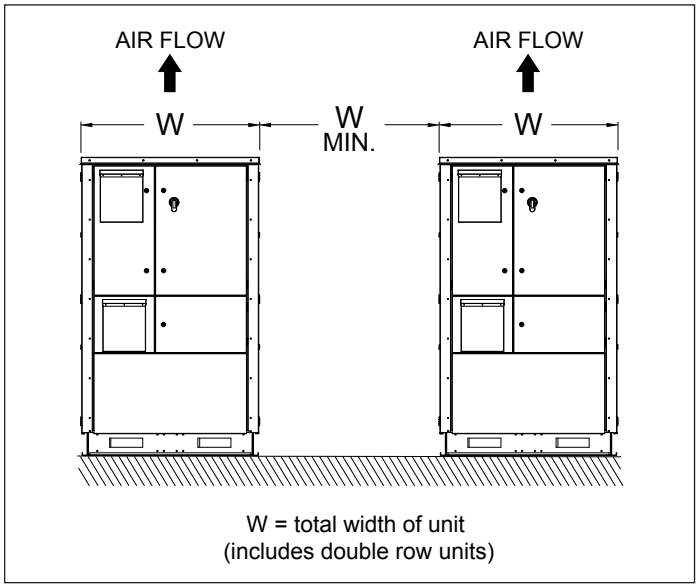


Figure 3 Proper mounting arrangement - distance between two units

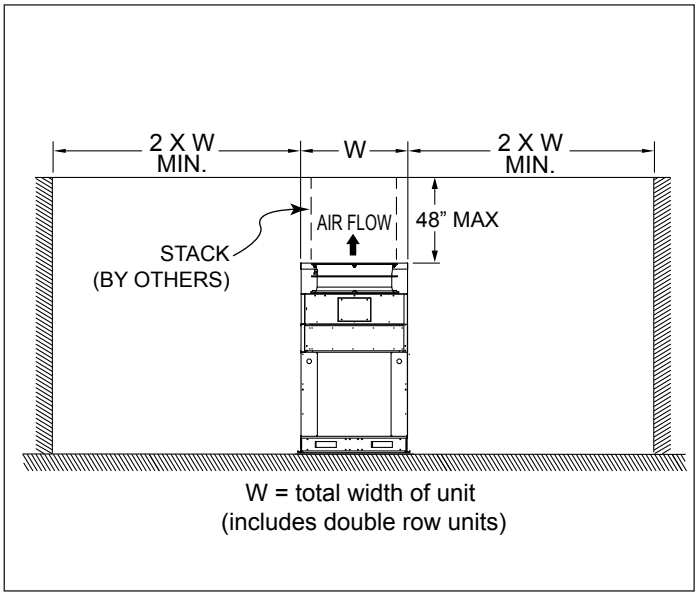


Figure 5 Proper mounting arrangement - closed area

6.3 UNIT WIRING

IMPORTANT: Wire connections may have come loose during transit. Check all screws for tightness prior to starting up the unit.

The unit must be grounded.

All system wiring must follow applicable local and national codes.

Internal wiring of fan motors, compressors, controllers, sensors and contactors have been completed at the factory. Wiring connection ends on terminal blocks in the control panel and are clearly labeled.

The evaporator controllers, external building management system (BMS) and thermostats must also be wired properly.

6.4 REFRIGERATION PIPING

All refrigerant system components must be installed in accordance with applicable local and national codes using proper engineering practices. Refer to the ASHRAE Refrigeration Handbook (chapter 1), the IIAR CO_2 Handbook (chapter 6), or the RSES Refrigeration Piping Handbook (section 4) Piping Procedure for proper design.

Evaporators and condensing units are cleaned and dehydrated at the factory. **Care must be taken during field piping to prevent contaminants and moisture from entering the system**. Do not leave dehydrated compressors or filter-driers on the condensing units open to the atmosphere any longer than necessary.

The equivalent line length should not exceed 70 ft (21 m). Line installation should always be done in conformity with best practices. **Proper system piping is the sole responsibility of the customer**.

Long lines and/or high operating temperature differences (discharge, hot gas, and suction lines) require some expansion loop to avoid line break.

All piping must be properly supported for proper operation. Follow ASHRAE, RSES, specifying engineer or the industry standard rules. Normally, any straight run must be supported in at least two locations near each end of the run. As a guide, 3/8'' to 7/8'' diameter pipes should be supported every 5', 1-1/8'' and 1-3/8'' every 7' and 1-5/8'' and larger every 9' to 10'. When changing directions in a run of tubing, **no corner should be left unsupported**. Support should be placed at a maximum of 2' in each direction from the corner.

Piping attached to vibrating parts (compressor, condensing unit base and high-pressure gas piping) must be supported in such a way that it will not limit the movement of the vibrating parts. Rigid mounting will fatigue the tubing.

Thoroughly inspect all piping after the equipment is in operation and add support whenever line vibrations are significantly greater than most of the other piping. Extra support is relatively inexpensive as compared to the loss of refrigerant. See Figure 6.

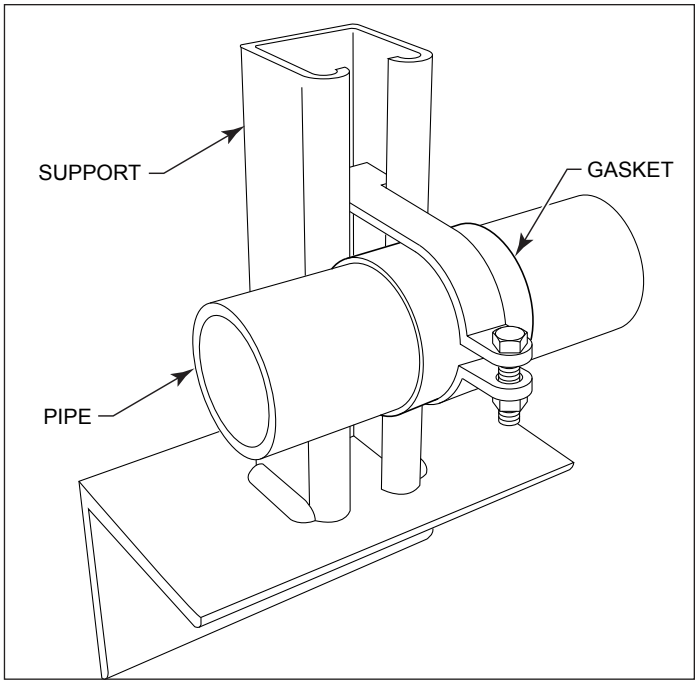


Figure 6 Typical pipe support

COPPER PIPES:

Use only high-quality CuFe tube (such as K65 and Streamline XHP brands with 1741 psig/120 bar MAWP) for units with 1305 psig/90 bar MAWP. Use only refrigeration tubing that is capped and nitrogenized, internally free of dirt, humidity or other contaminants. **Unsealed tubing should not be used**. Use only wrought copper fitting in accordance with the tubing type (for example CuFe). **Long radius elbows are highly recommended**. Use high-temperature brazing alloys that conform to AWS specifications for the application.

Lines must be purged with dry nitrogen while joints are brazed to avoid oxidation and carbon deposits.

Limit brazing/soldering flux to the minimum required to prevent contamination of the brazed/soldered joints internally. Flux only the male side of the connection, never the female. Remove excess flux after brazing/soldering.

More details can be found online at www.copper.org.

STAINLESS STEEL PIPES:

Use only high-quality 304 or 316 stainless steel IPS pipes for liquid and suction lines. To determine proper pipe schedule please refer to standard pipe pressure rating. Pipes must be free of dirt, humidity or other contaminants. Similar to copper tubing, use only wrought fitting in accordance with the pipe type and material.

Welding of the pipe must be done according to the ASME codes for high pressure welding by certified welders.

6.5 LINE SIZING AND BASIC PIPING RULES

LINE SIZING:

For proper line sizing, use an industry accepted program from a refrigerant or refrigeration valve manufacturer.

DANFOSS, COOLSELECTOR®

Line sizing, individual line sizing and a highly engineered selection program.

www.danfoss.com
Service and support. Download the Coolselector2 software.

BASIC PIPING RULES:

1. Ensure proper liquid refrigerant feed to evaporators.
2. Provide practical refrigerant line sizes without excessive pressure drop.
3. Prevent excessive amount of lubricating oil from being trapped in any part of the system.
4. Protect the compressor from lubricating oil loss at all times.
5. Prevent liquid refrigerant or oil from entering the compressors during operation and idle time.
6. Maintain a clean and dry system.

6.6 RECOMMENDED VELOCITY FOR GOOD OIL RETURN - FPM (M/S)

LINE	Minimum Horizontal	Minimum Vertical	Design	Maximum
Gas cooler outlet (transcritical mode)	NA	NA	600 (3.0) - 1100 (0.5)	1200 (6.1)
Liquid	NA	NA	100 (0.5) - 300 (1.5)	300 (1.5)
Suction	800 (4.1)	1000 (5.1)	1200 (6.1) - 3000 (15.2)	3000 (15.2)
Discharge	500 (2.5)	1000 (5.1)	1200 (6.1) - 2500 (12.7)	2500 (12.7)

6.7 GENERAL REQUIREMENTS FOR CO_2 SYSTEM

Due to the properties of CO_2, it should not be confined to an enclosed area in the system without a relief valve. If isolation valves are used on the line, they should be bypassed by a small check valve toward either the CO_2 flash tank (recommended) or an additional relief valve with setpoint no greater than the MAWP of the system, as shown in Figure 7.

6.8 SUCTION LINE

The suction line must be sized to maintain proper line velocities with a practical line pressure drop. It is usually equal to 2°F (1.1°C) of saturated temperature drop. To ensure proper oil return, all horizontal lines must be sloped down toward the compressor with a minimum pitch of 1/4" (6.4 mm) per 10 ft (3 m).

An access valve must be installed (when not part of the evaporator) on the evaporator suction line to read an accurate suction pressure for superheat adjustment.

In situations where it is necessary for the suction line to rise, an P-trap must be installed at the bottom of the riser as shown in Figure 8.

To ensure oil return through a riser in the suction line, a velocity of no less than 1000 FPM (5.1 m/s) is required.

When a system has capacity variation or unloaders, a double riser (Figure 9) may be necessary to keep the velocity at a minimum of 1000 FPM (5.1 m/s) at less than 50% capacity. You can drop one size suction riser to lift the oil. A trap should be provided for each additional 15 ft (4.6 m) of riser.

Avoid oil and refrigerant migration between active and inactive evaporators in a common suction system. When multiple evaporators are connected to a common suction line, it must enter from the top. The first evaporator suction connection should have an inverted trap as shown in Figure 10 and Figure 11.

In CO_2 refrigeration systems, suction lines should be properly insulated in all areas to avoid heat gain and condensation. They should not be exposed to heat or the sun.

If isolation valves are installed on the suction lines, full port ball valves must be used.

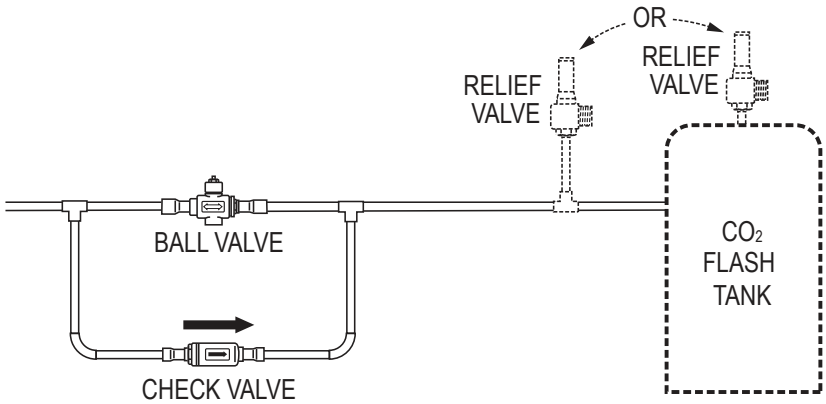


Figure 7 Shut-off with bypass valve to relief valve or flash tank

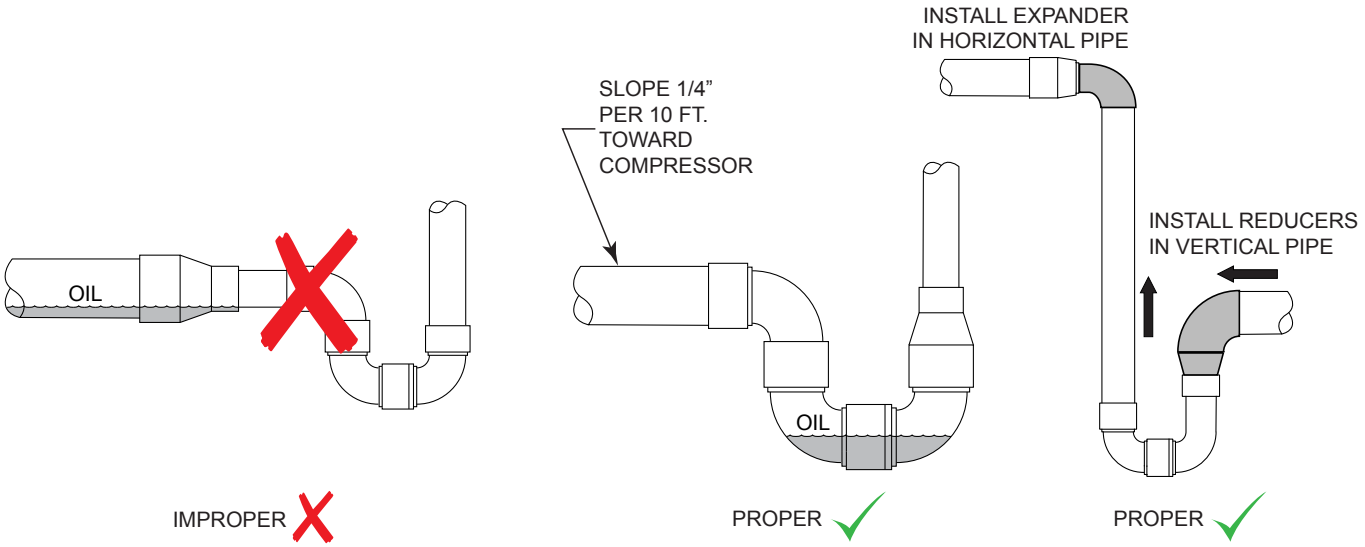


Figure 8 Suction oil trap construction

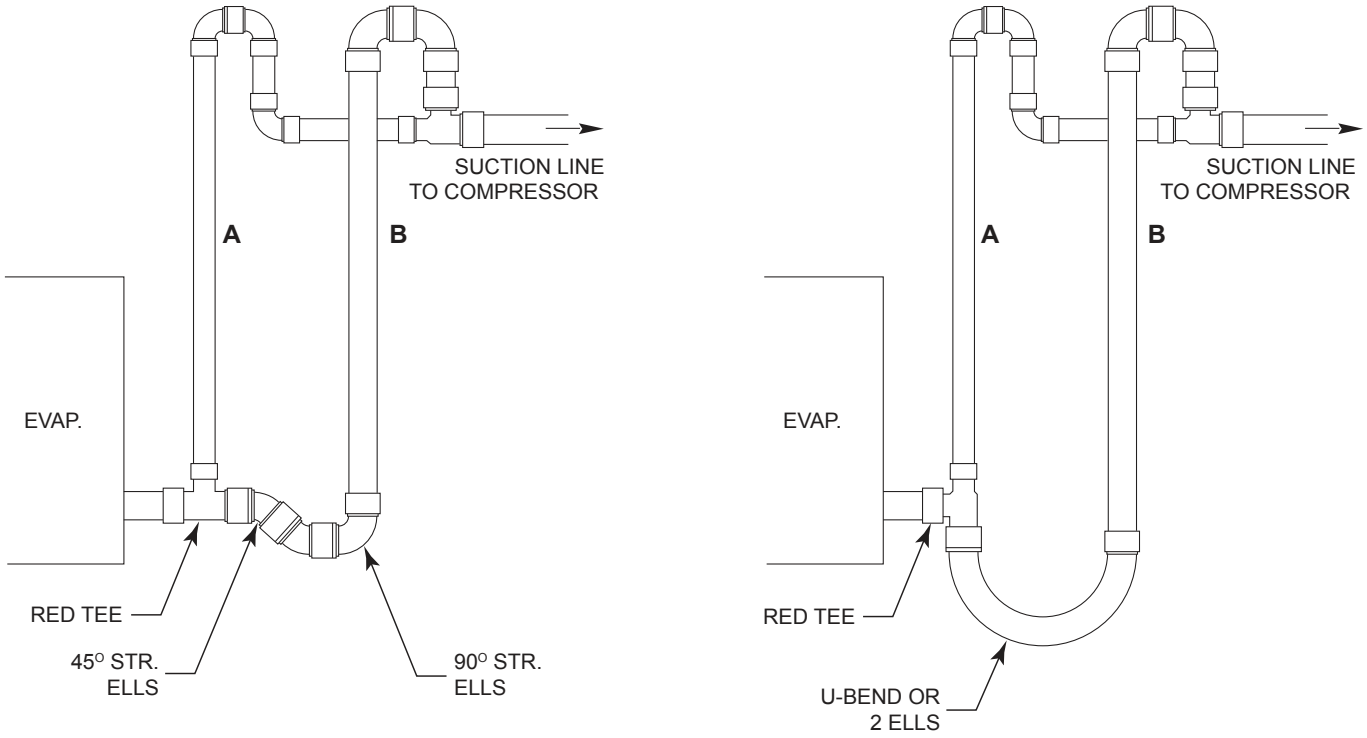


Figure 9 Double suction riser

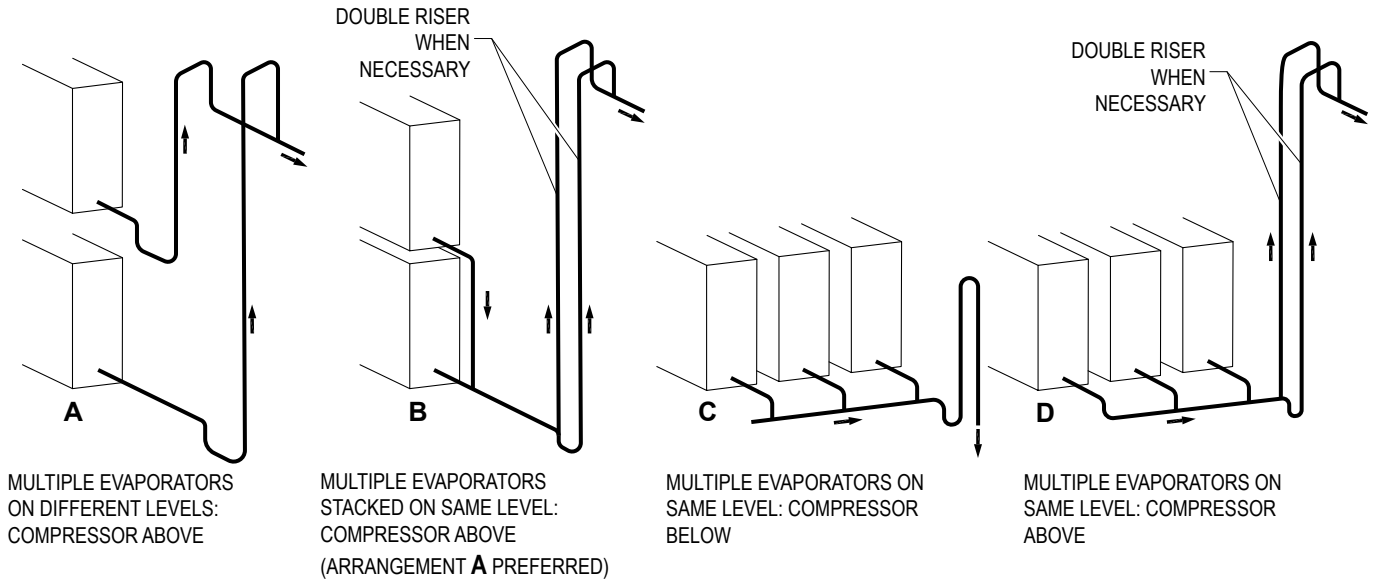


Figure 10 Multiple evaporator suction line construction

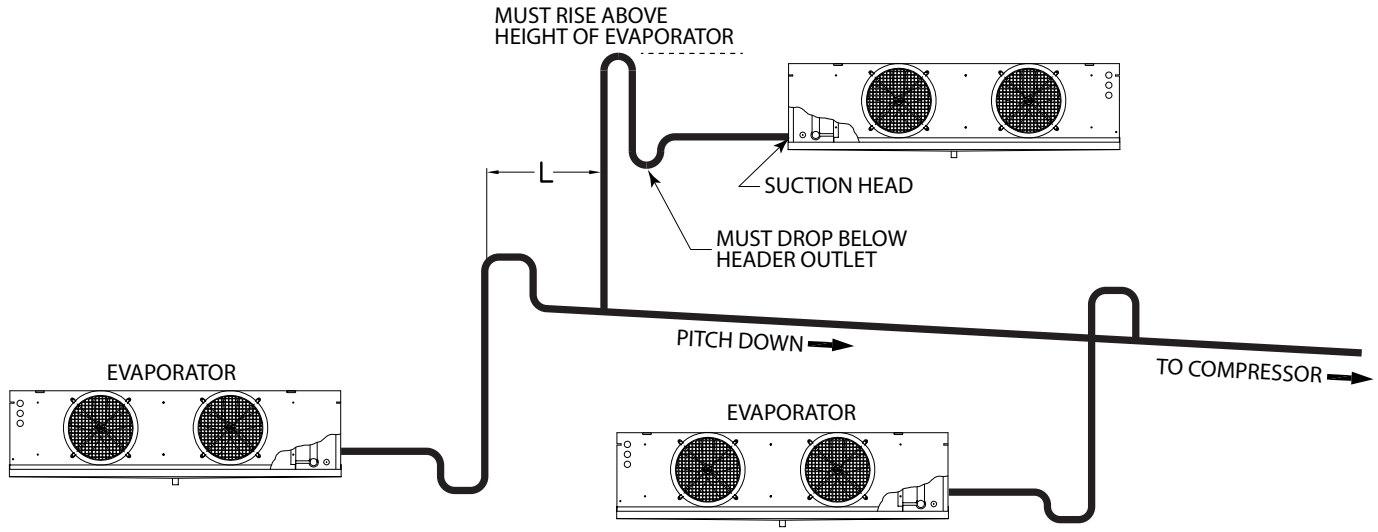


Figure 11 Multiple evaporator suction line construction

6.9 LIQUID LINE

Unlike in HFC systems, in CO_2 refrigeration systems, the liquid line is colder than the ambient temperature, with CO_2 temperature between 14°F to 59°F (-10°C to 15°C) depending on the application. Therefore, the liquid line must be properly insulated between the CO_2 flash tank and the evaporators. We recommend using 1" of insulation for outdoor areas and for long-distance routing in indoor non-refrigerated areas. If the line is exposed to direct sunlight, we recommend covering it with proper UV protective wrap, jacket or coating. You can use ½" insulation for indoor non-refrigerated areas with short distances routing (less than 30 ft (9 m)) and inside refrigerated areas with a temperature higher than the liquid line. There is no need for insulating the liquid line if the surrounding temperature is always below its temperature. The line may also be insulated in areas where condensation and ice build-up must be avoided.

The liquid line should always be connected to the dedicated liquid outlet at the bottom of CO_2 flash tank.

Liquid sub-cooling is provided through a heat exchanger installed on the liquid line. Subcooling is required especially when a liquid line rises higher than the flash tank. Make sure you have at least 0.9°F (0.5°C) of sub-cooling for each 10 ft (3 m) of liquid riser. Liquid lines with more than 30 ft (9 m) of vertical lift need special attention.

All RefPlus CO_2 condensing units have a subcooling heat exchanger. Make sure that the superheat temperature, when using a liquid/suction heat exchanger, does not exceed the maximum recommended by the compressor manufacturer.

In all cases, the amount of temperature change due to heat gain and pressure drop must be below the amount of available sub-cool to avoid flash gas in the liquid line. Contact RefPlus for more details.

The liquid connection must be taken from the bottom of the liquid line piping when multiple evaporators are on the same liquid line.

DO NOT exceed a maximum of 300 FPM (1.5 m/s) for the liquid line velocity from the flash tank to the evaporators.

Excessive pressure drop in the liquid line must be avoided to keep a solid column of liquid at the electronic expansion valve (EEV) inlet.

Before installing the expansion valve, ensure the distributor is either a Venturi Flow or orifice type. In the case of a orifice type, make sure the orifice is properly installed. When an auxiliary distributor adaptor is supplied with the orifice type, the orifice must be installed at the inlet of the auxiliary connector. This is to ensure that the hot gas bypasses the orifice. For optimum performance, the expansion valve outlet should be connected directly to the distributor.

If reducing couplings or adaptors are required, keep them close coupled. Do not install elbows between the expansion valves and the distributor. **The expansion valves must be selected to match the system capacity.** Follow the expansion valve manufacturer rating when selecting the valve. Use EEV that matches the RefPlus condensing unit and its pressure rating.

6.10 CONDENSATE DRAIN LINE

Copper or steel pipes should be properly protected from freezing. Food approved plastic can also be used for medium-temperature coolers above 35°F (2°C). The drain line must have a minimum of 1/4'' per foot pitch for proper drainage. The unit must be perfectly level in two directions. The drain line should be at least as large as the evaporator drain connection. **All plumbing connections should be made in accordance with local plumbing codes**. All condensate drain lines must be trapped and run to an open drain. They must **never** be connected directly to the sewer system. Traps in the drain lines must be in a warm ambiance. We recommend a trap on each evaporator. Traps located outside the building must be insulated and wrapped with a drain line heater. **The heater must be permanently energized**. A heat input of at least 20 W per linear foot of drain line for a 0°F (-18°C) room and 30 W per linear foot of drain line for a -20°F (-29°C) room should be satisfactory.

Always trap drain lines individually to prevent vapour migration.

WARNING. Power must be disconnected before cleaning the drain pan. Drain pans also serve as cover for hazardous moving parts. **Operation without the drain pan constitutes a hazard.**

Inspect drain pans periodically to ensure free drainage of condensate and detect any ice formation. If the drain pan contains standing water, check for proper installation and level.

Drain pans should be cleaned regularly with warm soapy water.

7. PRINCIPLES OF OPERATION

7.1 REFRIGERATION SYSTEM AND CONTROLS

All ONS series CO_2 condensing units are air-cooled and designed for an outdoor installation. These units operate in transcritical mode during warm outdoor conditions or upon request (such as optional heat reclaim) and in subcritical mode during cooler conditions. In transcritical mode, the refrigerant pressure is above the critical point of 1055 psig/ 72.8 bar. So, no condensation occurs in the gas cooler, and the refrigerant only cools down. In the subcritical mode, the gas cooler acts as a condenser, similar to HFC systems.

These units must always be connected to the power source except for service by a trained technician. With the 1305 psig/90 bar design at low side in Unit-OFF mode, if the CO_2 flash tank pressure rises to a predefined limit, the system goes ON via a pressure switch activation for a short period of time to reduce the flash tank pressure. **In this mode, the evaporators may not be activated by the system**.

7.2 SYSTEM CONTROLLER

The operation of the entire system is controlled by the CAREL PRack pR300T controller which is standard on all models. This controller has an integrated driver board to control two CO_2 electronic valves (HPV & BPV).

It has a total of 12 analogue inputs (AIs) for pressure and temperature sensors, 4 analogue outputs (AOs) with 0/10VDC signal for modulating devices, 12 digital inputs (DIs) for switches and alarms, and 13 digital outputs (DOs) for commands and activations. Low-temperature condensing units or units with the heat reclaim option also come with an expansion board that provides 10 additional universal channels for analogue input/output (AI/AO) and 6 additional digital outputs (DOs).

This controller is preprogrammed at the factory as per each application with default setpoints. Some setpoints, such as the Compressor Suction Pressure and Gas Cooler Fan setpoints, will need to be field adjusted according to the application needs. After installation and first start-up, the controller will need minimum supervision. It has preprogrammed procedures to ensure the unit can operate safely.

This controller starts the operation of the system via an external command (ON/OFF switch, BMS command, etc.). Then, it manages the modulation of the compressor(s), the modulation and cycling of the fan(s), and the opening of electronic valves to maintain all predefined setpoints and limits.

7.3 HIGH PRESSURE ELECTRONIC VALVE (HPV)

All units are equipped with either a CAREL E*V series or Parker GC series high pressure electronic valve (HPV) as shown in Figure 12. It is located at the end of gas cooler outlet line to the flash tank. It works as a high-pressure expansion valve. When high-pressure CO_2 passes through this valve, its pressure breaks and a two-phase flow exits the valve. This flow goes to the CO_2 flash tank/liquid receiver where gas and liquid CO_2 are separated.

The HPV controls the pressure of the high side of the system based on the gas cooler CO_2 outlet temperature. The procedure of the control is embedded in the core of the PRack controller. According to predefined criteria, it determines the operation mode (transcritical vs subcritical) and it adjusts the HPV opening to get to desired pressure. There are also safety factors in the controller that limit the opening of the HPV to protect both the gas cooler and the flash tank.

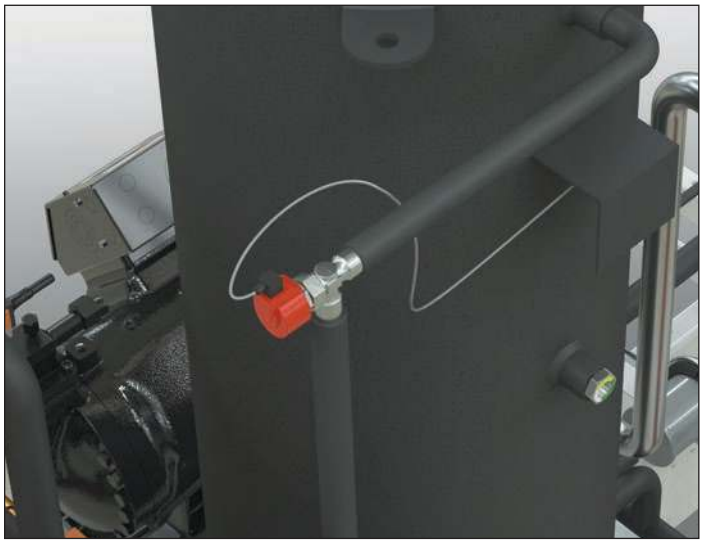


Figure 12 High-Pressure Electronic Valve (HPV)

7.4 BYPASS LINE ELECTRONIC VALVE (BPV) (MEDIUM/HIGH-TEMPERATURE UNITS ONLY)

Medium and high-temperature units are equipped with either a CAREL E*V series or Parker GC/FGB series high-pressure bypass line valve (BPV) as shown in Figure 13, page 15. It is located on the bypass gas line of the flash tank. The flash gas separated from the liquid CO_2 in the flash tank passes through this valve and goes back to the system via the suction line of the compressor where it mixes with superheated gas returning from the evaporators.

The BPV controls the pressure in the flash tank based on a predefined pressure setpoint in the PRack controller. It ensures that the flash tank has adequate pressure to properly deliver the liquid CO_2 to the evaporators. There are also safety procedures in the controller that limit the opening of the BPV to protect the flash tank pressure. Low-temperature condensing units with a dual stage Dorin compressor do not require a BPV valve and the pressure in the flash tank depends solely on the operation of the compressor.

Figure 13 High-pressure Bypass Line Valve (BPV)

7.5 GAS COOLER: FANS

Gas cooler fans control the CO_2 temperature on the gas cooler outlet. The first fan (or first two fans in gas coolers with a dual-row fan arrangement) is a 3-phase variable speed high-efficiency fan with ECM motor. This fan operates with ON/OFF command and 0/10 VDC signal from the PRack controller. The other fans (on larger models) are 3-phase high-efficiency twin-speed fans operating at high-speed. Both types of fans come standard on all ON series CO_2 condensing units.

The PRack controller directly modulates and manages the operation of all fans for proper operation of the gas cooler in transcritical mode at high ambient temperature and in subcritical/condensing mode at colder condition. The controller may stop all fans in extreme cold conditions in order to reach the minimum required gas cooler outlet temperature.

7.6 GAS COOLER: COIL

Gas cooler coil is designed and manufactured in accordance with cETLus requirements with 1741 psig/120 barg MAWP.

7.7 GAS COOLER: BYPASS VALVE

The gas cooler bypass valve is a 3-way modulating V-port type valve. It is standard on condensing units with up to two gas cooler fans. This valve is optionally available on larger gas coolers. It is also available with optional heat reclaim.

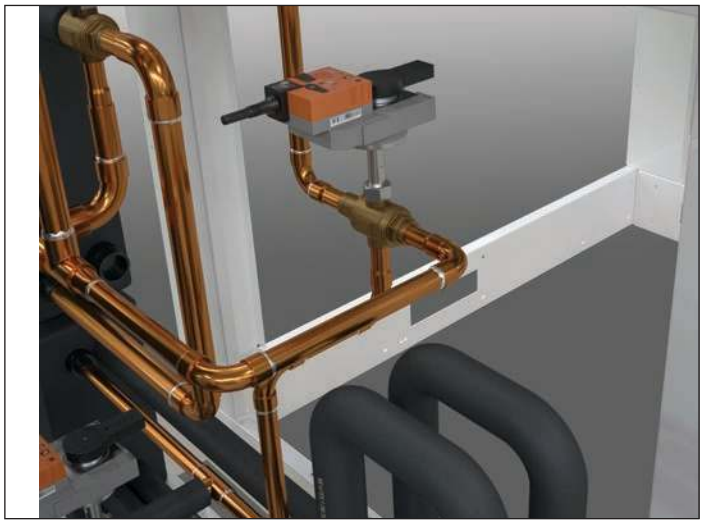


Figure 14 Gas cooler bypass valve

7.8 CO_2 COMPRESSOR(S)

CO_2 condensing units are available for only one refrigerated load, for high temperature above 41°F (5°C), medium temperature 32°F to 41°F (0°C to 5°C), and low temperature below 32°F (0°C) applications.

MT and **HT** units are offered with Emerson 4MTLS series and Bitzer standard series semi-hermetic reciprocating compressors. These compressors have dedicated relief valves on their high-side enclosure. **LT** units are offered with Dorin CD2S dual-stage semi-hermetic reciprocating compressors. They come with three relief valves for high, intermediate, and low pressure sides of the compressor.

All these compressors are capable of 50-100% modulation. However, at first startup, a vibration/resonance test will be necessary to check possible undesired vibrations.

For a safe and reliable operation, a compressor **should not start/stop more than 8 times per hour**. An adjustable preset time delay is defined in the PRack controller that limits the minimum duration of ON and OFF of the compressor to avoid short cycling.

7.9 CO_2 FLASH TANK/LIQUID RECEIVER

Each condensing unit comes with one vertical CO_2 flash tank, also called CO_2 liquid receiver. This tank works as a liquid/gas separator as well as a reservoir for charging the system with CO_2.

It is built in accordance with the ASME Code and comes with the CRN certification for Canadian installations. It has the MAWP in accordance with the pressure design of the condensing unit, that is 1305 psig (90 barg).

Tanks with less than 10 ft^3 volume come standard with one pressure relief valve. Larger tanks come with dual relief valves and changeover valves. Dual relief valves are also optionally available for smaller tanks.

Figure 15 CO_2 Flash tank / liquid receiver

7.10 VARIABLE FREQUENCY DRIVE (VFD)

All condensing units come with a variable frequency drive (VFD). The VFD receives a modulation signal from the PRack controller to modulate the speed of the first compressor in order to maintain the suction pressure setpoint.

Depending on the type of condensing unit, either an Emerson EVH series or a Danfoss FC-102 series VFD will be installed.

Figure 16 Variable Frequency Drive (VFD)

7.11 MECHANICAL HIGH-PRESSURE SAFETY SWITCH

The high-pressure safety switch (Figure 17) must not be set at more than 90% of the relief valve setting, according to CSA B52 and ASHRAE 15.

All units come with a mechanical pressure switch with a 1566 psig/108 barg cut-out and an integrated external reset button.

Units with 1305 psig/90 barg MAWP come with a second mechanical pressure switch with a 870 psig/60 barg cut-in installed on the CO_2 flash tank. It activates the unit when the flash tank pressure passes this limit. Cut-off value is a setpoint pre-programmed into the controller. This is the same setpoint used to allow the modulation of the compressor and the activation of the evaporators. Pressure setpoints for all these switches are factory set and **must not be modified**.

Figure 17 Mechanical high-pressure safety switch

7.12 EVAPORATORS WITH GUARDIAN+ RC-S CONTROLLER

All RefPlus CO_2 condensing units are offered with matching CO_2 evaporators. These evaporators are designed and manufactured with the pressure rating that matches the paired condensing unit. The selection of evaporators varies according to the needs of the clients.

For condensing units with one compressor, we recommend at least three evaporators to insure the system can perform a defrost procedure for each evaporator (one at a time) and avoid interrupting the operation of the condensing units.

For multi-compressor condensing units, a minimum of two evaporators can be used for the same application.

For both single and multi-compressor condensing units, a one-to-one arrangement is also possible (one evaporator with one condensing unit) with some considerations. In all cases, when selecting evaporators, the maximum allowable charge of the system shall not be exceeded. For more information, please contact RefPlus.

Guardian+ RC-S controllers manage the operation of the evaporators in cooling, off-time, and defrost modes. Each controller receives the enable signal from the condensing unit controller (PRack) to start the operation of the corresponding evaporator.

In multi-evaporator application, RC-S evaporator controllers connected to the same CO_2 condensing unit can be bonded together through TCP/IP communication so that only one evaporator can go to defrost mode (adaptive defrost) while the others are in operation.

In single-evaporator applications, this controller stops the condensing unit when the evaporator is in defrost mode.

For more information about the Guardian+ RC-S controller, please refer to its manual, available at refplus.com.

8. CONTROLS AND OPERATION

8.1 CONTROLLING THE CO_2 CONDENSING UNIT: PROCEDURES, PARAMETERS & FUNCTIONS

All RefPlus ONS series CO_2 condensing units are provided with a CAREL PRack pP300T transcritical controller with integrated/remote interface by which all parametrization of the program can be done. **All units are delivered preprogrammed at the factory.** The end user does not have access to the programming, except for changing a few particular operation setpoints. If any additional modifications are needed, please contact RefPlus technical support team.

The interface is made up of a screen and six buttons as shown in Figure 18.

Figure 18 CAREL PRack pP300T controller interface

Button		Function Associated
⚠	(ALARM)	Displays the list of active alarms and accesses the alarm log
⊙		Enters the main menu tree
↩		Returns to the higher-level screen
↑	(UP)	Scrolls a list upwards or increases the value highlighted by the cursor
↓	(DOWN)	Scrolls a list downwards or decreases the value highlighted by the cursor
↵	(ENTER)	Enters the selected sub-menu or confirms the set value

The description of LED lights of the three left buttons of interface:

LED	Button	Description
Red	⚠	**Steady**: alarms present and acknowledged **Flashing**: active alarms present and not acknowledged
Yellow	⊙	PRack pR300T is ON
Green	↩	PRack pR300T is powered

There are three types of screens on this interface:

- Main screen
- Menu screen
- Parameter setting screen

MAIN SCREEN

The **Main screen** is the default screen that the software returns to it if there is no user activity for a period of 5 minutes. This screen shows a summary of the system operation, including:

- Date and time
- Suction, gas cooler, and flash tank pressures as well as gas cooler outlet temperature
- Compressor and fan operation status and modulation, and any active alarm

Figure 19 Controller main screen

MENU SCREEN

The menu screen is accessible in three access levels with a different password associated with each level. The lowest level is for the user and the default password is 0000. The next two levels are for maintenance and manufacturer and **should not be accessed by an unauthorized person**.

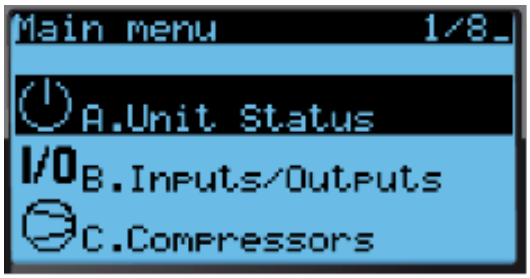
Here is the structure of the menu screen:

Menu screen	Sub-menu	Description
A. Unit status	a. Main info	See current status and probe values
	b. Setpoint	See and modify main Setpoints
	c. On/Off	On/Off settings of the system
B. In/Out	a. Status	Defining AI/AO/DI/DO of the system
	b. Manual man.	N/A
	c. Test	Test of I/O channels
C. Compressors (a. Line 1)	a.a. I/O status	I/O channels specific to compressor control
	a.b. Regulation	Compressor Setpoint and limits
	a.c. Work. hours	N/A
	a.d. Energy sav.	Compressor energy saving parameters
	a.e. Alarms	Compressor alarms

	a.f. Configuration	Compressor config.
	a.g. Advanced	Advanced adjustment
	a.g. Advanced	Advanced adjustment
D. Fans	a. I/O status	I/O channels specific to GC fan control
	b. Regulation	Fan Setpoint and limits
	c. driver EVD	N/A
	d. Energy saving	Fans energy saving parameters
	e. Alarms	Fan alarms
	f. Configuration	Fan configuration
	g. Advanced	I/O channels specific to GC fan control
E. Other Func.	a. Oil	N/A
	b. Subcooling	N/A
	c. Economizer	N/A
	d. Liq. injection	N/A
	e. Heat reclaim	For heat reclaim option
	f. Gen. functions	Function settings
	g. Chill Booster	N/A
	h. DSS	N/A
	i. Transcritical	Transcritical settings

In the above list, some menus are restricted and not accessible to the end user. They are factory programmed.

Here is a description of various menus the end user may need to access to configure the unit to its particular system.



SYSTEM ON/OFF

The system should ALWAYS be ON through the software in the following screen. In the program, it is set to switch the unit ON if a signal (digital input) is received from an external source (external switch or BMS signal) on ID6. This way, the system is always ready to perform protection procedures in case of high pressure in the flash tank.

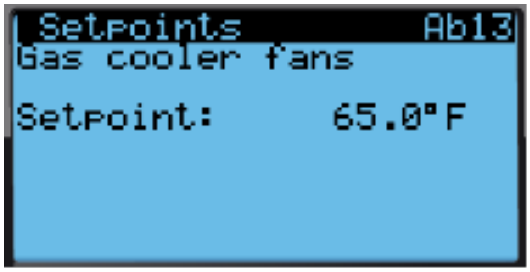
A. Unit status / c. On/Off

SYSTEM SETPOINTS

Suction pressure and gas cooler fan modulating temperature setpoints can be changed through the following screen:

A. Unit status / b. Setpoint /ab12

A. Unit status/ b. Setpoint /ab13



NOTE: For best system performance, it is not recommended to change the GC fan modulation temperature setpoint.

SYSTEM IN/OUT

The end user can see the I/O of the system through the inputs/outputs menu, but is not allowed to modify it. Example, input signal for system ON command:

COMPRESSOR CONTROL

Compressor settings are factory set and cannot be changed by the user (except its modulation setpoint). PID control logic is used to modulate the compressor. Its speed is controlled by the suction pressure.

For high-temperature (**HT**) applications, the default setpoint is 470 psig (32.4 barg) with an adjustment limit range of 440.7 to 552.9 psig (30.4 to 38.1 barg).

For medium-temperature (**MT**) applications, the default setpoint is 410 psig (28.3 barg) with an adjustment limit range of 375.6 to 440.7 psig (25.9 to 30.4 barg). For low temperature (**LT**) applications, the default setpoint is 200.2 psig/13.8 barg, with an adjustment limit range of 163.1 to 220.8 psig (11.2 to 15.2 barg).

Recommended operational saturated suction temperatures (SST) for **HT**, **MT** and **LT** applications are 25 to 40°F (-4 to 4°C) and -30 to -15°F (-34 to -26°C), respectively. **Lower SST may cause excessive discharge temperature**.

Here are the corresponding compressor setpoints:

Application	SST F (C)	SSP psig (barg)
HT	+40 (4.4)	552.9 (38.1)
	+35 (1.7)	513.4 (35.4)
	+30 (-1.1)	476.1 (32.8)
	+25 (-3.9)	440.7 (30.4)
MT	+25 (-3.9)	440.7 (30.4)
	+20 (-6.7)	407.2 (28.1)
	+15 (-9.4)	375.6 (25.9)
LT	-15 (-26.1)	220.8 (15.2)
	-20 (-28.9)	200.2 (13.8)
	-25 (-31.7)	181 (12.5)
	-30 (-34.4)	163.1 (11.2)

For **LT** applications, there is a fixed offset to the compressor setpoint during startup. This offset helps provide smoother operation of the compressor during pull down process while the cold room/freezer is still warm. Then, it automatically switches back to the desired setpoint.

During system operation at hot ambient condition, if the gas cooler pressure passes the predefined limit setpoint, the compressor's maximum allowable power will be reduced by 10% to protect the system against gas cooler high pressure, which may in turn activate the mechanical high-pressure switch. If the pressure drops below this limit, the maximum power automatically resets to 100%. Only qualified technicians can have access to these settings for field adjustment.

In the compressor settings, a.f. configuration and a.g. advanced sub-menus cannot be accessed in user mode.

GAS COOLER FAN CONTROL

Gas cooler fan(s) speed and modulation are controlled by a PID logic based on the gas cooler outlet temperature. The default setpoint is 65°F (18.3°C) with a differential of 20R (11.1K).

We strongly recommend not changing this setting. In systems with a gas cooler 3-way bypass valve and/or adiabatic pre-cooling system, changing the fan control setpoint may interfere with the proper operation.

In fan settings, f. configuration and g. advanced sub-menus cannot be viewed in user mode.

TRANSCRITICAL MODE CONTROL

The operation of the system in transcritical mode is parametrized at E. other functions / i. Transcritical setting. These settings are factory set and are not accessible in user mode. If a need arises for changing the transcritical parameters, please contact the RefPlus technical team.

8.2 STANDARD SEQUENCE OF OPERATION

CO_2 UNIT IS WIRED AND FACTORY PROGRAMED FOR A CONTINUOUS SEMI-AUTONOMOUS OPERATION.

RECOMMENDATION: With RefPlus CO_2 condensing units, it is best practice to always keep them energized, except for service purposes. Otherwise, hot-climate conditions may cause over pressure in the system and eventually lead to the activation of the relief valves.

The condensing unit is turned ON by closing the dry contact on ID6 of PRack pR300T. The activation source can be either:

- Building management system (BMS) that manages the operation of cold rooms and freezers in the building.
- ON/OFF switch.
- Thermostat installed in the cold room. If this option is used, a particular attention must be paid to adjust the thermostat setpoint according to the adjustment of the Guardian+ RC-S controllers, as they maintain and control the cold room temperature.

When the unit is turned ON, the controller follows all the programed sequences to put the compressor(s), all control valves, and gas cooler fans into operation.

Some valves may have a prepositioning step before going into normal modulation.

During startup with high reservoir pressure (at high ambient temperature), the controller starts the compressor with modulation at minimum and does not activate any evaporator (except only one LT evaporator for LT units with 2-stage compressor(s)) until the reservoir pressure drops below a predefined setpoint. At this point, it goes back to normal operation and enables all evaporator controllers to start their operation. If for any reason the pressure increases above this setpoint, the same procedure will be repeated.

At low ambient condition startup mode which is determined by a setpoint, specific procedures will be followed to assure the compressor can start the operation when the system pressure is too low due to low ambient temperature. Compressor runs at this mode up to a maximum duration (field adjusted) to build up pressure in the system.

Then, the controller switches to normal mode where the compressor will be stopped if any corresponding alarm is triggered.

The modulating compressor's safe operation is supervised by the VFD. The interlock input of the VFD is hard wired to several safety devices. If they are activated, the input signal to VFD interlock will be cut.

The VFD in return will immediately stop the compressor. These safety devices are compressor oil level monitor, compressor high pressure switch, compressor motor protection device (MPD), and compressor oil pressure switch (if present).

High pressure switch and VFD alarm are also wired to the controller. If they are activated, an alarm will be triggered on the controller.

8.3 OPTIONAL EVAPORATOR DEFROST

The defrost sequence with this CO_2 system is completely controlled and managed by the Guardian+ RC-S evaporator controllers. For proper defrost of all evaporators connected to the same condensing unit, their controllers must be bonded in a group. Air and electric defrost are both available for these evaporators.

Air defrost evaporators are recommended only for high and medium temperature applications with a room temperature above 34°F (1.1°C).

For colder conditions, we recommend evaporators with electric defrost to assure proper defrost of the coil and drain pan. All defrost sequences are initiated and managed by the evaporator controller. Our Guardian+ evaporator controllers also offer adaptive defrost that can reduce power consumption by minimizing the number of defrosts per day as well as their duration.

The evaporator controllers should be programmed in the end user facility to better match its requirements.

Air defrost: When the Guardian+ RC-S controller initiates defrost, either manually or automatically, it closes the EEV and liquid line solenoid valves (if present) and maintains the operation of the evaporators fan(s). This triggers the pump down of the evaporator until all liquid CO_2 inside the coil is evaporated. Fans continue to draw/blow the warm air through the evaporator coil until the end of the defrost, which is determined by either two probes installed between the coil fins or by a maximum defrost duration. At this point, it stops the fans and starts the drain time (if set). When drain time has elapsed, it switches to fan delay mode by opening the EEV. Evaporator fans will start when the coil temperature reaches the fan delay temperature or after maximum fan delay time.

Electric Defrost: When the Guardian+ RC-S controller initiates defrost, either manually or automatically, it closes the EEV and liquid line solenoid (if present) valves and maintains the operation of the evaporators fan(s) for 30 sec to 5 min, until all remaining liquid CO_2 is evaporated. Next, it stops the fan(s) and activates the electric heater to start the defrost. This process continues until either the end defrost is reached, which is determined by either two probes inserted between the coil fins or by a maximum defrost duration. At this point, it stops the heater and then, drain time (if set) starts. Drain and fan delay modes are similar to the air defrost procedure.

8.4 OPTIONAL ADIABATIC PRE-COOLING SYSTEM

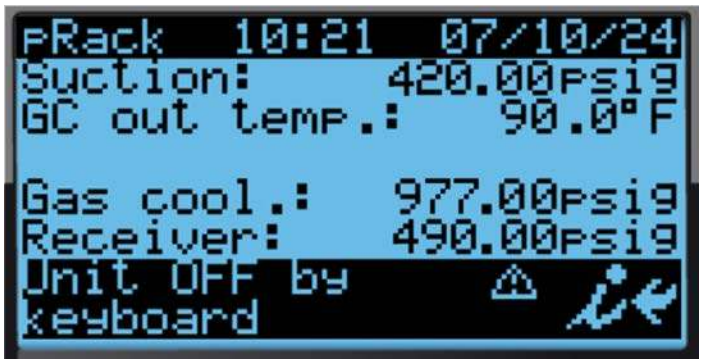
The unit may be equipped with an adiabatic pre-cooling option. This system has two main advantages: improve the overall energy efficiency of the unit and increase its nominal capacity. It also helps the unit to operate properly in very high ambient temperature. If the ambient temperature rises above 100°F (37.8°C), the use of an adiabatic system is mandatory for smooth operation. Otherwise, the unit may stop due to high discharge pressure. For more information regarding RefPlus' Opti-Mist+ Adiabatic System, please visit Refplus.com or contact a RefPlus representative.

NOTE: In cases where several condensing units are installed close to each other at the same facility, up to four units can share the same adiabatic system pump pack. This significantly reduces the capital cost of this system.

8.5 CONTROLLER CONFIGURATION

RETURNING TO DEFAULT CONFIGURATION OR SETTING CURRENT CONFIGURATION AS DEFAULT:

From the main screen:



1. Press ◎
2. Enter password using ↑ ↓
3. Press ↵ and main menu will be displayed.
4. Use ↑ ↓ to navigate to "I.Setup" and Press ↵

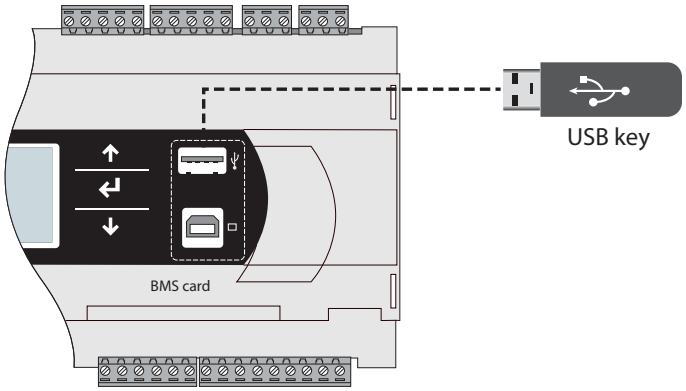
5. In the Setup menu, use ↑ ↓ to go to "d.Defaults".
6. Press ↵

7. On page Id01, Press ↵ twice to move cursor to "Load configurat."
8. While on “Load configurat.”, use ↑ ↓ to change the status from "NO" to "YES".
9. Press ↵ and the program starts the action of loading the previously saved configuration (every unit comes with a program saved in the factory).

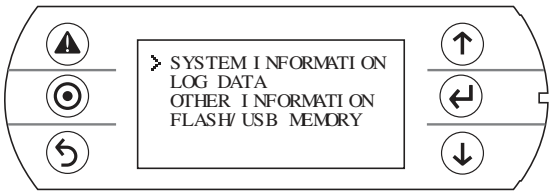
IMPORTANT!
If you do this action on the “Save configurat.” line, **you will save the current data as the default settings**. So, this action must be carried out with care. If you make a mistake and chose “Yes” on the wrong line, press any UP/DOWN arrow once again to select “No”. **DO NOT PRESS ENTER** on “Yes” while correcting a mistake. This will start the action.

UPLOADING A PROGRAM FROM USB TO PRACK300T CONTROLLER

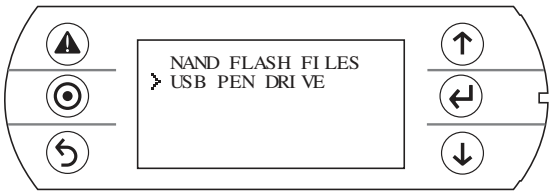
1. Insert a USB Key (which contains the package of updated program provided by RefPlus) to the USB port on the PRack.



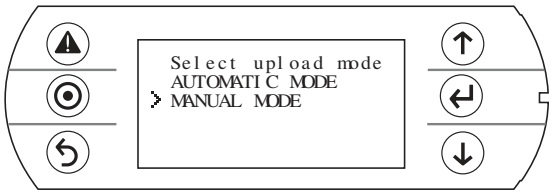
2. Press and hold the Alarm+Enter buttons for 3 seconds until the following menu appears:



3. Use ↑ ↓ to navigate to “FLASH/USB MEMORY”.
4. Press ↵
5. Use ↑ ↓ to navigate to "USB PEN DRIVE"
6. Press ↵



7. To upload the new program, use ↑ ↓ to navigate to "UPLOAD" (pen->pCO).
8. Press ↵
9. Use ↑ ↓ to navigate to "MANUAL MODE" and upload the new program to PRack according to RefPlus recommendation.
10. Press ↵



The display will show an explanatory page. Using UP/DOWN arrows, you can read the instructions on how to select/deselect the directory and files.

11. Press ↵ to go the directory page.

In this page, using the UP/DOWN arrows, choose the correct directory (if there are several directories). Inside this directory, you may see up to three types of files to upload:

FILE_DEV.DEV: this file contains all the parameters for any application. It is mandatory to upload it.

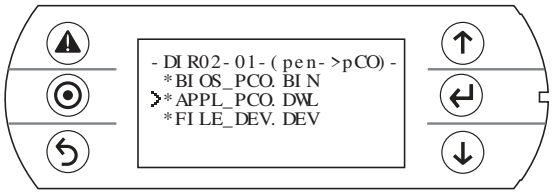
APPL_PCO.DWL: this file contains the latest version of the software provided by RefPlus, in case there is an update.

BIOS_PCO.BIN: this is the BIOS of the software, in case it needs to be updated.

12. Use ↑ ↓ to navigate to the appropriate file.

13. Press ↵ to select or deselect a file.

When a file is selected, the filename is preceded by a "*". For example, if all files are selected, the following screen will read:



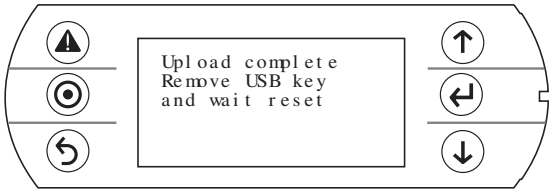
In the above list, all the files are selected.

14. Press ◎ to start the uploading process.

Uploading starts with the BIOS file, then the application file, and at the end, the DEV file (if all are selected for upload).

15. Follow the instructions on the screen if any farther action is required.

At the end, you will see the message that the process is complete:

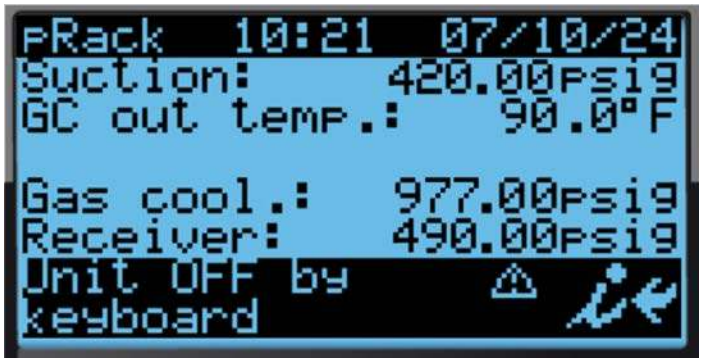


You may be asked to restart the PRack. If so, you need to disconnect the power source and then reconnect it.

RELOADING THE HPV/BPV SETTINGS AFTER UP-LOADING THE NEW SOFTWARE

If the HPV and BPV valves are not from Carel, for proper operation, RefPlus suggests that you reload the valve settings. To reload the valve settings:

From the main screen:



1. Press ◎
2. Enter the password using ↑ ↓
3. Press ↵
4. Use ↑ ↓ to navigate to "I.Setup".
5. Press ↵

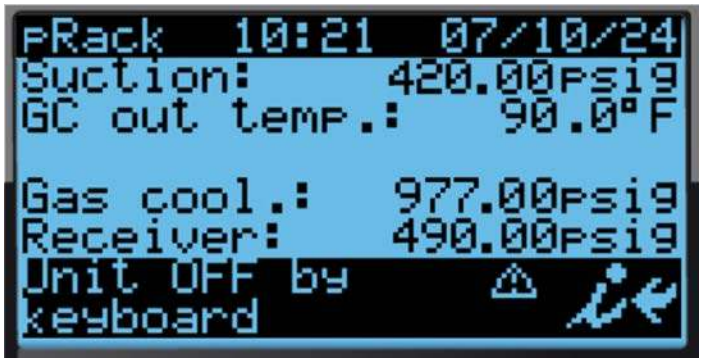
6. In the "Setup" menu, use ↑ ↓ to navigate to "d.Defaults".
7. Press ↵

8. Use ↑ ↓ to navigate to page Id04.
9. Press ↵ twice to go the line “DOWNLOAD EVD settings”.
10. Use ↑ ↓ to change the status from “No” to “Yes”.
11. Press ↵

After a couple of seconds, the program resends all the settings to the valve driver.

CHANGING THE PASSWORD ON THE UNIT CONTROLLER (PRACK300T) FOR SERVICE LEVEL

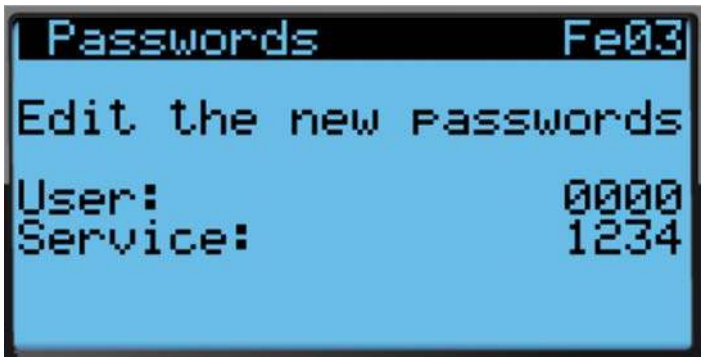
From the main screen:



1. Press ◎
2. Enter the password 1234 using ↑ ↓
3. Press ↵

4. Use ↑ ↓ to navigate to "F-Settings".
5. Press ↵

6. Use ↑ ↓ to navigate to "e.Passwords".
7. Press ↵
8. Use ↑ ↓ to navigate to page Fe03. On this page, you can choose your desired password for both end user and service levels.



9. Press ↵ to navigate to either User or Service.
10. Use ↑ ↓ to enter a new password.

At the end, the cursor must be is back at upper left corner of the screen so that the new password is registered, as show here:

9. START-UP

9.1 LEAK TESTING AND EVACUATION

IMPORTANT: Leak testing and evacuation must be done in accordance with local and national codes.

Once all refrigerant connections are made, leak test all joints before charging the system with refrigerant. After leak testing, all moisture and non-condensable gas must be evacuated from the system.

1. Make sure all isolation valves are open.
2. Make sure oil level in separator is visible in sight glass, if not, add oil through the oil line.
3. Check electrical connections to make sure there are no loose wires.
4. Do a visual inspection to make sure there is no damage to components or piping.
5. Once these items are done you are now ready to carry out an evacuation procedure.

Evacuation Procedure:

1. Connect a vacuum pump to at least 3 places or more on system (suction, discharge, liquid) then, if possible, connect a vacuum gauge near the evaporators, otherwise, connect it as far away as possible from the pump.
2. Remove fuses going to compressor(s). They can be reinstalled later on, once unit is charged.
3. Apply main power to unit and turn the unit on with disconnect switch.
4. Go to main controller (PLC) and activate vacuum mode as follows :
   - Press the menu button and enter the password.
   - Then go to input/output menu.
   - Then go to Manual Management menu.
   - Then go to vacuum menu and activate vacuum mode.
   - Press escape and you will be prompted with a manual mode screen in which you can enter a time limit. Once this timer has elapsed the controller will go back to normal.
   - This vacuum mode will facilitate and speed up the process, allowing any trapped air to be removed.
5. Proceed to start the vacuum pump and pull down to lower than 500 microns.
6. Once the target has been reached, isolate the pump from the system and proceed with the holding time in which the value must not rise more than 100 microns in 30min, if this fails then continue with vacuum until it passes.
7. If the vacuum is not holding, check for leaks and make sure that gauge hoses and caps are not leaking.
8. Once vacuum is done, isolate pump, remove vacuum gauge and proceed with charging.

NOTE: Break the vacuum in the system only with CO_2 in its gas phase.

9.2 OIL CHANGE AFTER INITIAL START-UP

Oil and filters (liquid, suction and oil) must be changed 24 to 48 hours following the initial start-up.

9.3 CHARGING THE SYSTEM WITH REFRIGERANT

IMPORTANT: Be sure leak testing and evacuation were successfully done before adding oil and refrigerant.

When charging the system with CO_2, use only gears rated and suitable for CO_2 charging (manifolds, hoses, gauges, valves, etc.).

Always use a proper scale to measure the CO_2 charge (lb/kg) in both its gas and liquid phases. Do not use other than the designated refrigerant (for charging, adding or recharging).

We recommend using refrigerant grade CO_2 (R744) with 99.9% purity and low moisture (<10ppm). Please check with your local providers to make sure they can satisfy this requirement. Before charging with refrigerant, make sure to have at hand cylinders containing only gaseous CO_2 and syphon type cylinders with liquid CO_2. In this case, it is either clearly mentioned on the cylinder or there is a syphon / deep tube sign on the cylinder to indicate that it is a liquid cylinder. Always verify with your provider if this is not clear.

<u>IMPORTANT</u>: Because CO_2 as a refrigerant has distinct properties, its charging procedure varies from other refrigerants. Therefore, it is highly important to pay attention to details and follow precisely the instructions provided here. This procedure should only be carried out by a technician specially trained for CO_2 refrigeration systems.

With triple point of 60 psig/-69.8°F (4.2 barg/-56.6°C), if liquid CO_2 is charged into a vacuumed system, dry ice may form inside the lines, which could block them, confine CO_2, and stop the charging process. This may also cause the line to burst, which can lead to harm or injury.

1. Once the proper vacuum obtained and maintained, break the system vacuum only with gaseous CO_2. **Never** break vacuum with liquid CO_2.
2. Inject CO_2 gas in the system through the charging port (Figure 20) located between the filter drier and the CO_2 tank. CO_2 charging must be maintained until a minimum pressure of 150 psig/10 barg is reached in the entire system.
3. Check the pressure reading on the controller screen to make sure the vapour was distributed evenly throughout the system. This will ensure there is enough pressure to avoid dry ice formation in the system.
4. Using the same charging port (Figure 20), inject liquid CO_2 until the maximum charge, specific to each unit, is reached. At this point, the low-level sensor must be active and the liquid line must be visible through the first sight glass.

Figure 20 CO_2 charging port

If the system liquid line pressure gets close to the pressure in the refrigerant cylinder, close the flash tank liquid line outlet shut-off valve and start the compressor to depressurize the liquid line and add more CO_2 until charge limit is reached.

CO_2 condensing units with 1305 psig/90 barg MAWP have a maximum charge limit that must never be exceeded. Otherwise, we may have a premature relief valve opening in stand-still mode.

IMPORTANT: If the system is inoperative for a very long period of time, the unit should be checked by a technician and a start-up procedure (section 9) should be carried out once the system is put back in operation.

10. SERVICE

System operating temperature, oil level, system suction pressure, and gas cooler pressure should be checked and recorded periodically to ensure stable system operation. For any help, tips, and questions pertaining to the condensing unit, refer to the troubleshooting chart on page 25 .

IMPORTANT: Disconnect all power before servicing.

10.1 INSPECTION

After a day of operation, check for any abnormal vibrations in the unit.

IMPORTANT: **Compressor hold-down bolts should be checked periodically and re-tightened if necessary.**

10.2 CLEANING

It is recommended that all condensing units and evaporators of a refrigeration system be checked periodically for dirt accumulation. Grease and dust must be removed from fans, fan guards and drain pans.

Occasional cleaning of finned surfaces can be done by first dusting off the fins, then cleaning with a mild detergent and a warm water spray. The inner face of the gas cooler coil may be cleaned through the access panel on the side of the units.

IMPORTANT: Do not use alkaline or acid solution as it will damage the coils. The detergent must be completely rinsed before stopping the cleaning operation.

10.3 FAN MOTORS

Fan motors are permanently lubricated and thermally protected for service-free operation. An automatic internal thermal protection could be triggered if the coil is blocked. If the motors are inoperative, check the supply voltage at the motor leads before attempting any maintenance and service. **The motors can start on the automatic thermal protector at any time**.

10.4 PROCEDURE FOR ADDING OIL (PRE-CHARGED SYSTEM)

The following procedure is for units with combined oil separator and oil receiver.

1. Shut down the unit.
2. Front-seat both compressor valves (suction/discharge) to isolate upstream of oil separator, and check that valve isolates downstream of the oil separator.
3. Depressurize the compressor to around 80 psi by bleeding CO_2 vapour using the service valve on the discharge line. This makes manual pumping easier.
4. Add oil through the service valve on the oil line between oil separator and compressor. Fill oil until it can be seen in the oil separator level sight glass.

Figure 21 Oil line service valve

5. Back-seat both compressor valves.
6. Restart the unit.

10.5 REFRIGERATION OILS

CAUTIONS

Units are designed for CO_2 refrigerant and are supplied with polyolester (POE) oil.

This oil is very hygroscopic and care should be taken when using POE.

All oil must be used at once. Any remaining oil must be properly disposed of.

POE must be handled carefully and proper personal protective equipment (gloves, eye protection etc.) must be used when handling POE lubricant. POE must not come into contact with surface or material that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

OIL COLOUR

New POE lubricant will be clear and straw color. With time, it may acquire a darker color. This does not indicate a problem, as the darker color merely reflects the activity of the lubricant's protective additive.

OIL LEVEL

POE oil lubricant exhibits a greater tendency to introduce oil into the cylinder during flooded start conditions. **IF THIS CONDITION IS ALLOWED TO CONTINUE, IT WILL CAUSE MECHANICAL FAILURE OF THE COMPRESSOR**.

A crankcase heater (CCH) is required with all condensing units and must be turned on 24 hours before start-up. All CO_2 units come with a CCH installed on their compressors.

All compressors are equipped with either Kriwan INT-130 or TraxOil OW5 oil level regulator (OLR). They ensure adequate oil level is maintained in the compressor.

Verify the required amount of oil in the compressors. Some additional oil may be required when excessive refrigerant charge is required. Contact RefPlus for more details.

POE oil must be used with all our CO_2 condensing units. The exact POE code depends on the type of compressor. COPELAND uses POE68 while BITZER and DORIN use POE85.

PAG oil can also be used with a DORIN compressor. However, since these compressors are precharged with POE oil, special care must be taken to replace the oil. **NEVER** mix PAG and POE oils, as it will cause severe foaming and poor compressor lubrication.

10.6 OIL IN SEMI-HERMETIC COMPRESSORS

Oil level must be maintained at 1/2 or 3/4 full (Bitzer compressor) or 1/8 to 1/2 full (Copeland compressor) as indicated on the sight glass. If oil level is low, add manufacturer approved oil to the compressor. Do not over fill. Check oil level 2 hours and 2 days after the addition of oil.

WARNING: Excess oil in a system may lead to liquid slugging and compressor damage.

A well-balanced unit should not require any additional oil after a week of operation.

If the level does not stabilize, there is an oil logging problem. Check all piping for proper installation. Correct any defect that would prevent the oil from coming back. Remove excess oil if the level goes over 3/4 full sight glass.

10.7 RECOMMENDED POE OIL FOR CO_2 REFRIGERANT

Copeland compressors: COPELAND POE 68 oil, RL68HB-1 GALLON CO_2

Bitzer compressors: Bitzer POE 85 oil, BSE85K 1 GALLON CO_2

Dorin compressors: Nu Calgon Oil Emkarate 85HB

10.8 LIST OF SYSTEM ALARMS

ALARM DESCRIPTION	TYPE	RESET TYPE
Compressor high pressure switch ID	Serious	Manual
Common fan overload	Serious	Manual
Warning inverter [VFD* fault alarm]	Serious	Manual
Low superheat alarm	Serious	Auto
High discharge pressure alarm	Serious	Auto
Low discharge pressure alarm	Serious	Auto
Suction high pressure alarm	Serious	Auto
Suction low pressure alarm	Serious	Auto
High receiver pressure alarm	Serious	Auto
Low receiver pressure alarm	Serious	Auto
Compressor overload alarm	Serious	Auto
High gas cooler pressure alarm	Serious	Auto
Low gas cooler pressure alarm	Serious	Auto
Common Oil alarm from ID	Warning	Auto
[Low] liquid level alarm	Warning	Auto

* Electronic Variable Frequency Drive (compressors)

11. ANNUAL PREVENTIVE MAINTENANCE

CO_2 condensing units deliver an exceptional blend of performance and environmental responsibility. However, their distinct operating requirements call for a fresh approach to preventative maintenance. By combining routine inspections, proactive service, and a solid grasp of how it differs from traditional systems, your unit can provide dependable, trouble-free operation for years to come.

Your CO_2 condensing unit will benefit from preventive maintenance. W highly recommended the following preventive maintenance schedule be followed closely:

Oil Levels: Inspect oil levels. Reservoir and compressor oil should stay within the recommended range.

Oil Separator & Filter: Replace the element (annually) or when a 10 psi pressure drop is observed - whichever occurs first.

Strainers: Remove debris from oil and CO_2 strainers.

Leak Inspection: Inspect the system for any signs of oil or refrigerant that could point to a leak.

Electrical Connections: With the power disconnected, check all contactors and controls for any loose connections or frayed wires.

Heater: Make sure crankcase and oil reservoir heaters are energized when the system is off. This will prevent oil migration.

Gas Cooler: Check the condition of the gas cooler coil for dirt and debris. Clean coil if it is dirty or clogged.

Piping Clamps: Check for wear and tightness of the piping clamps.

Corrosion: Inspect unit for corrosion. This is especially important on steel components exposed to harsh conditions.

Liquid Filter Drier Cores: Replace anytime the system is opened or moisture is detected.

Suction Filter Elements: Replace annually.

12. TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE STEPS
Compressor not running	1. Main switch open. 2. Fuse blown. 3. Motor protection device (MPD) tripped. 4. Oil level switch/oil differential switch on alarm 5. VFD of modulating compressor on alarm. 6. VFD of modulating compressor on off or manual mode. 7. Compressor off by controller (No cooling required/Controller on alarm) 8. Defective contactor or coil. 9. Compressor high pressure switch is triggered. 10. Motor electrical trouble. 11. Loose wiring.	1. Close switch 2. Check electrical circuits and motor winding for shots or grounds. Investigate for possible overloading. Replace fuses after fault is corrected. 3. Overloads are automatically reset. Check unit closely when unit comes back on line. 4. Check oil level in the compressor and oil reservoir. Repair or replace defective parts. 5. Check the alarm log on the VFD module LCD and act accordingly. 6. Switch to auto mode on the VFD module LCD. 7. Check the alarm log on the controller. Act accordingly if needed or wait until unit calls for cooling. 8. Repair or replace coil. 9. Determine type and cause of shutdown and correct it before resetting safety switch. 10. Check electrical circuits and motor for open windings. Also check for a short circuit or motor burn out. 11. Check all wire junctions. Tighten all terminal screws.
Compressor is noisy or vibrating	1. Flooding of refrigerant into crankcase. 2. Improper piping support on suction, hot gas or liquid line. 3. Worn compressor. 4. Resonance in modulating compressor.	1. Check setting of expansion valves and superheating heat exchanger and its modulating valve. 2. Relocate, add, or remove hangers. 3. Replace. 4. Use VFD settings to avoid the frequencies that trigger the vibration.
High-discharge pressure	1. Non-condensable in system. 2. System overcharges with refrigerant. 3. Discharge shutoff valve partially closed. 4. Gas cooler fan(s) not operating or running too slow. 5. Faulty gas cooler temperature/pressure regulation. 6. Dirty gas cooler coil. 7. Dirty oil separator. 8. High reservoir pressure. 9. High suction pressure.	1. Remove the non-condensable. 2. Remove excess refrigerant. Maximum CO_2 charge limit of the system must be respected. 3. Open valve. 4. Check electrical circuit or possible fan blockage. Check the gas cooler fan control settings. 5. Check HPV valve operation and adjust control setting. 6. Clean gas cooler coil. 7. Change the oil separator filter. 8. See troubleshooting for reservoir pressure 9. See troubleshooting for suction pressure
Low-discharge pressure	1. Faulty gas cooler temperature/pressure regulation. 2. Suction shut-off valve partially closed. 3. Insufficient refrigerant in system. 4. Low suction pressure. 5. Gas cooler fans running too fast at low ambient temperature.	1. Check HPV valve operation and adjust control setting. 2. Open the valve. 3. Check for leaks. Repair and add charge. 4. See troubleshooting for suction pressure. 5. Check the gas cooler fan control settings.
High-suction pressure	1. Excessive load. 2. Expansion valve (EEV) overfeeding. 3. Faulty reservoir pressure regulating valve (RPRV) regulation.	1. Reduce load or add additional equipment. 2. Regulate superheat. Check temperature and pressure probes on the suction line. 3. Check RPRV valve operation and adjust control setting.

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE STEPS
Low-suction pressure	1. Lack of refrigerant. 2. Evaporator dirty or iced. 3. Clogged suction line or compressor suction gas strainers (if installed). 4. Clogged liquid line filter dryer. 5. Expansion valve (EEV) underfeeding. 6. Discharge pressure too low. 7. Faulty reservoir pressure regulating valve RPRV regulation. 8. Reservoir pressure too low.	1. Check for leaks. Repair leak and add charge. 2. Clean evaporator. Verify the defrost settings and operation 3. Replace cartridge(s). 4. Replace liquid line filter dryer cartridge or filter dryer. 5. Regulate superheat. Check temperature and pressure probes on the suction line. 6. See troubleshooting for low-discharge pressure. 7. Check RPRV valve operation and adjust control setting. 8. See troubleshooting for reservoir pressure.
High reservoir pressure	1. Faulty reservoir pressure regulating valve RPRV. 2. Faulty gas cooler temperature/pressure regulation. 3. Long period off unit (stand-still condition) at high ambient temperature.	1. Check RPRV valve operation and adjust control setting. 2. Check HPV valve operation and adjust control setting. 3. Start the unit. The modulating compressor runs at minimum speed to decrease the suction and reservoir pressures. It may stop and rerun for several times automatically until the pressure in the reservoir reduces enough for continuous operation of the system. If it fails to succeed, some refrigerant may need to be removed from suction line to reduce its pressure. This may happen at very high suction pressure.
Low reservoir pressure	1. Lack of refrigerant. 2. Faulty reservoir pressure regulating valve RPRV regulation. 3. Faulty gas cooler temperature/pressure regulation. 4. Long period off unit (stand-still condition) at low ambient temperature.	1. Check for leaks. Repair leak and add charge. 2. Check RPRV valve operation and adjust control setting. 3. Check HPV valve operation and adjust control setting. 4. Start the unit. The controller starts at low ambient temperature mode until pressure builds up in the gas cooler and reservoir. Then, it switches to normal operation mode. If it fails to succeed, see troubleshooting for other causes of low reservoir and low suction pressure.
Low or no oil pressure	1. Clogged oil filter. 2. Excessive liquid in crankcase. 3. Oil level regulator defective. 4. Oil differential pressure switch defective. 5. Worn oil pump. 6. Low oil level. 7. Crankcase oil filter is dirty or clogged. Oil pressure sensor is dirty. 8. Loose fitting on oil lines. 9. Pump housing gasket leaks.	1. Clean. 2. Check crankcase heater. Reset the suction superheat 3-way valve controller setpoint or expansion valve for higher superheat. Check liquid line solenoid valve operation (if installed). 3. Replace oil level regulator. 4. Replace oil pressure switch (if installed). 5. Replace oil pump (if installed). 6. Add oil. 7. Clean crankcase oil filter or sensor. 8. Check and tighten system. 9. Replace gasket.

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE STEPS
Compressor looses oil	1. Clogged oil return line and filter. 2. Excessive liquid in crankcase. 3. Oil level regulator defective. 4. Lack of refrigerant. 5. Excessive compression ring blow-by. 6. Refrigerant flood-back. 7. Improper piping or traps.	1. Clean. 2. Check crankcase heater. Reset the suction superheat 3 way valve controller setpoint or expansion valve for higher superheat. Check liquid line solenoid valve operation (if installed). 3. Replace oil level regulator. 4. Check for leaks and repair. Add refrigerant. 5. Replace valve plate. 6. Maintain proper superheat at compressor. 7. Correct piping.
Compressor thermal protector switch open	1. Operating beyond design conditions. 2. Discharge valve partially shut. 3. Blown valve plate gasket. 4. Dirty gas cooler coil. 5. Overcharged system.	1. Add facilities so that conditions are within allowable limits. 2. Open valve. 3. Replace gasket. 4. Clean coil. 5. Reduce charge.

REPLACEMENT PARTS

Download the parts manual
at http://refplus.com/en/parts-services/

CO_2 CONDENSING UNIT STARTUP REPORT FORM

IMPORTANT: This startup report form must be filled out, signed and sent to RefPlus for the warranty to be honoured.

1. GENERAL INFORMATION

JOB LOCATION: _____

REFPLUS RJ No: _____

CONDENSING UNIT MODEL No.: _____

COMPRESSOR MODEL No.: _____

CONTRACTOR NAME: _____

CONDENSING UNIT SERIAL No.: _____

COMPRESSOR #1 SERIAL No.: _____

COMPRESSOR #2 SERIAL No.: _____

COMPRESSOR #3 SERIAL No.: _____

2. PRE-START-UP (Check each item when completed)

☐ CHECK ALL ELECTRICAL CONNECTIONS AND TERMINALS FOR TIGHTNESS

☐ CHECK ALL FAN MOTORS AND MOTOR MOUNTS FOR TIGHTNESS

☐ VERIFY REFRIGERANT CHARGE USING CHARGING CHART LABEL ON CONDENSING UNIT

☐ CHECK REFRIGERANT AND OIL LEVEL IN SYSTEM

☐ CHECK CRANKCASE HEATER / RECEIVER HEATER FOR PROPER OPERATION

☐ CHECK ALL MECHANICAL SEALS AND REFRIGERANT PIPING CONNECTIONS FOR TIGHTNESS

3. START-UP

REFRIGERANT

	COMPRESSOR 1	COMPRESSOR 2	COMPRESSOR 3
REFRIGERANT CHARGE (LBS)	_____	_____	_____

FANS

☐ CHECK FAN MOTORS FOR PROPER ROTATION.

ELECTRICAL

		COMPRESSOR 1	COMPRESSOR 2	COMPRESSOR 3		COMPRESSOR 1	COMPRESSOR 2	COMPRESSOR 3
COMPRESSOR VOLTAGE	L1-L2	_____	_____	_____	L2-L3	_____	_____	_____
COMPRESSOR AMPS	L1	_____	_____	_____	L1	_____	_____	_____
	VOLTS	_____	_____	_____	PHASE	_____	_____	_____
COMPRESSOR VOLTAGE	L3-L4	_____	_____	_____				
COMPRESSOR AMPS	L1	_____	_____	_____				
	VOLTS	_____	_____	_____				
	HERTZ	_____	_____	_____				

MAIN POWER (DESIGN): _____V / _____ PH / _____Hz

MAIN POWER (MEASURED): _____V

CONTROL VOLTAGE (MEASURED): _____V

TOTAL UNIT AMPERAGE (MEASURED) _____ AMPS

FAN 1	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 2	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 3	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 4	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 5	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 6	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 7	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 8	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____ AMPS (LINE 3)	_____ AMPS (RATED)
FAN 9	_____AMPS (LINE 1)	_____ AMPS (LINE 2)	_____AMPS (LINE 3)	_____ AMPS (RATED)
FAN 10	_____ AMPS (LINE 1)	_____ AMPS (LINE 2)	_____AMPS (LINE 3)	_____ AMPS (RATED)

TEMPERATURE	**START-UP**	**AFTER 24 HOURS OF OPERATION**
AMBIENT TEMPERATURE	_____ ºF	_____ ºF
SUPERHEAT AT COMPRESSOR	_____ ºF	_____ ºF
DISCHARGE TEMPERATURE	_____ ºF	_____ ºF
TEMPERATURE	**START-UP**	**AFTER 24 HOURS OF OPERATION**
SUB-COOLING	_____ ºF	_____ ºF
LIQUID TEMPERATURE	_____ ºF	_____ ºF

PRESSURES (in cooling mode)

	COMPRESSOR 1	COMPRESSOR 2	COMPRESSOR 3		COMPRESSOR 1	COMPRESSOR 2	COMPRESSOR 3
REFRIGERANT SUCTION (PSIG)				TEMPERATURE AT COMPRESSOR (ºF)			
REFRIGERANT DISCHARGE (PSIG)				TEMPERATURE AT COMPRESSOR (ºF)			
EVACUATION: NUMBER TIMES				FINAL MICRON			

4. FIELD INSTALLED EXPANSION VALVE

MANUFACTURER _____

MODEL _____

DATE: _____ **TECHNICIAN**: _____

SIGNATURE: _____

FILL OUT FORM MANUALLY, TAKE A PHOTO AND SEND TO:
service@refplus.com

GENERAL WARRANTY

REFPLUS (SELLER) WARRANTS THAT THE EQUIPMENT MANUFACTURED BY THE SELLER, INCLUDING SERVICE PARTS, AND SOLD UNDER THIS CONTRACT SHALL BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF TWELVE (12) MONTHS FROM THE DATE OF EQUIPMENT START-UP OR EIGHTEEN (18) MONTHS FROM THE DATE OF SHIPMENT, WHICHEVER OCCURS FIRST. ZIEHL-ABEGG FAN ASSEMBLIES ARE WARRANTED AGAINST DEFECTS IN MATERIALS AND WORKMANSHIP FOR A PERIOD OF TWENTY-FOUR (24) MONTHS FROM THE DATE OF EQUIPMENT START-UP OR THIRTY (30) MONTHS FROM THE DATE OF SHIPMENT, WHICHEVER OCCURS FIRST.

WRITTEN NOTICE OF A DEFECT IN MATERIAL AND WORKMANSHIP SHALL BE SENT TO SELLER IMMEDIATELY UPON DISCOVERY BY BUYER. DEFECTIVE PARTS SHALL BE REPAIRED OR REPLACED PROVIDED THAT INSPECTION BY SELLER VERIFIES THE CLAIMED DEFECT(S). THE SELLER'S OBLIGATION UNDER THIS WARRANTY IS LIMITED SOLELY TO THE REPAIR OR REPLACEMENT, AT SELLER'S OPTIONS, OF ANY PART OR PARTS THEREOF WHICH SHALL DISCLOSE TO THE SELLER'S SATISFACTION TO HAVE BEEN DEFECTIVE UNDER NORMAL USE AND SERVICE. THIS SHALL BE THE BUYER'S EXCLUSIVE REMEDY. ALL OTHER WARRANTIES, WHETHER VERBAL OR WRITTEN, AND ALL WARRANTIES IMPLIED BY LAW, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY EXCLUDED. NO REPRESENTATIVE OR AGENT OF SELLER IS AUTHORIZED TO MODIFY OR EXPAND THE EXPRESS WARRANTIES OF SELLER. REPAIRS MADE WITHOUT THE PRIOR WRITTEN APPROVAL OF SELLER SHALL VOID ALL WARRANTIES COVERING MATERIAL AND WORKMANSHIP. SELLER SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT INCIDENTAL, CONSEQUENTIAL, OR OTHER FORM OF LOSS, INJURY, DAMAGE, COST, OR EXPENSE, WHETHER CAUSED BY DELAY, FAILURE, OR PERFORMANCE, BREACH OF WARRANTY, OR BY ANY CAUSE WHATSOEVER. FAILURE ON THE PART OF BUYER OR OF OTHER PARTIES TO PROPERLY MAINTAIN THE PRODUCT(S) SOLD UNDER THIS CONTRACT, OR THE OPERATION OF SUCH PRODUCT(S), BY BUYER AND/OR OTHER PARTIES UNDER CONDITIONS MORE SEVERE THAN THOSE FOR WHICH SUCH PRODUCT(S) WERE DESIGNED SHALL VOID ALL WARRANTIES COVERING MATERIALS AND WORKMANSHIP. WARRANTY IS VOID IF PRODUCT IS USED OR OPERATED ON LOW OR IMPROPER VOLTAGES OR IN A MANNER CONTRARY TO THE INSTRUCTIONS COVERING THE INSTALLATION, USE AND MAINTENANCE WHICH ACCOMPANIES SUCH PRODUCT. SELLER'S OBLIGATION UNDER THIS WARRANTY SHALL BE VOID IF BUYER FAILS WITHOUT LEGAL JUSTIFICATION TO PAY SELLER, WHEN DUE, THE FULL PURCHASE PRICE FOR THE EQUIPMENT SOLD HEREUNDER. BUYER ASSUMES LIABILITY FOR AND SHALL BEAR THE COSTS OF COMPLIANCE WITH ALL LAWS, REGULATIONS, CODES STANDARDS OR ORDINANCES APPLICABLE TO THE LOCATION, OPERATION AND MAINTENANCE OF THE PRODUCT(S) SOLD UNDER THIS CONTRACT. THIS WARRANTY APPLIES ONLY TO THE ORIGINAL PURCHASER OF THE EQUIPMENT AND DOES NOT EXTEND, EXPRESSLY OR BY IMPLICATION, TO THE THIRD PARTIES OR OTHERS WITHOUT THE SPECIFIC WRITTEN APPROVAL AND ACKNOWLEDGMENT OF SELLER.

PROOF OF START-UP:
START-UP REPORT FORM SHALL BE FILLED, SIGNED BY BUYER, AND RECEIVED BY SELLER AT THE TIME OF INSTALLATION OF A COMPLETE UNIT IN ORDER TO ESTABLISH THE EFFECTIVE DATE OF THE WARRANTY AND PROVE INDUSTRY BEST PRACTICES WERE COMPLIED WITH FLAWLESSLY FOR THE INSTALLATION OF THE EQUIPMENT. THIS WILL ALSO DEMONSTRATE THAT PROPER START-UP PROCEDURES FOUND IN THE INSTALLATION, OPERATING AND MAINTENANCE MANUAL (IOM) SUPPLIED WITH THE EQUIPMENT WERE FOLLOWED, FAILING WHICH, THE PRESENT WARRANTY SHALL BE NULL AND VOID.

COMPRESSOR WARRANTY:
A COMPRESSOR DETERMINED BY SELLER TO HAVE BEEN DEFECTIVE WITHIN THE WARRANTY PERIOD SHALL BE RETURNED TO THE NEAREST AUTHORIZED DEALER OF THE COMPRESSOR, WITHOUT ANY ADDITIONAL IMPLICATION FROM THE SELLER. COMPRESSOR MANUFACTURER/DISTRIBUTOR SHALL HONOR THE COMPRESSOR LIMITED WARRANTY. NO FREIGHT SHALL BE ALLOWED FOR TRANSPORTATION OF THE COMPRESSOR TO AND FROM THE COMPRESSOR DEALER. THE REPLACEMENT COMPRESSOR SHALL BE IDENTICAL TO THE MODEL BEING REPLACED. ADDITIONAL CHARGES, WHICH MAY RESULT FROM THE REPLACEMENT OF ANOTHER THAN IDENTICAL COMPRESSOR, ARE NOT COVERED BY THIS WARRANTY.

OPTIONAL EXTENDED WARRANTY ON COMPRESSORS:
THE SELLER OFFERS AN OPTIONAL 4-YEAR EXTENDED WARRANTY ON ALL ITS COMPRESSORS. THIS WARRANTY IS SUBJECT TO THE ABOVE-STATED WARRANTY, IS NON-TRANSFERABLE AND IS ONLY VALID IN CANADA AND THE USA.

EXCLUSIONS:
- THIS WARRANTY DOES NOT COVER THE COSTS OF REMOVING, SHIPPING, OR REINSTALLING THE EQUIPMENT.
- THIS WARRANTY DOES NOT COVER NORMAL WEAR AND TEAR OR THE EROSION, CORROSION AND/OR DETERIORATION OF THE PRODUCT(S) FROM UNUSUAL CAUSES.
- THIS WARRANTY DOES NOT COVER THE REPAIR OR REPLACEMENT OF ANY EQUIPMENT WHICH HAS BEEN REPAIRED OR ALTERED OUTSIDE OF THE FACTORY IN ANY WAY.
- THIS WARRANTY DOES NOT COVER EQUIPMENT AND PARTS WHICH HAVE BEEN SUBJECT TO NEGLIGENCE, MISUSE, OR ABUSE, OR TO PRESSURES IN EXCESS OF STATED LIMITS.
- THIS WARRANTY DOES NOT APPLY TO DEFECTS IN PRODUCT(S) FOR WHICH PAYMENT IN FULL HAS NOT BEEN RECEIVED BY SELLER.
- NO WARRANTIES BY SELLER SHALL APPLY TO ACCESSORIES SUPPLIED BY OTHERS.
- THIS WARRANTY DOES NOT APPLY TO THE LOSS OF FOOD OR ANY PRODUCTS OR REFRIGERANT DUE TO AN EQUIPMENT FAILURE OR FOR ANY OTHER REASON.
- THIS WARRANTY DOES NOT APPLY IF THE START-UP REPORT FORM WAS NOT FILLED, SIGNED, AND PRESENTED AND RECEIVED BY SELLER BY THE BUYER AT THE TIME OF INSTALLATION.

NOTES

The RefPlus EcoEfficient+ program aims to improve your environmental footprint by reducing refrigerant leakage, noise and power consumption with uncompromising performance.

ecoefficient+

cityquiet zeroleak smartpower

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