TRANSCRITICAL CO_2 RACK

Medium and Low Temperature

IMPORTANT

Keep in store for future reference!

Installation, Operation, and Service Manual

P/N 3182569_D
March 2025

BEFORE YOU BEGIN

Read the safety information completely and carefully.

The precautions and use of the procedures described herein are intended to use the product correctly and safely. Comply with the precautions described below to protect you and others from possible injuries. Relative to their potential danger, the relevant matters are divided into four parts as defined by ANSI Z535.5.

ANSI Z535.5 DEFINITIONS

⚠ DANGER	**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	**NOTICE** is used to address practices not related to personal injury.
SAFETY INSTRUCTIONS	**SAFETY INSTRUCTIONS** (or equivalent) signs indicate specific safety-related instructions or procedures.

⚠ WARNING

» **Contractors shall strictly adhere to specifications provided by the Engineer of Record (EOR), as well as US Environmental Protection Agency regulations, OSHA regulations, and all other federal, state and local codes. This work should only be done by qualified, licensed contractors.**

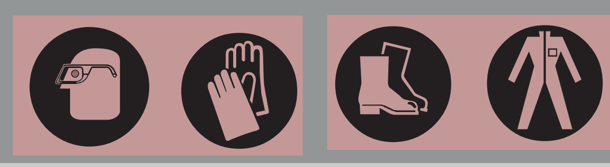
» **There are numerous hazards, not limited to, but including: burns due to high temperatures, high pressures, toxic substances, electrical arcs and shocks, very heavy equipment with specific lift points and structural constraints, food and product damage or contamination, public safety, noise, and possible environmental damage.**

» **Never leave operating compressors unattended during the manual soft-start process. Always power rocker switches off when unattended.**

⚠ WARNING

» **PERSONAL PROTECTION EQUIPMENT (PPE)**

» **Only qualified personnel should install and service this equipment. Personal Protection Equipment (PPE) is required whenever servicing this equipment. Wear safety glasses, gloves, protective boots or shoes, long pants, and a long-sleeve shirt as required when working with this equipment. Observe all precautions on tags, stickers, labels and literature attached to this equipment.**



⚠ WARNING

» **Proper Field Wiring and Grounding Required!**

» **Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.**

ENVIRONMENTAL CONCERNS

Hussmann recommends responsible handling of refrigerants. Only certified technicians may handle these refrigerants. All technicians must be aware and follow the requirements set forth by the Federal Clean Air Act (Section 608) for any service procedure being performed on this equipment that involves refrigerant. Additionally, some states have other requirements that must be adhered to for responsible management of refrigerants.

WARNING

— LOCK OUT / TAG OUT —

» **To avoid serious injury or death from electrical shock, always disconnect the electrical power at the main disconnect when servicing or replacing any electrical component. This includes, but is not limited to, such items as controllers, electrical panels, condensers, lights, fans, and heaters.**

CAUTION

» **This manual was written in accordance with originally prescribed equipment that is subject to change. Hussmann reserves the right to change all or part of the equipment for future stores such as, but not limited to, controllers, valves and electrical specifications. It is the installers responsibility to reference the refrigeration drawings supplied for each installation, as directed by the Engineer of Record.**

FOR CALIFORNIA INSTALLATIONS ONLY:

WARNING:

Cancer and Reproductive Harm
www.P65Warnings.ca.gov

August 31, 2018 3069575

This warning does not mean that Hussmann products will cause cancer or reproductive harm, or is in violation of any product-safety standards or requirements. As clarified by the California State government, Proposition 65 can be considered more of a 'right to know' law than a pure product safety law. When used as designed, Hussmann believes that our products are not harmful. We provide the Proposition 65 warning to stay in compliance with California State law. It is your responsibility to provide accurate Proposition 65 warning labels to your customers when necessary. For more information on Proposition 65, please visit the California State government website.

WARNING

» **This equipment is prohibited from use in California with any refrigerants on the "List of Prohibited Substances" for that specific end-use, per California Code of Regulations, Title 17, Section 95374.**

» **Use in other locations is limited to refrigerants permitted by country, state, or local laws and is the responsibility of the installer/end-user to ensure only permitted refrigerants are used.**

» **This disclosure statement has been reviewed and approved by Hussmann and Hussmann attests, under penalty of perjury, that these statements are true and accurate.**

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TRANSCRITICAL CO_2 SYSTEM OVERVIEW

GENERAL SAFETY GUIDANCE FOR CO_2 SYSTEMS

CO_2 systems have similar safety concerns with all other refrigerants, in that it displaces oxygen and is heavier than air and will concentrate closer to the floor if there is a system leak. CO_2 should be monitored for leaks similar to other refrigerants. Confirm operation of leak detectors, (e.g. by exhaling near the sensor) audible / visible alarms, and machine room ventilation.

Also, Transcritical CO_2 type flash tanks are normally kept around +32°F. If the temperature of the flash tank reaches 49.7°F, CO_2 will start to vent from the regulating relief valve (set at 650 psi). This would typically only happen during a long power outage.

Ventilate adjacent enclosed areas to prevent the formation of dangerous concentrations of carbon dioxide. Personnel including rescue workers should not enter areas in which the carbon dioxide content exceeds 3% (30,000ppm) by measurement unless wearing an SCBA or supplied-air respirators. Avoid contact of the skin or eyes with solid carbon dioxide (dry ice) or objects cooled by solid carbon dioxide. Additional information on the safe use and handling of carbon dioxide can be found in Standards from the Compressed Gas Association Standard https://www.cganet.com/.

ASPHYXIATION

R744 is odorless, heavier than air and is an asphyxiant. **Assume an unsafe level of CO_2, and ventilate the room prior to entering if sensor reading is maxed out or non-responsive, .**

- Practical limit of R744, 0.006 lb/ft3 (56,000 ppm);

Note
The practical limit is defined in ASHRAE 34 but may vary depending on regional regulations. The table below summarizes the effect of CO_2 at various concentrations in the air.

A leak of R744 could result in a concentration exceeding the practical limit in an enclosed, occupied space such as a cold room. Precautions must be taken to prevent asphyxiation. These include the use of permanent leak detection, which activates an alarm in the event of a leak.

PPM of CO_2	Effects
370	Concentration in atmosphere
5,000	Long-term exposure limit (8 hours)
15,000	Short-term exposure limit (10 min)
30,000	Discomfort, breathing difficulties, headache, dizziness, etc.
100,000	Loss of consciousness, death
300,000	Quick death

INTRODUCTION TO TRANSCRITICAL CO_2

This manual provides general information that covers the installation, startup, maintenance and service of centralized transcritical systems using carbon dioxide (CO_2). For detailed information regarding a specific component or application use the QR codes in this manual or contact your Hussmann representative.

Additional specifications for job-specific site installation may include:

- **Legend of Equipment Load and Electrical Requirements**
- **Site-Specific Sequence of Operations**
- **Specifications of Components**
- **Piping Diagrams**
- **Site-Specific Dimension and Lifting Requirements**
- **Equipment Overview and List of Options**

CO_2 QUALITY

Carbon dioxide that is purchased for use in refrigeration systems should be of a purity level high enough to prevent accumulation of non-condensible gases and moisture. A build-up of these gases can block small orifices, such as expansion valves or lead to high discharge pressure, reducing operation or causing the system to become inoperable.

CO_2 is commercially available at several different purity levels. The common names and percent purity are listed below. Hussmann recommends using Refrigeration Grade (99.99% purity) CO_2.

Grade	Purity
Industrial Grade	99.5%
Bone Dry (minimum acceptable)	99.8%
Anaerobic Grade	99.9%
Refrigeration Grade (Hussmann recommended)	**99.99%**
Coleman (Instrument) Grade	99.99%
Research Grade	99.999%
Ultra-Pure Grade	99.9999%

***Medical Grade CO_2 should not be used, due to the outlet pressure regulators typically present on tanks.**

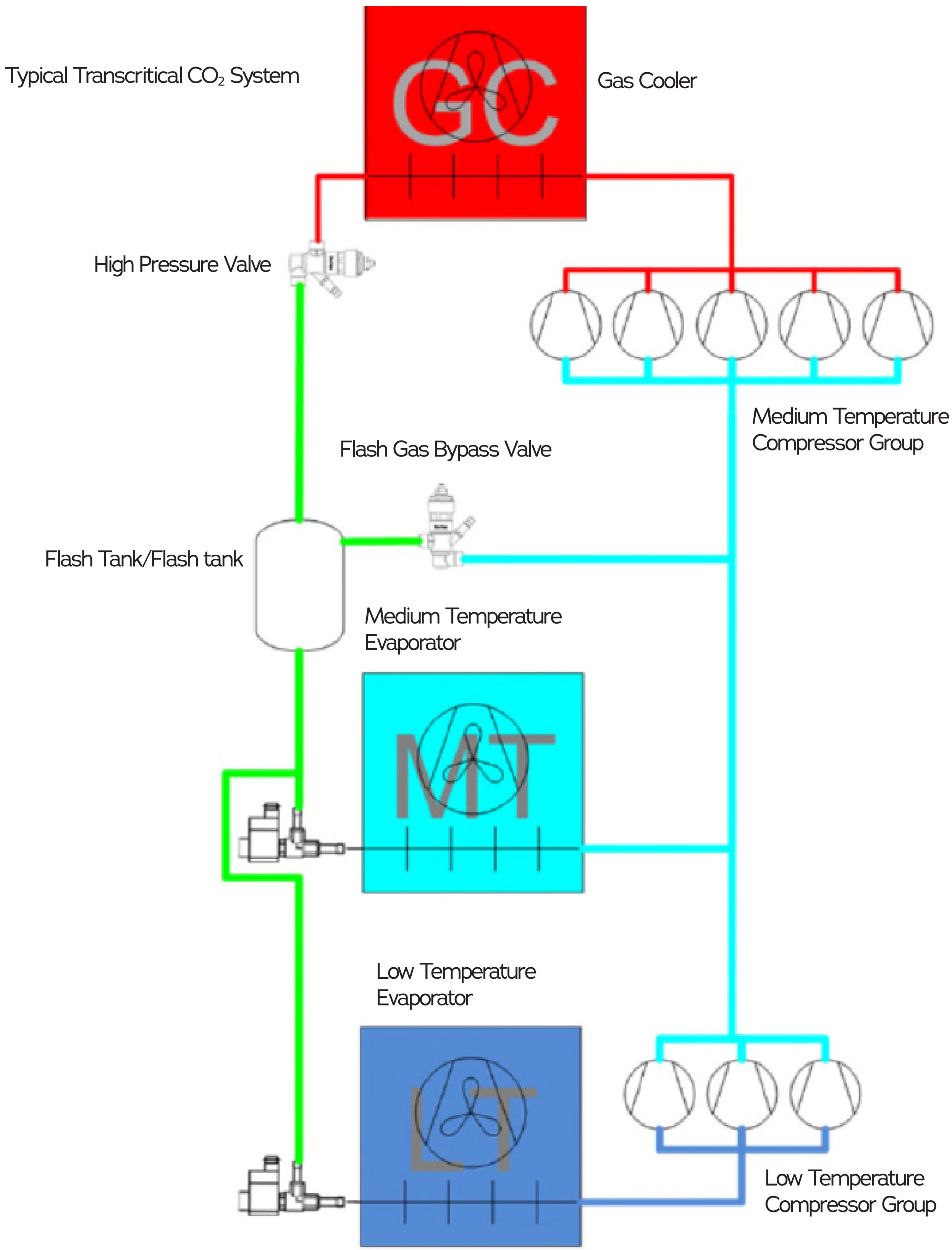
*The use of Bone-Dry Grade is the minimum acceptable purity to ensure proper operation of the equipment and is pure enough to prevent accumulation of non-condensable gases in the system.

Mixing of higher purity grades of CO_2 is acceptable. Lower grades of CO_2 contain higher levels of contaminants & water and may decrease system performance. Higher levels of moisture may react with the CO_2 and form carbonic acid that can degrade component integrity. Hussmann recommends keeping enough refrigeration grade CO_2 on-site to charge the system.

One of the benefits of CO_2 compared to synthetics is a high vapor density. CO_2 for low temp is approximately 5 times more dense, and this translates into smaller suction pipe sizes than other synthetic refrigerants.

TRANSCRITICAL CO_2 DIAGRAMS

CO_2 has found use in the supermarket industry in a wide variety of system layouts. Below and on the following page are example diagrams of a Transcritical CO_2 System.



SYSTEM OVERVIEW

This refrigeration systems uses naturally occurring, environmentally friendly, and energy efficient CO_2 that is compliant with federal environmental regulations.

This CO_2 equipment is designed with a “high side” (1740 psi max. pressure). The high side suction handles all Medium Temp. (MT) loads for the store as well as the LT Discharge and Flash Tank Flash Gas (652psi max pressure). The “low side” for the Low Temp. (LT) loads (435 psi max. pressure). The “intermediate side” liquid CO_2 (652psi max pressure) is sent to store medium and low temperature evaporators.

One point to remember is the MT part of the system needs to be running before running the (LT) compressors. Another main difference is that the LT discharge helps manage a reasonable superheat at the MT compressors. A liquid to LT suction plate heat exchanger is utilized to help provide a reasonable superheat at the LT compressors.

SYSTEM INSPECTION

Upon delivery of the unit(s), verify that the correct unit and equipment is received by comparing the information on the unit serial plate with the ordering and submittal documents. All equipment should be thoroughly examined for shipping damage before and during unloading. This equipment has been carefully inspected at our factory. Any claim for loss or damage must be made to the carrier.
The carrier will provide any necessary inspection reports and/or claim forms.

NOTE:
In addition to the legend, each rack has specific set points.

LEGEND, LABELS & WIRING DIAGRAMS

Each rack is shipped with a detailed legend that identifies the specialized components used such as compressors, valves, oil separators, etc. The legend details, BTUH loads, control valves, circuit information and suction temperatures. The type of refrigerant and lubricant to be used are prominently displayed on the front of the rack. All racks include complete wiring diagrams (control, primary power, board and point layout.) All wiring is color coded.

CO_2 NOMENCLATURE CHART

TC R 2 01-09 M B O A

Variation (A = Standard)

Unit Location (O = Outdoor)

Application (B = Booster)

Power Voltage (M = 460/3/60)

Two digit number representing total number of compressors from 1 to 9

Number of suction groups*

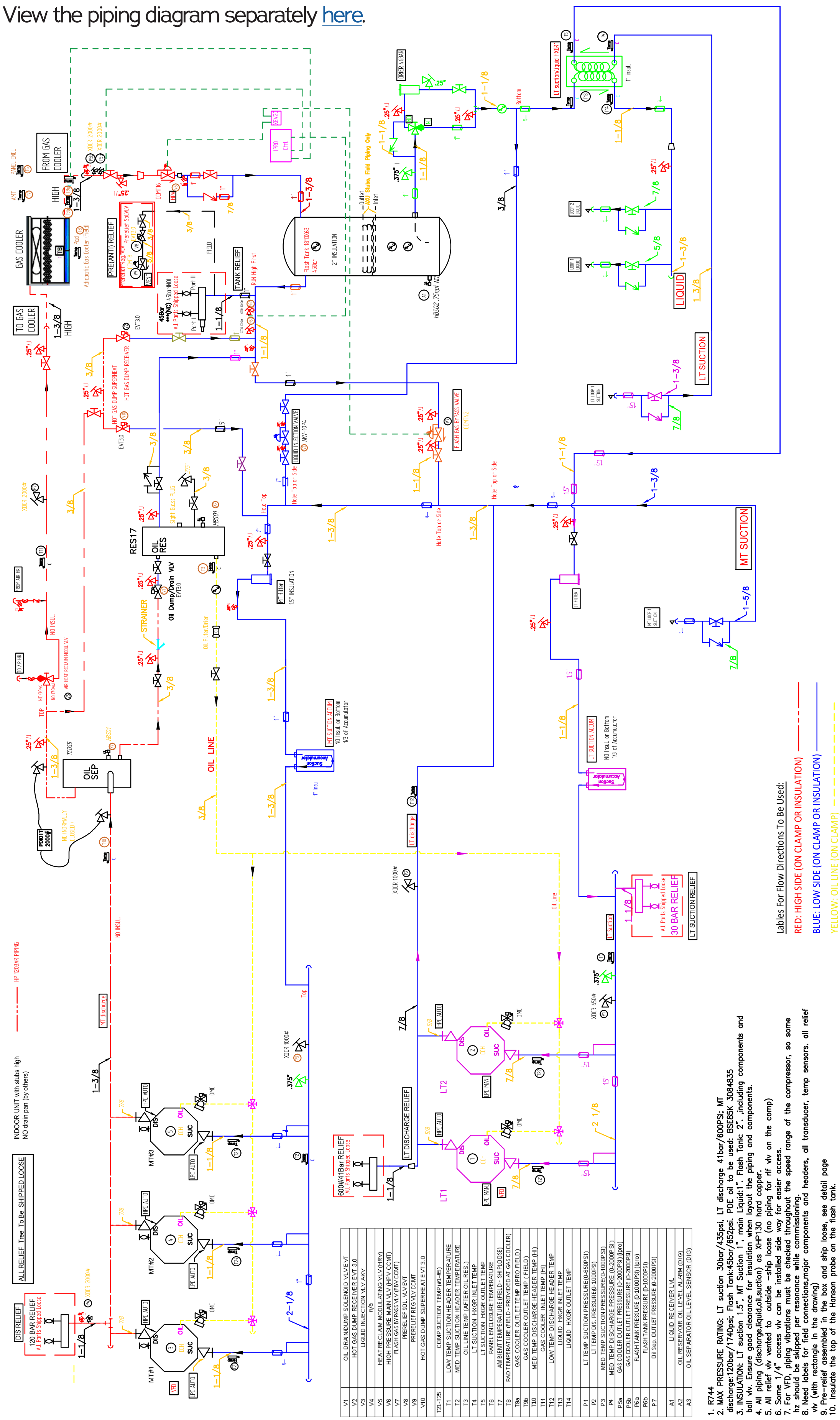
Unit Type (R = Rack)

Transcritical CO_2

* Contact Hussmann Design Engineering for additional information

TYPICAL CO_2 PIPING

View the piping diagram separately here.



MACHINE ROOM REQUIREMENTS

Equipment must be located in a dedicated operating area to provide enough working space for service personnel and meet electrical codes. Hussmann recommends ventilation should be a minimum of 65 cfm per compressor unit horse power. The air inlet should be sized for a maximum of 500 fpm velocity. Ventilation fans should cycle by thermostatic control.

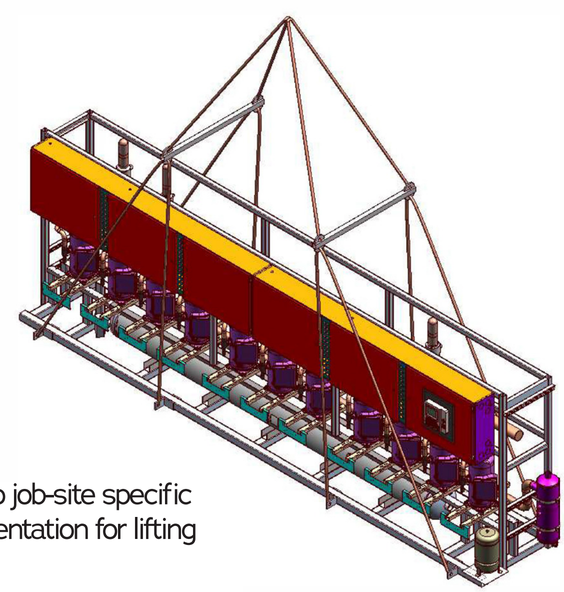
Proper ventilation provides needed air flow across the compressors that helps maintain the operation of the rack. Duct work may be necessary. All ventilation equipment is field-supplied and installed. **Check national and local codes for ventilation requirements before installation.** The equipment room floor must solidly support the compressor unit as a live load. Ground level installation seldom presents problems, but a mezzanine installation must be carefully engineered.

A concrete base must be built on the mezzanine floor to keep mechanical vibrations and noise to an acceptable level.

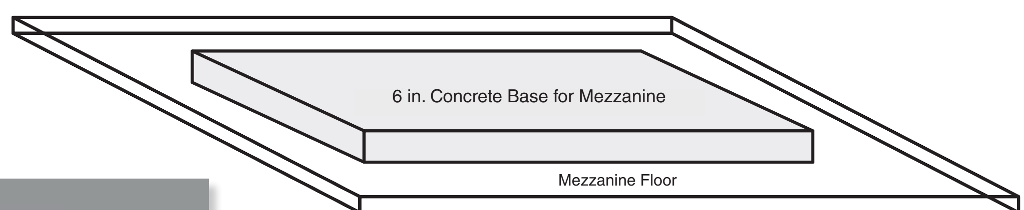
NOTE:
Recommended spacing is site specific. It is the installer's responsibility to check local codes and standards.

HANDLING

Each compressor rack has lower base frame brackets for rigging and lifting. It is important to use the spreader bar to prevent the rigging from damaging the rack. Before placing the rack in the machine room, remove the shipping skid. For units with vertical flash tanks, be aware of the level sensor on top of the flash tank. Lifting cables and other equipment must not come in contact with any unit piping or electrical components.



Refer to job-site specific documentation for lifting details.



⚠WARNING

» **Be careful when moving or lifting rack. Serious bodily injury or death could occur from falling equipment.**

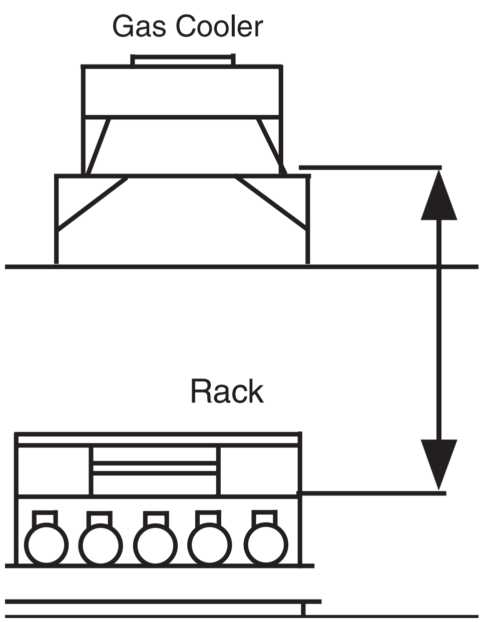
RACK UNIT PLACEMENT

Observe the minimum and maximum distances as described below for setting the rack in relation to other refrigeration equipment:

Minimum Allowable Distances

Air-cooled Gas Cooler:

- **The gas cooler should preferably be located at or above the mounting surface of the rack. If the gas cooler is mounted well below the rack consult with Hussmann for proper piping practices. If the gas cooler is located more than 15 feet above the rack mounting surface, install an oil trap on vertical lines every 10 to 15 feet.**



FLOOR DRAIN

Provide a floor drain for disposal of condensate that may form on the compressor unit.

REMOTE GAS COOLER PLACEMENT

Locate the gas cooler with at least three feet of clearance on all sides to provide adequate air circulation if not otherwise specified by the gas cooler manufacturer. If roof mounted, place on column-supported beams or load-bearing walls.

INSTALLING VIBRATION PADS

Each rack must be located in the machine room so that it is accessible from all sides. A minimum of 36 inches of clearance is recommended to provide easy access to components. Vibration isolation pads are supplied with each rack. The entire weight of the rack must rest on these pads. The pads should be located as shown in the image below. Cross-level the compressor unit so all compressors are level with each other. To ensure both proper leveling and vibration isolation, perform the following:

Vibration Pad Quantities
3 in. x 3 in. x 2 in.

# of compressors per pack	Reciprocating or Scroll
2 Compressors	4 Each
3 Compressors	4 Each
4 Compressors	6 Each
5 Compressors	6 Each
6 Compressors	6 Each
7 Compressors	8 Each
8 Compressors	8 Each
9 Compressors	8 Each
10 Compressors	10 Each

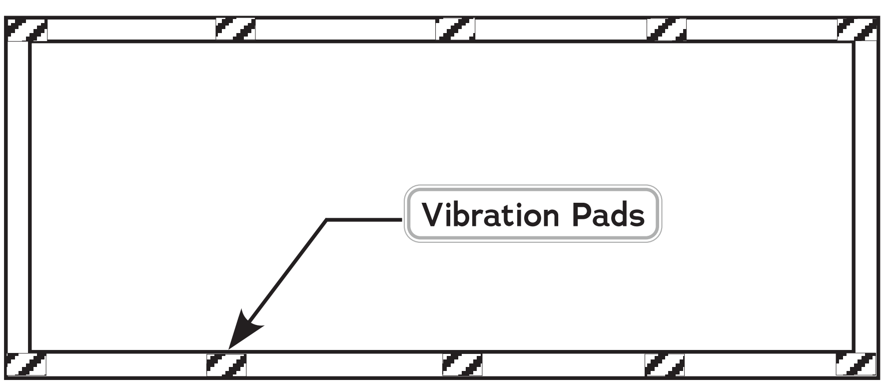
*10 for Bitzer and Vertical Flash tank

1. Lift the rack following local, state and federal requirements for safety.

2. Place minimum 15 gauge 3 in. by 3-in. galvanized or stainless steel shims to compensate for uneven floors. (Shims must be field supplied.)

3. Place vibration isolation pads on top of shims. See vibration pad quantities in the table at right to determine the number of pads to be used.

4. Pads should be placed over structural joist members when rack is placed on sub-floor.



COMPONENT PIPING & LINE SIZING

COPPER TUBE & FITTINGS

All CO_2 Liquid and MT Suction lines have a maximum design pressure of 652 psi. These lines can be run with ACR-Type K copper. These are typical refrigeration fittings manufactured to ASTM B75 and B251.

All LT Suction lines have a maximum design pressure of 435 psi. These lines can be run with ACR-Type L copper. Any standard type fittings may be used (ASTM B75 and B251).

All discharge piping lines have a maximum design pressure of 1885 psi. These lines can be run with XHP130 copper.

Additional industry practices still apply:

Brazed joints should be made with standard industry practices. Use nitrogen purging, flux, and Sil-foss (Hussmann recommends 15% silver content). Insulation requirements should follow job specifications. Standard tube bracing and supports are required, and standard suction practices are required (trapping and proper riser sizing).

INSULATION

Insulation should be used on CO_2 system piping to reduce the heat transfer to ambient air and to maintain sub-cooling in the CO_2 liquid line to the case. The insulation should be sized to allow for the worst case conditions of heating from showroom lighting and ambient temperatures. In order to minimize the required insulation thickness, install pipe in air conditioned space as much as possible. Do not size insulation for condensation prevention only. Pipe should be insulated according to local codes and customer specifications.

When installing piping that has not been pre-insulated, there are several options for insulation. Closed-cell elastomeric insulation is very popular in refrigeration applications. This type of insulation can also be used in secondary system applications. For detailed information regarding this type of insulation visit the Armaflex website at www.armaflex.com.

Always follow the manufacturer's recommendations for insulation thickness and proper installation.

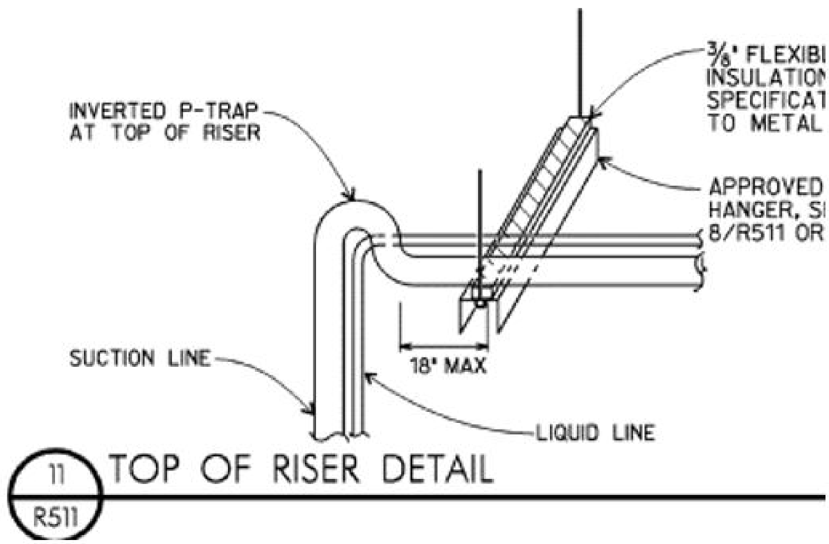
RACK PIPING OVERVIEW

This section provides information for installing the refrigeration lines for a rack. The components are piped as completely as practical at the factory. Field piping requires only interconnection of the major components and the coolers, freezers and display cases. Piping must also be supported to minimize vibration. Pulsation of the refrigerant and compressor vibration can cause piping to vibrate. This vibration can cause line breakage and damage to components.

Use only clean, dehydrated, sealed refrigeration grade copper tubing. Use dry nitrogen at low pressure in the tubing during brazing to prevent the formation of copper oxide. All joints should be made with a 15 percent silver alloy brazing material. Use as a minimum 45 percent silver solder for dissimilar metals.

Vertical risers should be supported within 18" of the inverted trap.

Hanger should attach to top chord of the rafter/truss.



Maximum Spacing Between Pipe Supports for Copper Tubing

Nominal (OD) Diameter	Max. Span in Ft.
5/8	5
7/8	6
1 1/8	7
1 3/8	8
1 5/8	9
2 1/8	10
2 5/8	11
3 1/8	12
3 5/8	13
4 1/8	14

①

1967 ASHRAE Guide and Data Book

⚠WARNING

» **Always use a pressure regulator when operating nitrogen tanks.**

REFRIGERATION LINE RUNS

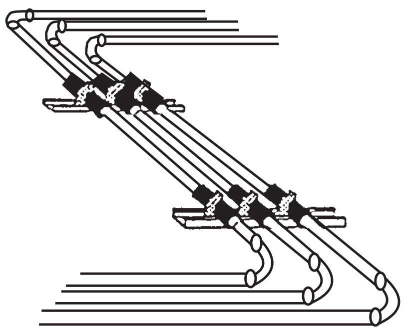
Liquid Lines and suction lines must be free to expand and contract independently of each other. Do not clamp or solder them together. Supports must allow tubing to expand and contract freely. Do not exceed 100 feet without a change of direction or/and offset. Pitch horizontal suction lines toward the compressor rack with a slope of 1/2" for every 10 feet. All suction risers should have a p-trap installed at the base of the riser and have an inserted trap installed at the top of the riser. All traps should be the same diameter as the horizontal run.

- **Install a suction midpoint p-trap for every 16' of vertical rise.**
- **Install a one-piece trap for both the base and inverted trap.**

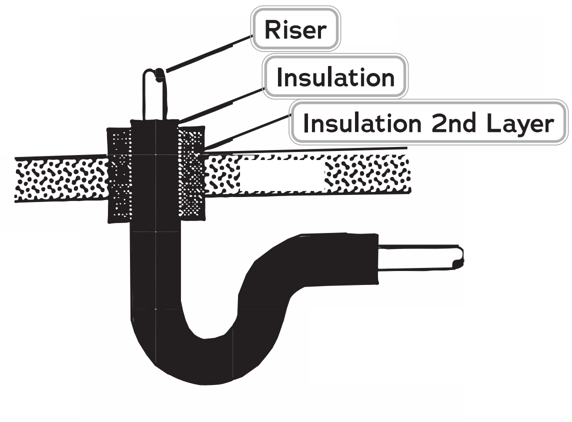
Use long radius elbows to reduce line resistance and breakage. Avoid the use of 45 degree elbows. Install service valves at several locations for ease of maintenance and reduction of service costs. These valves must be UL approved for the minimum design working pressure of the system.

THROUGH WALLS OR FLOORS

Refrigeration lines that are run through walls or floors must have a p-trap installed, and the lines must be properly insulated. Avoid running lines through the refrigeration cases. When this is done, the lines must be adequately insulated using a closed-cell elastomeric foam insulation.



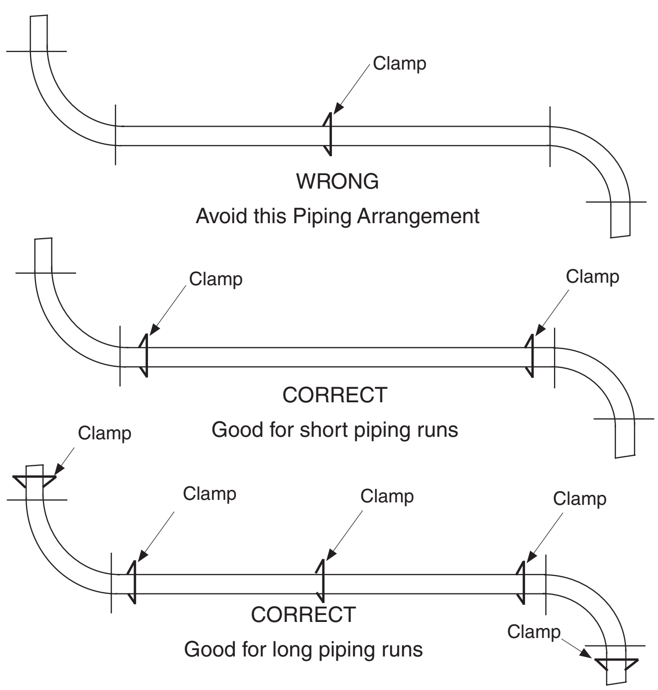
Floor Piping Run



FROM MACHINERY TO SOLID OBJECT

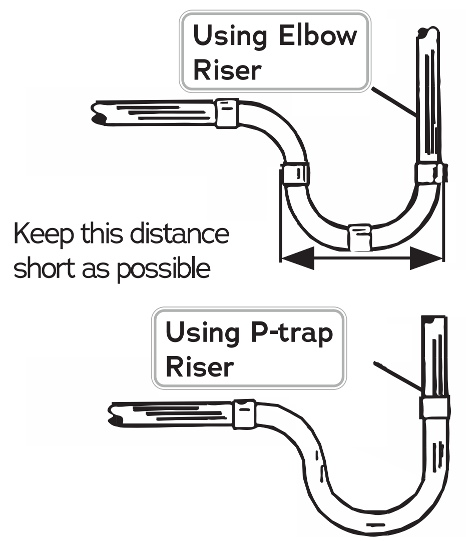
When mounting lines from machinery to a solid object allow line freedom for vibration to prevent metal fatigue.

Don't over support piping that is in contact with the compressor racks. The machinery must not be tightly stressed from piping that does not allow for some vibration. If piping is too tight metal fatigue will occur.



P-TRAP CONSTRUCTION

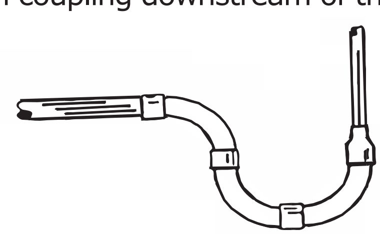
P-traps must be installed at the bottom of all suction risers to return oil to the compressors to avoid trapping oil.



P-trap Construction

REDUCED RISER

When a reduced riser is necessary, place the reduction coupling downstream of the p-trap.



Reduces Riser

PROTECTING VALVES AND CLAMPS

When brazing near factory installed clamps or valves be sure to protect them with a wet rag to avoid overheating. Insulate all reduced risers. Avoid using water or wet rags to cool a brazed joint. Allow brazed joints to air cool.

All clamps must be properly anchored. Rubber grommets must be installed to prevent chafing of the lines.

Elbows

Only use long radius elbows. Long elbows have been shown to have less pressure drop and greater strength. It is especially important to use long radius elbows to hot gas discharge lines.

FACTORY SUPPLIED STUBS

Stub sizes provided from the manifolds do not automatically correspond to the line sizes necessary. It is the installer's responsibility to supply reduction couplings.

RACK INSULATION

All suction lines and sub-cooled liquid lines must be insulated. CO_2 liquid in the liquid line will warm if the lines are left unprotected, resulting in energy loss. Overtime this can lead to the liquid changing into a gas before it ever reaches the expansion valves. This is known as flashing. Flashing causes irregular flow through valves. If this occurs significant refrigerant loss and poor energy performance will occur. Compressor motors will fail if the suction line gas is too warm as it enters the compressors. Insulate all CO_2 liquid lines and medium temperature suction lines with 1" wall, closed-cell insulation. Insulate all CO_2 low temperature suction lines with 1-½" wall, closed-cell insulation.

FLASH TANK SAFETY RELIEF VALVE

The safety relief valves must be properly vented in accordance with ASHRAE Standard 15 and applicable local codes.

NOTE:

Gas Cooler return lines should be free draining with no traps. All interconnecting valving to be field supplied and installed.

RACK TO HEAT RECLAIM

Refer to the instructions accompanying the system to be installed due to the variety of heat reclaim systems.

OFFSET AND EXPANSION LOOP CONSTRUCTION

For low temperature applications multiply the length of the run in feet by 0.0169.

For medium temperature application multiply the length of the run in feet by 0.0112. The product will be inches of linear expansion for the length of run.

Examples: Low temperature application, a run of 84 ft of 1 3/8 in. OD.

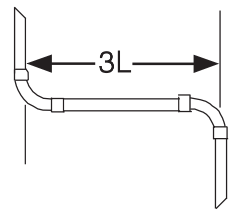
84 ft x .0169 = 1.4196 inches expansion.

Select the smallest "Inches Expansion" figure equal to or greater than the product in step one from the table below. Follow that column down until it intersects the OD line size of the run. The number listed at the intersection is the "L" valve for figuring offset an expansion loop sizes.

Equivalent Feet for Angle Valve and 90°Elbow				
Inches Expansion				
0.5	1.0	1.5	2.0	OD Line Size
10	15	19	22	7/8
11	16	20	24	1 1/8
11	17	21	26	1 3/8
12	18	23	28	1 5/8
14	20	25	31	2 1/8
16	22	27	32	2 5/8
18	24	30	34	3 1/8
20	28	34	39	4 1/8

Example:
The smallest "Inches Expansion" equal to or greater than 1.4196 is 1.5. The 1.5 column intersects with the 1 3/8 line at 21. Use "L" value 21. For an offset multiply the "L" value by 3 to determine the length of the offset.

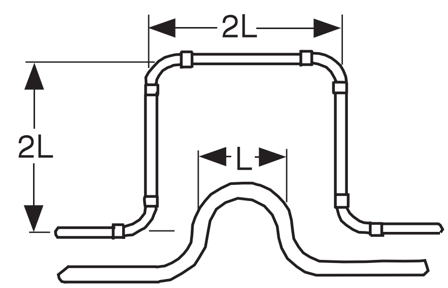
Example:
An "L" value of 21 would mean
3L = 3 X 21 or 3L = 63.



Offset Construction

The offset distance required for low temperature application for an 84 ft run of 1 3/8 line is 63 inches. For an expansion loop multiply the "L" value by 2 if hard copper and long radius elbows are used. If the expansion loop is formed in soft copper the loop diameter equals "L."

Example:
For the same 84 ft run, a hard copper loop is 42 x 42 inches. A soft copper loop is 21 x 21 inches.



Expansion Loop Piping

Application
Do not exceed a straight run for 100 feet without a change in direction or construction of an expansion loop. Place an offset or loop in the middle of the run to minimize pipe shift and joint stress.

NOTE:
Sizing of all refrigerant lines is the responsibility of the installing contractor. Contact Hussmann, Application Engineering if assistance is needed.

BRANCH LINE PIPING

Suction line

Pitch in the direction of flow. Line size may be reduced by one size at one third of case run load and again after the second third. Do not reduce below evaporator connection size. Suction returns from evaporators enter at the top of the branch line.

Liquid Line - Off-time and Electric Defrost

May be reduced by one size after one half other case load run. Do not reduce below evaporator connection size. Take-offs to evaporators exit from the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3-inch diameter.)

COPPER TUBING CONSIDERATIONS

Due to the higher pressures required of CO_2 Transcritical systems, special copper tubing and fittings must be used in order to handle these higher head pressures. Design pressures of the various system segments will dictate the appropriate copper tubing type. All copper-to-copper brazed connections should use (as a minimum) brazing material that contains 15 percent silver (Silphos). All copper-to-steel connections should use 45 percent to 56 percent brazing material. During the brazing process, it is required to flow dry nitrogen within the piping in order to prevent oxidation and scaling.

Product Line	*Product Type*	*Diameter*	
Copper Tube	Streamline ACR - Type L (Hard Lengths)	1/8” – 1-3/8”	UL Approved for 700 psi
	Streamline ACR - Type K (Hard Lengths)	1/8” – 2-5/8”	
Copper Fittings	Streamline Wrot Solder-Joint Pressure	1/8” – 2-5/8”	
Copper Tube	Streamline XHP130 (CuFe2P)	3/8" - 2-5/8"	UL Recognized to 130 BAR

Wieland K-65 copper tubing is rated for 120 bar (1740 psi) and can also be used with CO_2 Transcritical systems. Check local codes for requirements.

EQUIPMENT START-UP PROCEDURES

GENERAL RACK COMPONENTS

Each CO_2 rack contains the following components:

Quantity of 4-9 Bitzer compressors with:

Factory piping with:

- **Suction, discharge, liquid header**
- **Defrost header (if applicable)**
- **Oil separator, Oil Reservoir and return system**
- **Flash tank**
- **Suction filters on each suction group**
- **Liquid filter drier and sight glass**
- **Liquid level indicator or liquid level switch**
- **High and low pressure controls**
- **Oil pressure safety control**
- **Primary overload protection**
- **High pressure & flash gas valves**

CONTROL SETTINGS GENERAL DESCRIPTION

There are two potential control settings required to be set up prior to startup:

- **Low Pressure Controls**
- **Inverter Settings**

TRANSCRITICAL CO_2 SAMPLE SETUP SHEET

All set points are to be on a setup sheet mounted inside the door of the rack's electrical cabinet. This sheet includes all set points for field-adjusted components. (i.e. suction pressure, discharge pressure, flash tank pressure setting).

HUSSMANN® REFRIGERATION SYSTEMS

Hussmann Refrigeration Equipment CO2 Commissioning Sign Off Sheet

All sections of this document must be completed before the installation will be accepted.

General Information

Store Name :	Store #:
Location (street, city, state, zip):	
Rack Model # :	Rack Serial # :
Start-up date :	Commissioning date :
Installing contractor :	
Address :	
Phone # :	
E-mail address :	

INSTALLATION APPROVAL
The work carried out during this project is complete, and the standard achieved is acceptable.

Customer Representative

Signature	Date

Refrigeration Contractor

Signature	Date

By signing this form, you are confirming that the work detailed below is complete, and that all systems are operating as intended.
All handover documentation has been completed, and you are satisfied with their contents.
All issues are either resolved and/or you are satisfied with the plan for resolution.

Compressors manufacturer / low temp:	
Compressors manufacturer/ medium temp:	
Type of oil used:	

Compressor # (ex. 1/+20)		Model #	Serial #
Compressor #	1		
Compressor #	2		
Compressor #	3		
Compressor #	4		
Compressor #	5		
Compressor #	6		
Compressor #	7		
Compressor #	8		
Compressor #	9		
Compressor #	10		

Compressor # (ex. 1/+20)		CC Heater (amp)	Net oil pressure	High pressure cut in and cut out setting	Voltage L1-L2	Voltage L1-L3	Voltage L2-L3	Amperage L1	Amperage L2	Amperage L3
Compressor #	1									
Compressor #	2									
Compressor #	3									
Compressor #	4									
Compressor #	5									
Compressor #	6									
Compressor #	7									
Compressor #	8									
Compressor #	9									
Compressor #	10									

Rack Checklist

Is the rack placed on anti-vibration pads?	Yes	No
Is leak detection installed?	Yes	No
If so, has it been tested, certified and functional?	Yes	No
Is there an alarm or screen on entrance of compressor room indicating the CO_2 PPM?	Yes	No
Is proper signage on compressor room?	Yes	No
Do all exhaust fans operate correctly?	Yes	No
Are all rack panels closed?	Yes	No
Was the system under pressure upon reception?	Yes	No
If not, has Hussmann been notified?	Yes	No
Are all check valves in place per the engineering diagram?	Yes	No
Has the flow direction of all check valves been verified per engineering piping diagram?	Yes	No
Refrigerant grade (grade must be Bone Dry or higher):		
Refrigerant charge (LBS):		
Is the refrigerant the same as indicated on the rack's name plate?	Yes	No

Electrical				
Control system manufacturer:				
Verify the control voltage	L1>GD			
	L2>GD			
	L1>L2			
Verify all electrical connections are tight: (performed by contractor, prior to startup)	Yes		No	
CO_2 Swagelok outlet oil pressure setting if applicable:			PSIG	
High Pressure Alarm Setting:			PSIG	
Suction Groups				
Low Temp				
Check and record the rack suction pressure:	EMS		Gauge	
Check and record the rack suction temperature:	EMS		Meter	
Check and record the rack suction superheat temperature:	EMS		Meter	
Confirmed calibration of EMS discharge transducer?:	Yes		No	
Check and record the rack discharge pressure:	EMS		Gauge	
Check and record the rack discharge temperature:	EMS		Meter	
Medium Temp				
Check and record the rack suction pressure:	EMS		Gauge	
Check and record the rack suction temperature:	EMS		Meter	
Check and record the rack suction superheat temperature:	EMS		Meter	
Confirm calibration of EMS discharge transducer?:	Yes		No	
Check and record the rack discharge pressure:	EMS		Gauge	
Check and record the rack discharge temperature:	EMS		Meter	
Check and record the condenser drop-leg temp or gas cooler return:	EMS		Meter	

Misc.		
Is there heat reclaim?	Yes	No
What type of heat reclaim?		
Heat reclaim control settings (cut in/cut out)		
Is surplus C02 available on the site?	Yes	No
If so, how many lbs.?		
Does this rack have sub-cooling?	Yes	No
Liquid (sub cooling) temperature set point.		DegF
Liquid temperature:		DegF
Note Flash gas bypass valve setting (acceptable range 520 - 610 psig for flash tank)?		
Is the gas cooler / condenser clean and free of debris?	Yes	No
Gas cooler / condenser fans have the correct rotation?	Yes	No
Is there a VFD controlling the fans on the gas cooler: First Pair	Yes	No
Is there a VFD controlling the fans on the gas cooler: All	Yes	No
Confirm correct settings / operation of VFD?	Yes	No
Has gas cooler throttle valve been set if applicable?	Yes	No
What type of piping used for the gas cooler / condenser?		
Confirmed operation of flash tank alarm device?:	Yes	No
Level of refrigerant in flash tank, at what ambient temperature?	%	DegF
Caps are on, and tightened at end of start-up?	Yes	No
Confirm that there is enough oil in the oil reservior?	Yes	No
Confirm the oil level in each compressor is correct per the mfg. recommendation?	Yes	No
Has the operation of the OMC been verified?	Yes	No
Has the oil been changed after start up?	Yes	No
Are all the relief valves well fastened?	Yes	No
Has the oil level alarm been functionally tested?	Yes	No
Does the battery backup close the suction stops on the rack when a power loss occurs...if applicable?	Yes	No
Notes :		

LEAK TESTING (CO_2 RACK)

Leaks can be very costly over time. It is very important to follow EPA Greenchill Installation Leak Tightness Guidelines as well as Greenchill Leak Prevention and Repair Guidelines. Ensure all compressor control ON-OFF switch are in the OFF position.

Do not start any compressors without ensuring there is oil in them. Serious damage to the compressors may result from not having oil in them.

Always use a pressure regulator with a nitrogen tank. Do not exceed two pounds of pressure and vent lines when brazing. Do not exceed 1400 pounds of pressure for leak testing the Transcritical High Side. Do not exceed 350 psig of pressure for leak testing the Transcritical Low Side.

Isolate all pressure transducers during vacuum and pressure testing.

LEAK TESTING (CO_2)

All refrigeration lines under the floor should be leak and pressure tested and inspected prior to backfilling. All underground lines should be pressurized to 350 psi and hold for 24 hours. It is recommended to test piping before tying in the cases. If any leaks are found, isolate the leaks, discharge the gas and repair the leaks, and then repeat the test. This general method is not different from any other synthetic refrigeration system.

Field pressure testing is done both for leak testing and for the pressure rating of a system. It is possible to check for leaks at a lower pressure, but codes dictate that the system be proven tight at the system design pressures. For CO_2, the LT suction lines and evaporators are rated for 435 psi and the high side including MT suction lines and liquid lines are rated for 650 psi. Also, check to see if there are any specific job pressure testing requirements that might require higher pressure testing.

The pressure test schedule below should be used as standard guidance:

PIPE SECTION	PRESSURE TEST PRESSURES (PSIG)
LT SUCTION	350
MT SUCTION/LIQUID	525
MT DISCHARGE/DRAIN	1400

PRE-CHARGE CHECKLIST

While the system is being evacuated preparation for charging can begin. During any of the pull downs check:

- **Merchandiser's electrical requirements and power supply electrical connections are tight and clean**
- **Check for proper fan operation and case controller settings.**
- **Walk-in coolers and freezers electrical requirements and power supply**
- **Damper operation, if equipped.**
- **Heat Reclaim and other systems**

CO_2 RACK CHARGING / EVACUATION

CO_2 has a low tolerance for moisture so care should be taken to evacuate the system before charging (similar to synthetic refrigerants). Ensure all individual line tests have been completed and all the nitrogen has been removed before completing the vacuum process. Using the correct pump (minimum of 10 CFM) and technique for the vacuum to obtain the target of 70 microns. Of course, the rack also will need to be evacuated and put under vacuum before charging.

The triple evacuation method should be used to achieve a leak-free, dry system. For the first evacuation, the system should be pulled down to 1000 microns. The second evacuation should be pulled to 500 microns. The final evacuation should be pulled down to at least 300 microns. A dry, leak-free system is when the system holds a vacuum of 300 microns for 24 hours with the vacuum pump de-energized and valved off. Between each evacuation, break the vacuum with dry nitrogen.

Use a copper manifold to join the connections on the high, intermediate and low side simultaneously. Ensure that the connections to the vacuum pump can be manually isolated.

A maximum of 2 vacuum pumps will be allowed, adding up to at least 10 CFM. However, it is preferable to use a single vacuum pump, capable of at least 25 CFM. It is important that the oil in the pumps be changed regularly until the micron level has been reached:

- **1st oil change after first evacuation.**
- **2nd oil change after second evacuation**

A few things should be considered when starting the vacuum process:

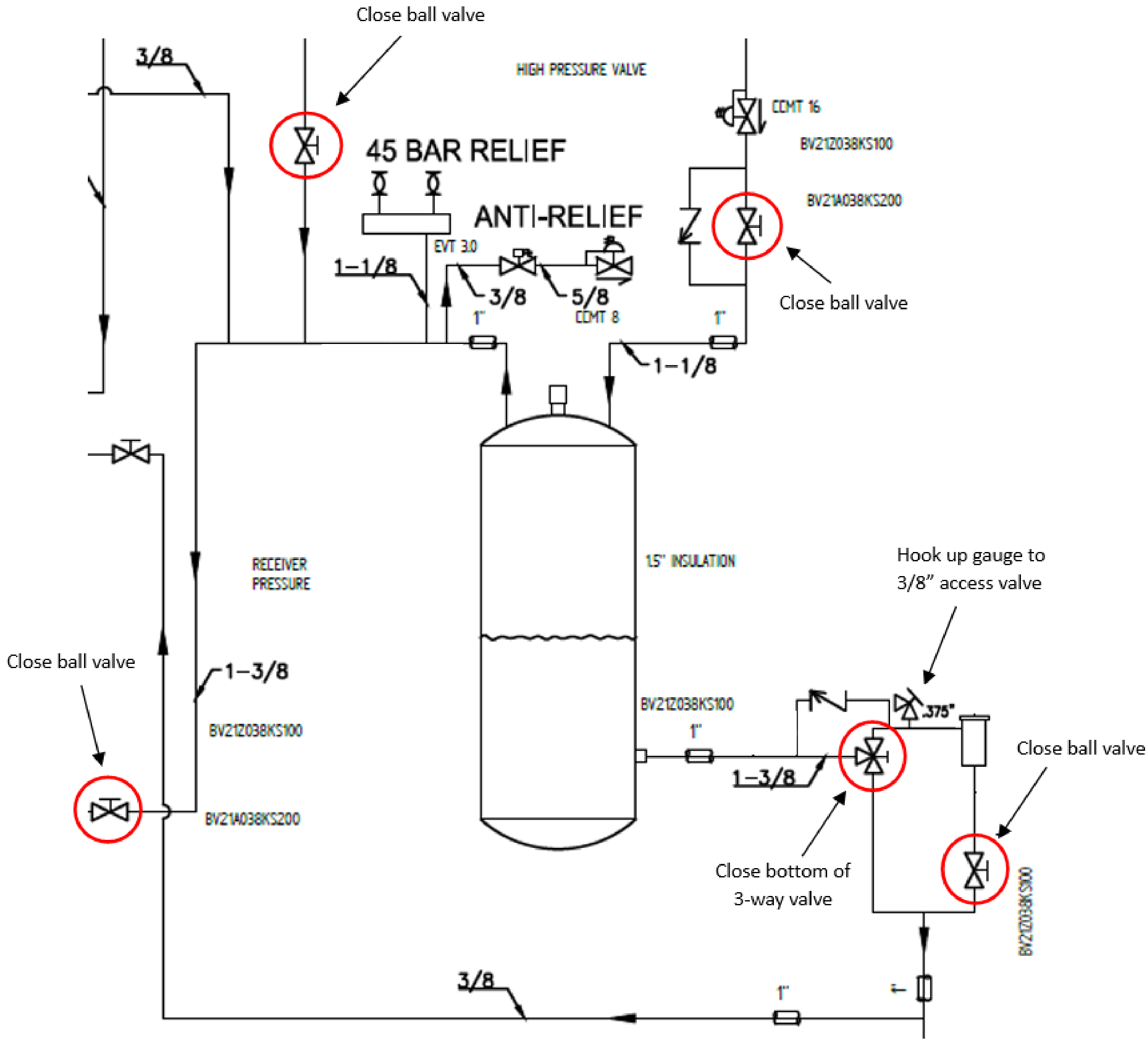
1. Ensure the system is 100% free of leaks.
2. All the connections from the vacuum pump to the rack should be soft drawn copper lines 5/8”.
3. Ensure the connections have been tested before starting the pump.
4. All the caps on the rack and in the cases need to be installed and tightened.
5. All the valve packings need to be tightened.
6. Ensure liquid filters are installed before starting the third vacuum.
7. Crankcase heaters should be turned on.

NOTE
It is important to note that a low vacuum pulled on transducers may damage the sensor. Consult with the sensor manufacturer if the transducer should be isolated during these conditions.

It is important that the start-up sheet be filled out and a picture of the gauge indicating 300 microns (hold for 24 hours) be kept for records.

CHARGING CONTINUED

Once the vacuum is broken with CO_2 at a pressure of 100 psi (to prevent formation of dry ice), isolate the flash tank with the 5 valves that are circled below. To charge the system, hook up the gauge to the access valve next to the in-line filter/drier. After 100 psi, the dip tube may be used, drawing liquid CO_2 from the tanks for faster charging. Close the outlet of the flash tank to allow filling the flash tank first. Stop charging once the bottom sight glass is full and after the flash tank outlet valve is opened to all refrigerated fixtures (with all loads calling for cooling and valves opened).



- **Open compressors – open service valves on suction and discharge.**
- **Open oil supply line immediately downstream of the oil separator and reservoir.**
- **Pressure transducers – open angle valves.**
- **Leave open ball valves – to branches, gas cooler, heat reclaim, flash tank.**

Set all mechanical pressure controls.

During the last evacuation look up and make a list of the required control settings for the system.

OIL LEVELS

Check oil levels for each compressor and the oil reservoir. Compressor sight glass 1/8 to ½ full, oil reservoir bottom sight glass filled. See legend for oil types used in CO_2 rack system.

If the oil is low, add the appropriate oil or lubricant to match the compressor used. Consult the compressor manufacturer for the correct oil type per the given application.

EVACUATION

Nitrogen and moisture will remain in the system unless proper evacuation procedures are followed. Nitrogen left in the system may cause head pressure problems. Moisture causes EEV ice blockage, wax build up, acid oil and sludge formation.

- **Do not simply purge the system. This procedure is expensive, harmful to the environment, and may leave moisture and nitrogen behind.**
- **Do not run the compressors to evacuate. This procedure introduces moisture into the compressor's crankcase oil and does not produce adequate vacuum to remove moisture from the rest of the system at normal temperatures.**

⚠CAUTION

» **Never trap liquid refrigerant between closed valves as this could cause a hydraulic explosion.**

FINAL CHECKS

Once the rack is up and running, it is the responsibility of the installer to see that all the fine adjustments are made so the rack delivers maximum temperature performance and efficiency for the customer.

These adjustments include:

- **Defrost scheduling and timing**
- **Gas Cooler controls**
- **Case Controller adjustment**

CONTROL CHECKS

1. During the duration of filling the flash tank, all mechanical controls should be set; Low Pressure Switch and verify oil failure at the compressor and oil separator and reservoir.

- **Low pressure controls should be set below the rack set point. They should be verified with a set of gauges, and close the suction stems in to verify each control will cut out.**
- **Each control should display an alarm in the controller when each test is complete.**

CO_2 RACK PRE-STARTUP CHECKLIST GUIDE

Piping, Evacuating, and Charging

☐ All field-installed piping completed, including cases, walk-ins, gas cooler, heat reclaim, etc.

☐ Remotely mounted relief valves should be installed per the installation details.

☐ All piping should be pressure tested per local codes.

☐ The system should be evacuated as described in the Hussmann Transcritical CO_2 IOM.

☐ The vacuum on the system should be broken using CO_2 vapor tanks to a pressure of 100 psi to prevent the formation of dry ice, as described in the 'CO2 Rack Evacuation / Charging' section of this manual. Liquid may be used to charge the system once the pressure is above 100 psi. Enough CO_2 should be available on site in both liquid tanks and vapor tanks to fully charge the system. The CO_2 should be Refrigerant Grade CO_2 (99.9% purity) or better.

☐ Verify that all filters are installed on the rack, including the oil separators, suction filters, and liquid driers (field installed).

☐ The oil reservoir should be filled with the oil specified by the compressor manufacturer; BSE85K for Bitzer and RH68HB for Copeland. Enough oil should be available on site for the initial startup and first oil change.

Rack

☐ All electrical connections in the rack control panel are properly tightened.

☐ Main power and control power is on, and the voltage is correct.

☐ All rack control boards are online and communicating with the rack controller.

☐ All rack temperature sensors are reading correctly in the rack controller.

☐ All rack pressure transducer shut-off valves are open, and the transducers are reading correctly in the rack controller.

☐ Compressor crankcase heaters should be turned on 24 hours prior to system start up.

☐ There should be a minimum of 40% of the rack evaporator load for MT available for the initial startup of the system.

Gas Cooler

☐ All electrical connections in the gas cooler control panel are properly tightened.

☐ Power is on and the voltage is correct.

☐ Verify that the gas cooler fan staging, speed control, and rotation are correct.

☐ Adiabatic gas coolers should have the water turned on and drain lines completed.

☐ Gas cooler outlet temperature sensor(s) should be installed, insulated, and wired to the rack controller per the installation details.

☐ All control wiring for the gas cooler operation is installed as required. This may include wiring for communication, fan speed reference, fan staging, ambient temperature, adiabatic pre-coil temperature, alarm/status outputs, etc. See installation details for specific requirements.

☐ The gas cooler temperature sensor(s) are reading correctly in the rack controller.

☐ If equipped, the control boards installed in the gas cooler are online and communicating with the rack controller.

Cases and Walk-ins

☐ All case controller communication wiring should be complete.
☐ The power for the cases and walk-in evap coils should be turned on.
☐ All case controllers should be addressed and communicating with the rack controller.
☐ All temperature sensors on the cases and walk-in evap coils are reading correctly in the case controllers.
☐ All pressure transducer shut-off valves are open, and the transducers are reading correctly in the case controllers.
☐ Verify operation of all case and walk-in evap coil fans.
☐ The case drain lines or evac system should be completed.
☐ All penetrations should be sealed.
☐ The case controller programming in the rack controllers is complete.
☐ The walk-in leak detector system should be operational.

Other

☐ If the rack is indoors, verify that the machine room leak detection and ventilation is functional.
☐ All work areas represent a safe work environment and are free of construction debris.
☐ The customer or contractor must provide competent personnel with proper tools and equipment and be present onsite for the entirety of the FQS visit.
☐ If equipped, the backup condensing unit and generator should be installed and operational.

CO_2 RACK STARTUP PROCEDURE

1. Once the controls have been set and the flash tank is full (do not exceed 600 psig), the Medium Temp (MT) should be started first.
2. Once there is enough load to keep the racks running, look at all the amperages on all the compressors. Record this data for future reference (can be written on the control panel).

CO_2 RACK STARTUP SEQUENCE

1. Prior to starting the rack up or putting power to the rack, make sure all the electrical connections in the rack panels and compressors are tight. All case controller panels for all coolers and freezers, and cases should be checked.
2. At least 40% of the rack evaporator load (both MT and LT) should be available prior to rack startup.
3. Several tests should be performed on the rack prior to running. (Note: Control must be powered up.)

   - **Perform a phase loss test to make sure all the case controller EEVs shut down.**
   - **Once the phase loss is reset, all the case controllers should return to normal**
   - **Leak detection in all walk-in boxes and mechanical rooms must be tested, and fully functional. The exhaust fan should be in operation prior to charging of the system.**
   - **Leak detection is not recommended to shut down the rack as this may result in additional CO_2 being released to the atmosphere.**

CO_2 RACK STARTUP SEQUENCE

1. Prior to starting the rack up or putting power to the rack, make sure all the electrical connections in the rack panels and compressors are tight. All case controller panels for all coolers and freezers, and cases should be checked.
2. At least 40% of the rack evaporator load (both MT and LT) should be available prior to rack startup.
3. Several tests should be performed on the rack prior to running. (Note: Control must be powered up.)
   - **Perform a phase loss test to make sure all the case controller EEVs shut down.**
   - **Once the phase loss is reset, all the case controllers should return to normal**
   - **Leak detection in all walk-in boxes and mechanical rooms must be tested, and fully functional. The exhaust fan should be in operation prior to charging of the system.**
   - **Leak detection is not recommended to shut down the rack as this may result in additional CO_2 being released to the atmosphere.**
4. Check the system operating temperatures and defrost time. The length and number of defrost cycles must be set in accordance with case manufacturers' recommendations and the owner/operator's defrost guidelines.
5. A final defrost schedule must be provided to the store manager during the week of grand opening as well added to the door of the rack. All work within start-up procedure needs to be recorded in a logbook kept in the motor room.
6. After the compressor is started, continue charging until the system has sufficient refrigerant for proper operation. During start-up, no compressor is to be left operating unattended and unwatched until the system is properly charged with refrigerant and oil.
7. After the system has been in operation for a minimum of 7 days, all expansion valve strainers must be cleaned and is recommended for valves with removable screens.

NOTE
For new contruction, it is recommended that all freezer boxes are set at 35° F, and run for a minimum of 48 hours, then drop to 10° for 24 hours. This will pull the moisture out of the floor in the freezers. If the customer has a requirements or specification, follow it.

Monitor the following:

1. Flood back.
2. Keep an eye on oil levels in the oil reservoir and well as in the compressor crankcase.
3. Monitor flash tank pressure to ensure it never exceeds 600psi. If so, review operation and set points.
4. It is recommended to place the filters back in the suction shell.
5. Flash Tank Pressure must be 80 psig above the Medium Temp Suction pressure to ensure oil flow to the compressors.

AFTER STARTUP

Oil and Filter Replacement

1. Charge the rack fully with oil. After the rack is full, it is recommended to change the suction, liquid and oil filters within 30 days or as required by the customer's specifications. Hussmann supplies filters for startup and enough for one change after startup.
2. Additional oil changes may be needed based on customer-specific requirements and to ensure the unit is clean.
   NOTE: Any time the system is opened after this point, the drier cores must be replaced.
3. Leak test with a CO_2 sniffer type tool, such as D-Tek CO_2 Refrigerant Leak Detector.
4. Defrost lengths and pressures should be verified to ensure that energy consumption is at a minimum.
5. Always check that each case (after defrost) temperature exceeds 32° F in the evaporator and the coil is clear.
6. If the coil is not clearing using the recommended defrost settings call the case manufacturer for review.
7. Ensure that all the programming is finished and well understood by servicing contractor.
8. Ensure that all temperature sensors and pressure sensors are well calibrated.
9. Ensure all control panels are closed.
10. Record CO_2 level in the flash tank for future reference.
11. Fill out start up form (sample shown on Page 31), and send to Hussmann a maximum of 3 weeks after initial start up.

THERMOSTAT SETTINGS

Adjustments to electronic controls:

Thoroughly inspect all field piping while the equipment is running and add supports where line vibration occurs. Be sure additional supports do not conflict with pipe expansion and contraction.

When merchandisers are completely stocked, check the operation of the system again. At 90 days recheck the entire system, including all field wiring. Future maintenance costs may be reduced if an oil acidity test is run at this time. Replace acidic oil.

LOW PRESSURE CONTROLS

Compressor low pressure controls are field set. Consult your Hussmann factory representative for setting parameters and operational criteria.

SEQUENCE OF OPERATION

OVERVIEW

The TC CO_2 Rack Sequence of Operations establishes control objectives, recommendations, and standard operating parameters for a refrigeration system. The system is capable of running in low and high ambient conditions. The system provides the basis of a simple and cost-effective refrigeration rack utilizing a natural refrigerant. With future amendments (e.g., Ejectors, Flooded Evaporators, Dew Point Cooling etc.), this system would be capable of capturing nearly 100 percent of its waste heat for reuse and able to optimize system efficiency by more than 30 percent.

For the purposes of this sequence, the TC CO_2 Rack is comprised of a multiple number of MT and LT Compressors on common suction headers. Whereas the LT Compressors discharge into a common header tied to the MT suction and where the MT Compressors discharge into a common header with a coalescing oil separator mounted on a supporting frame. All compressors are fed from a common oil reservoir maintained at flash tank pressure. Other components typically found on a booster system: suction filters & liquid driers, compressor oil level controls, flash tank, liquid-suction heat exchangers, high pressure, and flash gas valves.

Additional components that are not always utilized on a CO_2 Rack but commonly applied are: suction accumulators, 3-way diverting valves (e.g., heat reclaim), flash gas to gas cooler or flash gas to liquid heat exchangers, hot gas dump and liquid injection valves, and ejectors.

The specific functions in which this sequence will establish controls are:

- **Compressor Staging**
- **System Operation**
- **Compressor Variable Capacity**
- **Suction Float Control**
- **Pressure Relief Valves**
- **Oil Management**
- **Heat Reclaim Control**
- **Gas Cooler Fan control**
- **High Pressure Valve & Flash Gas Bypass Valve**
- **Valve Controls (e.g., Hot Gas, Liquid Injection etc.)**
- **Phase Loss**
- **Circuit Stage Up (auto restart after power failure)**

ABBREVIATIONS

CO_2	Carbon Dioxide	SC	Subcritical
EEV	Electronic Expansion Valve, EXV	SST	Saturated Suction Temperature
Flash Tank	Liquid Vapor Separator	TC	Transcritical
HG	Hot Gas	HPV	High Pressure Valve, ICMTS, Gas Cooler Valve (GCV)
IT	Intermediate or Parallel Group	FGB	Flash Gas Bypass Valve
LT	Low Temperature	BPHE	Brazed Plate Heat Exchanger
MT	Medium Temperature	PRV	Pressure Relief Valve
PLM	Phase Loss Monitor		

TYPICAL INPUT & OUTPUT POINTS

Analog Output – VFD or Digital Unloader (Modulating Compressor Capacity)
Analog Output – Gas Cooler Fan Speed
Analog Output – Oil Drain Solenoid SSR

Relay Output (N.O.) – Compressor On (1 per compressor)
Relay Output (N.O.) – iPro Enable
Relay Output (N.O.) – Anti-Relief Solenoid
Relay Output (N.O.) – Hot Gas Dump Superheat Solenoid
Relay Output (N.O.) – Hot Gas Dump Flash tank Solenoid
Relay Output (N.O.) – Liquid Injection Solenoid

Digital Input (N.O.) – General Compresor Alarm
Digital Input (N.O.) – Compressor VFD Alarm
Digital Input (N.O.) – Oil Fail (1 per compressor)
Digital Input (N.O.) – Phase Loss
Digital Input (N.O.) – Phase Loss Generator Feed (whenapp.)
Digital Input (N.O.) – Low Liquid Flash tank
Digital Input (N.O.) – Oil Reservoir Low Alarm
Digital Input (N.O.) – Oil Separator High Alarm

Analog Input – Suction Pressure
Analog Input – Suction Temperature
Analog Input – Compressor Run Proof (1 per compressor)
Analog Input – Discharge Pressure
Analog Input – Discharge Temperature
Analog Input – Rack Leak Detector
Analog Input – Gas Cooler Outlet Pressure
Analog Input – Gas Cooler Outlet Temperature
Analog Input – Flash tank Pressure
Analog Input – Ambient Temperature
Analog Input – Pad Temperature

Stepper Output – Anti-Relief Valve
Stepper Output – High Pressure Valve
Stepper Output – Flash Gas Bypass Valve

COMMUNICATION

All Rack & Gas Cooler I/O boards are located at the main rack control panel on the rack frame. The boards are networked to the main rack controller via the local board network. The main rack controller will also communicate with the High-Pressure Controller and EEV Case Controllers.

NOTE

It is typical for I/O Boards and/or the Rack Controller to support an open BMS protocol (e.g., BACnet, Modbus, Lon Works) and open IoT protocol (e.g., MQTT) to add the capability of integrating additional control solutions or communicating to a cloud portal.

COMPRESSOR STAGING

Each suction group will be piped in parallel to the same suction or discharge header. Typical suction groups for CO_2 are Low Temperature (e.g., -20°F), Medium Temperature (20°F) and the Intermediate Temperature (also referred to as Parallel Compression, e.g., 36°F). The parallel piped compressors are staged by the EMS controller based on the pressure (psig) in the common suction header. The staging typically maintains the suction manifold pressure +/- 2F SST of the target setpoint.

It is common for CO_2 Systems to include a feature to allow the lead compressor to operate below target setpoint, pulling the suction pressure down to the pump down setpoint. Pump down allows a larger operating range typically when under low loads and reduces lead compressor cycles. As the suction pressure rises above the setpoint range the controller will add compressor capacity by increasing the voltage to the VFD or Digital Unloaders and by staging ON compressors; conversely as the suction pressure decreases below the setpoint range compressors will be staged OFF and the VFD or Digital Unloaders will decrease capacity.

Parameter	Value	Unit	Remarks
LT Suction Pressure Pumpdown	162	psig	Typical Setpoint
LT Suction Pressure	162-208	psig	Typical Operating Range
MT Suction Pressure Pumpdown	328	psig	Typical Setpoint
MT Suction Pressure	328-420	psig	Typical Operating Range

Table:1, Typical Operating Suction Pressures

SYSTEM OPERATION

The Low Temperature Compressors are Boosted by the Medium Temperature Compressors to the Condenser Gas Cooler. The high compression ratio for Low Temperature CO_2 Compressors would result in excessively high discharge temperatures, of which the industry does not provide components for (e.g., compressors, piping etc.).

However, piping the LT Compressors into the MT Suction significantly decrease the power consumption of the LT Compressors, but there is a slight increase in the MT Load. This design is also beneficial for managing the MT Superheat, as CO_2 Systems require slightly higher superheat than a typical Rack (e.g., 36- 52°F). The LT Compressors help mitigate low superheat concerns from the flash gas bypass valve and low superheat from the evaporators.

Medium Temperature Suction Groups must have at least 1 compressor available in order for LT Compressors to run. If for any reason all MT Compressors are not available (e.g., off on oil, safety line, high pressure, or phase loss etc.), the LT Compressors must be locked out, otherwise opening the MT Suction Pressure Relief could result.

Additional notes regarding above basic operation control strategy:

- **The order in which compressors are staged may be handled internally by the EMS controller. It may be required to configure each compressors power, capacity, or displacement.**
- **VFD or Digital Unloaders fill in and create overlaps between compressor steps.**
- **Ensure the variable speed compressor ramps up and down appropriately between stages. When the suction pressure is unstable, it is not expected that the variable compressor reaches max speed before staging up and reaches min speed before staging down.**
- **When modulating compressor capacity up to bring suction pressure lower toward setpoint, analog output may not always bring the compressor capacity to 100 percent before cycling other compressors.**
- **Stage Timer delays may be shortened due to excessive suction pressure.**
- **Set proportional band or neutral zone band to limit compressor cycling under 40 cycles per day.**

NOTE
Bitzer recommends max of 6 starts per hour & minimum 10 minutes between two starts.

COMPRESSOR CAPACITY CONTROL

All compressor capacity control sequences will be executed by the rack controller. The control circuit for each compressor is routed through a relay output point controlled by the rack controller. The control circuit provides control power to each compressor contactor's coil. The compressor relay outputs are normally open, which prevents the compressors to run unless the EMS has full control of the system.

Each compressor will incorporate a mechanical high pressure safety switch that will break voltage to the compressor contactor in the event of a high pressure trip. Steps should be taken to prevent frequent compressor cycles in case of multiple, subsequent high pressure events. The discharge pressure will be monitored by the refrigeration controller. In the event of a High Discharge Pressure event, the refrigeration controller will stage down compressor capacity to reduce discharge pressure while keeping the compressor group operating. However, during a high suction event (e.g., MOP) a command to turn off all circuits is sent while allowing the rack to stage as normal.

Each suction group will be provided with at least one variable capacity compressor. The rack controller will provide a signal through an analog output to the compressor's VFD or digital unloader (e.g., CM-RC). The rack controller will determine the voltage output required to provide the percentage of required unloading to maintain the suction pressure setpoint. All compressor staging is designed to maintain the suction pressure setpoint with overlap in capacity to reduce short cycle and staging up or down.

Parameter	Value	Unit	Remarks
MT Low Suction Pressure	345	psig	Suction group failure and alarm
LT Low Suction Pressure	160	psig	Suction group failure and alarm
MT High Suction Pressure	475	psig	Suction group alarm only
LT High Suction Pressure	290	psig	Suction group alarm only
MT High Discharge Setpoint	1522	psig	Suction group failure and alarm
LT High Discharge Setpoint	490	psig	Suction group failure and alarm
MT Discharge Pressure	600-1300	psig	Typical Operating Range
LT Compressor VFD Hz Range	30-75	Hz	Typical Compressor Speed Range
MT Compressor VFD Hz Range	25-70	Hz	Typical Compressor Speed Range
Compressor Minimum Off Time	1	min	Typical Setting
Compressor Hourly Running Cycles Exceeded Alarm	6	starts/hr	Typical Setting (starts per hour)

Table: 2, Typical Suction Group Parameters

COMPRESSOR FLOAT CONTROL

The rack controller will monitor the temperature and superheat of all evaporators. Provided the temperature (or superheat)of all evaporators (not in defrost)remain within the parameters dictated by the case controller, the rack suction float strategy will be employed as follows.

The Rack Suction pressure setpoint will continually increase by the Float Circuit Control Increment value every 600 seconds until the Float Circuit Control Upper Limit has been reached. The float strategy typically does not include a Blast Chiller, Prep Room,or Walk-In Box circuits. However, system performance should be observed before including a circuit in the float strategy.

If during the execution of the Float Circuit Control algorithm, any evaporator superheat decreases below the acceptable limits, the rack suction pressure setpoint will decrease per the Float Circuit Control Increment value (typically every 300 seconds) until the original rack suction pressure setpoint has been reached. If all evaporator superheat (not in defrost) increases back into acceptable ranges during float-down, suction pressure will begin to float up toward upper limit.

Parameter	Value	Unit	Remarks
Suction Pressure Float Up Delay	10	min	
Suction Pressure Float Down Delay	5	min	
Max Float Up	5	°F	From SST Setpoint

Table:3, Typical Float Parameters

OIL MANAGEMENT

The TC CO_2 Rack has two distinct oil management areas, only one of which is controlled by the Rack Controller. The EMS will control the level and draining of the Oil Separator, only located on the Discharge of the MT Compressors. Any time the Oil Separator indicates the oil level is high, the rack controller will pulse the Oil Drain Solenoid. This is to ensure ample time is given to drain the separator but not excessively so to send hot gas to the Flash Tank. The Oil Drain Solenoid may also pulse open in the event of a trouble compressor, unable to fill with oil (when applicable).

Ensure that during high ambient conditions the duty cycle of the Oil Drain Solenoid is enough to drain the Separator. For example, a cycle of 15s open with 45s closed may be sufficient.

The Compressors are equipped with Emerson OMC CO_2 oil level controls. The OMC monitors the compressor oil level and will open the Compressor Oil Solenoid to fill the Compressor when the oil level drops. The OMC is connected to the compressor control circuit and will interrupt control power when unable to fill to required level due to low oil supply. The OMC sends a digital closure to indicate oil alarm condition. The Rack Controller will generate an oil fail alarm.

Typical Oil Management Parameters

Parameter	Value	Unit	Remarks
Oil Separator Drain Pulse Time	15	sec	
Oil Separator Drain Period Time	45	sec	
Typical Oil Pressure	490-550	psig	Pressurized with Flash Tank, maintain > 75 psig MT SP
Typical Oil Drain Cycles	20-40	per/hr	

PRESSURE RELIEF VALVES (PRV)

Key Terms

PRV—The pressure relief valve is a required safety device to prevent damage or injury during system operation and shutdown. On transcritical booster systems there are multiple PRVs on each system.

Change Over Valve—A change over valve is a three-way valve that allows for the technician to change the operation of one pressure relief valve to a secondary of back-up valve.

Very High-Pressure Relief—The very high-pressure relief valve is the PRV device with the highest pressure rating on the system. In typical systems this valve will have a relief rating of 1,740 psi (120 bar). This device is intended to protect the gas cooler and medium temperature discharge lines.

High Pressure Relief—The high-pressure relief is the PRV with a relief rating slightly above the operating pressure of the flash tank, medium temperature evaporators, and circuits. In a typical system this PRV will have a relief value of 650 psi (45 bar). This device prevents damage to field piping, evaporators, flash tank, and medium temperature suction lines.

Low Pressure Relief—The low-pressure relief is the PRV with the lowest pressure rating on the system which is above the low temperature suction pressure. In a typical system this PRV will have a relief value of 435 psi (30 bar). This device protects the low temperature evaporators and low temperature suction lines.

PRV System

The rack includes multiple PRVs consisting of a dual port isolation valve fitted with two pressure relief valves for easy service. If a pressure relief gets stuck open even with the pressure at the normal operating range, it is recommended to change the secondary relief valve and replace the first one stuck open.

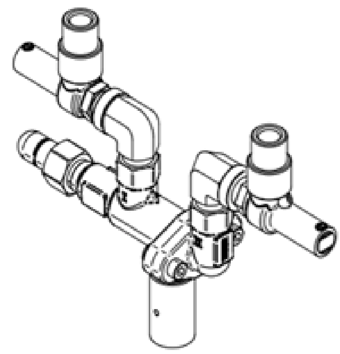
- **The Low Temperature Suction Line is protected by 435 psi (30 bar) reliefs.**
- **The Medium Temperature Suction Line is protected by 652 psi (45 bar) reliefs.**
- **The Flash tank (Liquid Line) is protected by 652 psi (45 bar) reliefs.**
- **The Medium Temperature Discharge Line is protected by 1,740 psi (120 bar) reliefs.**

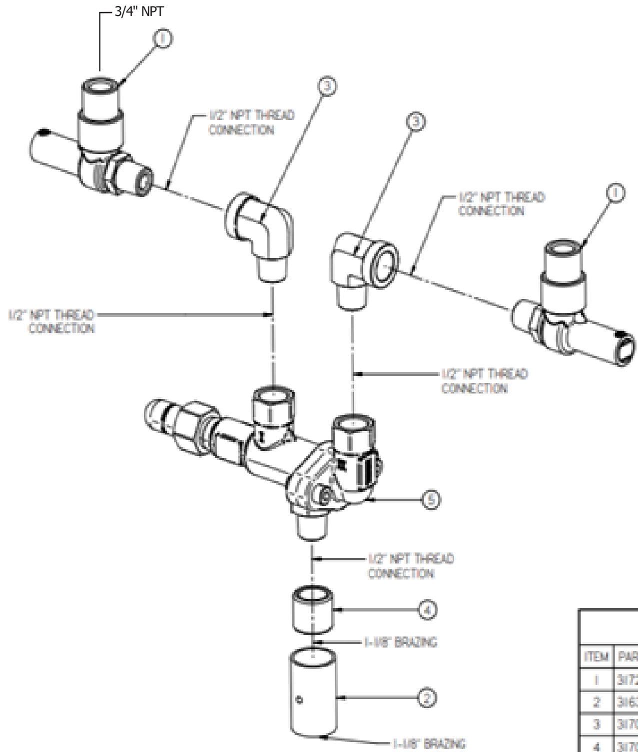
Important Installation Details

- Pressure relief valves should not have piping installed downstream of the PRV. Installing piping after the valve may result in the formation of dry ice inside the pipe preventing the flow of relieved refrigerant gas.
- Relief valves must be installed with the outlet of the valve facing down or to the side. Installation in another orientation will result in potential accumulation of water, ice, or snow preventing proper operation of the device.
- The pressure relief valves and accompanying parts are included in the ship loose package included with the system shipment.
- Indoor installations require piping the relief devices outside of the machine room to prevent the possible accumulation of CO_2 inside an enclosed space.
- Always consult local regulations for any additional requirements.
- Wiring has to be done between anti-relief box and rack electrical panel. 24 V solenoid already has terminals identified in the rack. SDR-4 should connect on a 2-valve board driver that is already identified.

PRV Components

435 psi (30 bar) PRV

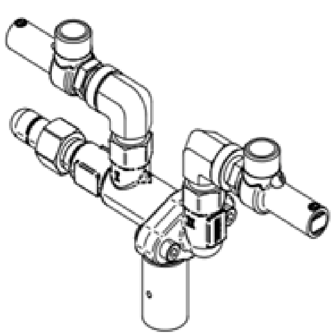


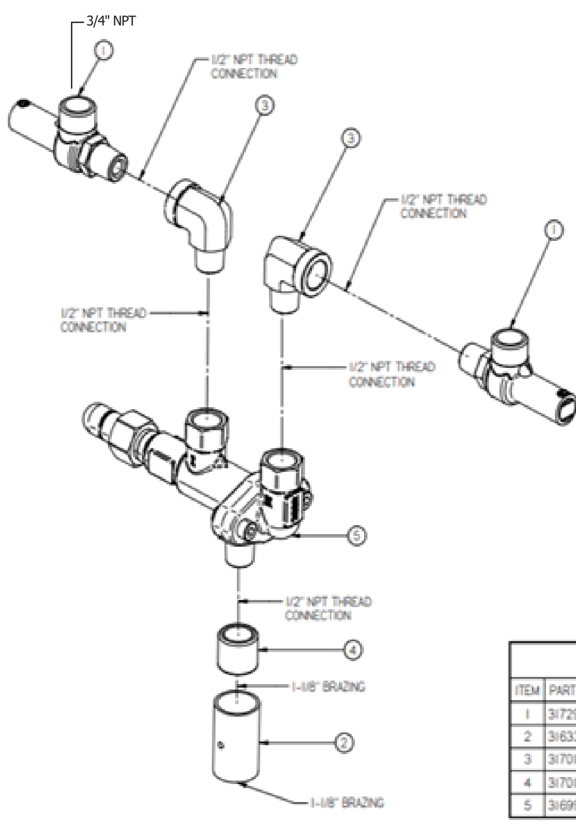


PART LIST - ASSEMBLY

ITEM	PART NUMBER	TITLE	QTY
1	3172991	VALVE-PRESS RELIEF .500 NPTM X .750	2
2	3163317	COUPLING-STAKED-STOP C X C 1-1/8	1
3	3170169	ADAPTER-.500 NPT M X F 90 ELBOW	2
4	3170166	BUSHING-1-1/8 FTG X .50 FNPT FLUSH	1
5	3169980	VALVE-.500 NPT M X F 3 WAY CHANGEOVER	1

652 psi (45 bar) PRV

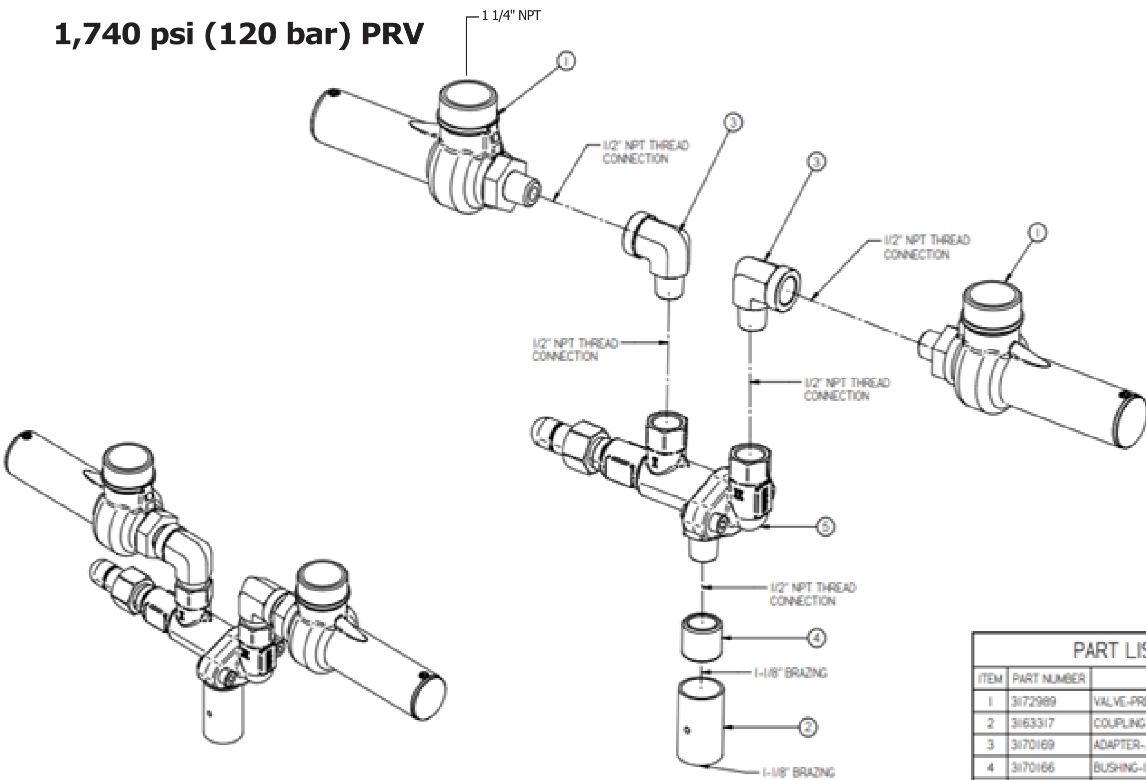




PART LIST - ASSEMBLY

ITEM	PART NUMBER	TITLE	QTY
1	3172990	VALVE-PRESS RELIEF .500 NPTM X .750	2
2	3163317	COUPLING-STAKED-STOP C X C 1-1/8	1
3	3170169	ADAPTER-.500 NPT M X F 90 ELBOW	2
4	3170166	BUSHING-1-1/8 FTG X .50 FNPT FLUSH	1
5	3169980	VALVE-.500 NPT M X F 3 WAY CHANGEOVER	1

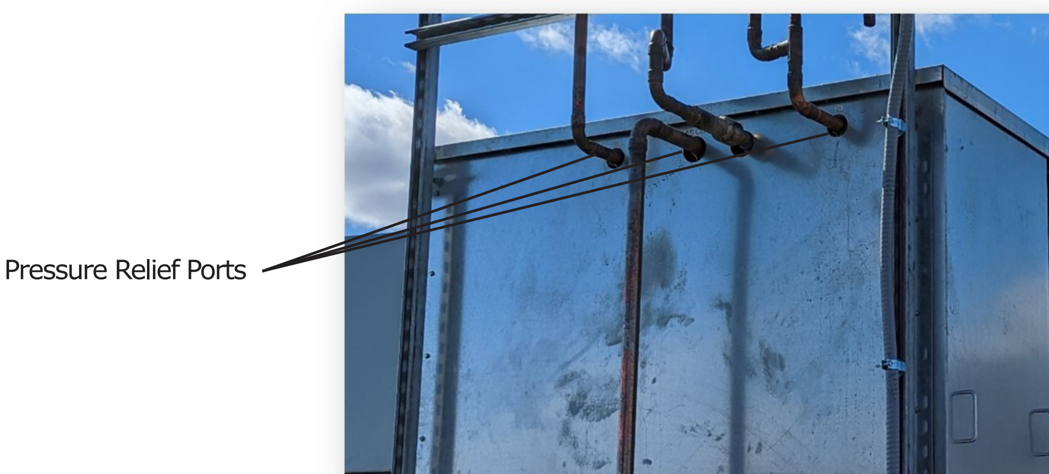
1,740 psi (120 bar) PRV



PART LIST - ASSEMBLY			
ITEM	PART NUMBER	TITLE	QTY
1	3172989	VALVE-PRESS RELIEF .500 NPTM X 1.250	2
2	3163317	COUPLING-STAKED-STOP C X C 1-1/8	1
3	3170169	ADAPTER-.500 NPT M X F 90 ELBOW	2
4	3170166	BUSHING-1-1/8 FTG X .50 FNPT FLUSH	1
5	3169980	VALVE-.500 NPT M X F 3 WAY CHANGEOVER	1

PRV Installation

1. Locate the pressure relief ports on the system and identify the pressure for each port from the attached label on the assembly

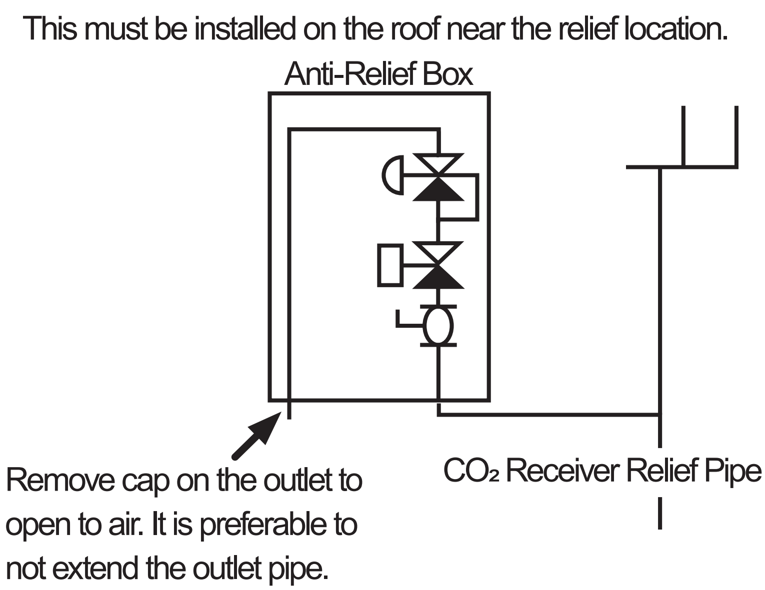


2. Identify the best location for the pressure relief devices for your location. It is recommended that the devices are located in a manner to prevent discharge in the working areas for technicians
    a. Located on the roof above the machine room is ideal for indoor systems. Consider potential snow levels when choosing mounting height.


    b. Top mount is an option for outdoor systems where the structure to support the PRVs can be affixed to the exterior of the system. This positioning keeps the relief valves away from technicians during service.


3. Using Unistrut or equivalent material construct an assembly to support the weight of the PRVs. When considering the construction please allow for additional forces applied during a release of pressurized gas.
4. Once your support structure has been constructed and attached to a fixed surface pipe the relief valve ports to the appropriate PRV. It is important that the correct pressure valve is attached to the appropriate port. Failure to do so will result in damage to the system or loss of charge.
   a. Piping for the very high pressure relief should only be done using iron/copper alloy (K65 & XHP) pipe. Failure to use the correct material on this relief valve will result in material failure of the pipe.
   b. Piping for the high pressure and low pressure relief valves may be done in L-type ACR for sizes up to 1-3/8”.
5. Secure piping using appropriate clamps to the support structure to prevent damage from wind, snow or pressure releases.
6. Install provided adapters and attach change over valve assembly to piping.
7. Finally install pressure relief valves onto the change over valves.
8. Once fully assembled ensure the final mounting is secure.
9. Once system charging begins, verify that all connections and valve outlets for potential leaks.

Typical Anti-Relief Box Diagram



Pressure Rating Chart

Included below is the Mueller pressure rating chart for Type-L & K ACR copper tubing to be used in low pressure 435 psi (30 bar) and 650 psi (45 bar) relief valve assemblies.

STREAMLINE® NITROGENIZED seamless copper tube is available in sizes 3/8" OD through 3-1/8" OD. Larger sizes from 3-5/8" OD through 8-1/8" OD are cleaned and capped. Manufactured and cleaned in accordance with ASTM B280. 20-ft. lengths hard drawn - cleaned and capped - color coded - Marked "ACR/MED"

TYPE K NITROGENIZED ACR / MED — **RATED WORKING PRESSURE (PSIG)**

O.D. DIA.	WT/FT	150°F	200°F	250°F	300°F	400°F
3/8	0.145	913	877	860	842	537
1/2	0.269	960	923	904	885	565
5/8	0.344	758	728	713	698	446
3/4	0.418	700 †	700 †	700 †	577	368
7/8	0.641	700 †	700 †	700 †	668	426
1 1/8	0.839	700 †	700 †	700 †	513	327
1 3/8	1.04	700 †	700 †	700 †	416	266
1 5/8	1.36	700 †	700 †	700 †	387	247
2 1/8	2.06	700 †	700 †	700 †	341	217
2 5/8	2.93	700 †	700 †	700 †	312	199
3 1/8	4	500^	500^	500^	302	193
3 5/8	5.12	450^	450^	450^	286	183
4 1/8	6.51	450^	450^	450^	282	180
5 1/8	9.67	293	281	276	270	172
6 1/8	13.9	295	283	277	271	173
8 1/8	25.9	314	301	295	289	184

TYPE L NITROGENIZED ACR / MED

O.D. DIA.	WT/FT	150°F	200°F	250°F	300°F	400°F
3/8	0.126	777	747	731	716	457
1/2	0.198	700 †	700 †	700 †	612	391
5/8	0.285	700 †	700 †	700 †	567	362
3/4	0.362	700 †	700 †	700 †	496	316
7/8	0.455	700 †	700 †	700 †	457	292
1 1/8	0.655	700 †	700 †	700 †	388	248
1 3/8	0.884	700 †	700 †	700 †	344	220
1 5/8	1.14	650^	650^	650^	320	205
2 1/8	1.75	550^	550^	550^	285	182
2 5/8	2.48	500^	500^	500^	263	168
3 1/8	3.33	450^	450^	450^	249	159
3 5/8	4.29	450^	450^	450^	238	152
4 1/8	5.38	400^	400^	400^	230	147
5 1/8	7.61	229	229	215	211	135
6 1/8	10.2	213	213	201	196	125
8 1/8	19.3	230	230	216	212	135

Tables give computed allowable stress at indicated temperatures for copper tube that has been annealed either through brazing or an annealing furnace.

† UL Recognized to 700 PSI (select sizes)
^ Rated in accordance with UL 207 Performance Testing

A BRAND OF MUELLER INDUSTRIES

HEAT RECLAIM CONTROL

When applicable, CO_2 Heat Reclaim can be incorporated with either air (e.g.,space heating or dehumidification) or water (e.g., domestic hot water).

Air Heat Reclaim

One mounted plate heat exchanger using CO2 to heat glycol/water mixture which is pumped to an HVAC unit.
Installed 3-way modulating valve and one fluid pump enabled by leaving fluid temperature to HVAC unit (on 130F, off 200F).
The modulating valve is controlled based on CO2 pressure difference.
Also includes:

- Circuit Setter valve on outlet of heat exchanger fluid line
- Strainer installed before pump
- Expansion tank on fluid return line
- Air scoop and purge valve on fluid return line
- Auto-fill tank on return fluid line
- Pressure Relief Valve on fluid supply line
- Heat reclaim coil needs to be rated for high pressure

Water Heat Reclaim

- For Water Heat Reclaim, a plate heat exchanger is typically utilized to heat domestic water.

DANFOSS CTR VALVE

What is a CTR Valve?

A CTR valve is a versatile component used in fluid control systems to direct the flow of liquids or gases between three different ports. The valve typically consists of three ports: an inlet port, outlet port, and a third port that can be connected to the heat source of the heat sink circuit.

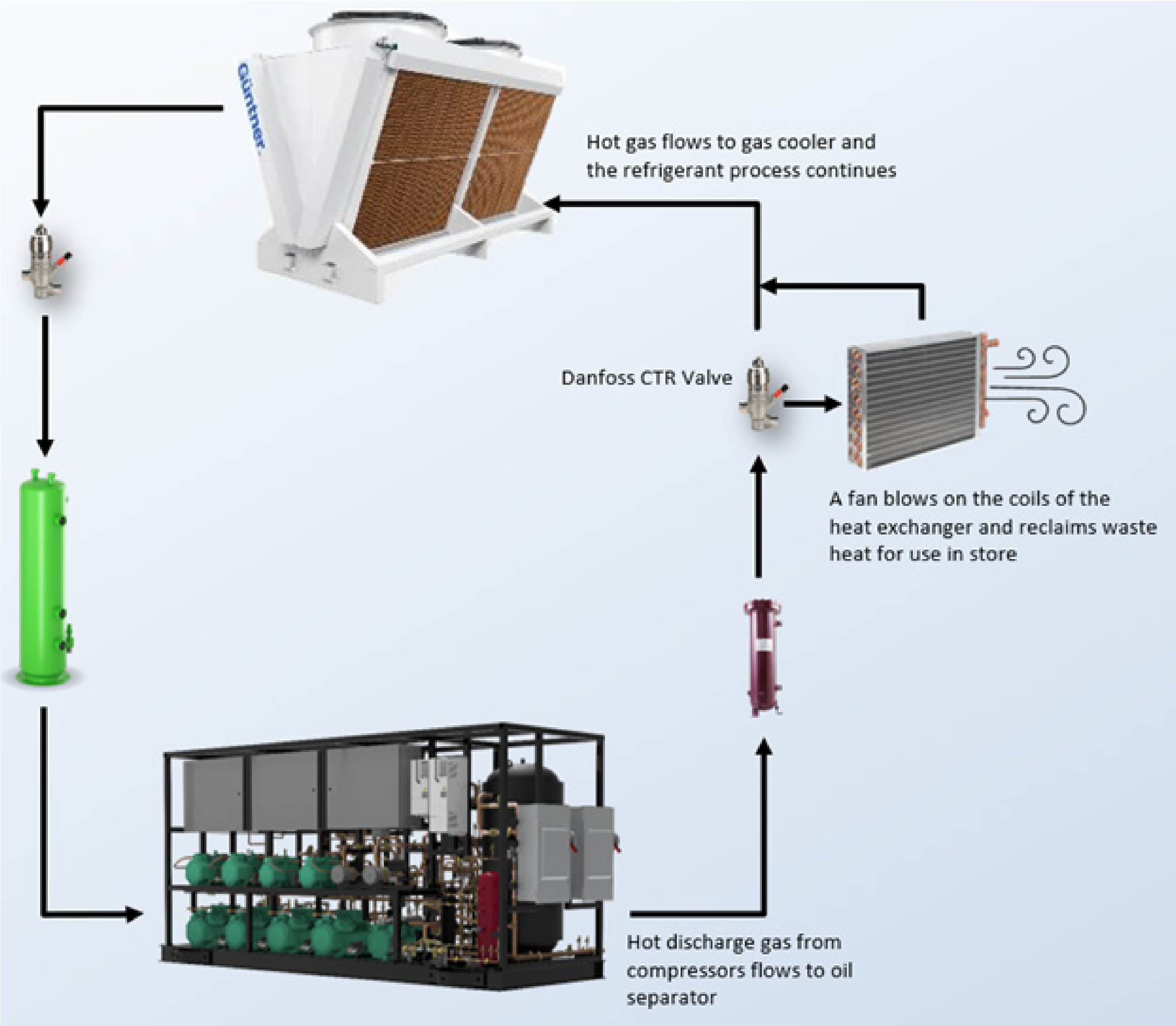
In transcritical CO_2 systems, the Danfoss CTR valve is specially designed for heat reclaim. It redirects the flow of CO_2 between two different circuits in order to recover heat from one circuit and transfer it to another. This valve can be used in refrigeration systems of any size, ranging from very small applications to large systems.

This CTR valve acts as a replacement for ball valves that have typically been used to regulate the flow of surplus heat from compressor pack to heat exchanger. It prevents pressure peaks in the system, eliminating system down time and the risk of insufficient heat supply for store heating and hot water.

How does a CTR Valve work?

The CTR valve plays a pivotal role in heat reclaim systems by efficiently controlling the direction of refrigerant flow between the refrigeration cycle and the heat recovery loop. In these systems, the CTR valve is placed on the line to the gas cooler, after the oil separator. The CO_2 then flows through the valve and is directed to the heat sink where it transfers the captured heat to be re-purposed for heating water, air, or other processes. Because this valve has three ports, by shifting the valve's actuator, refrigerant flow is directed either to the refrigerant system or the heat recovery system, depending on the operational requirements.

Air Heat Reclaim with Danfoss CTR Valve
Example:



GAS COOLER FAN CONTROL

The rack controller monitors the Ambient, Pad (when applicable) and Gas Cooler Outlet Temperature. The rack controller will calculate the temperature difference between the Ambient (or Pad if Adiabatic) temperature and the Gas Cooler Outlet Temperature. The gas cooler fan speed will increase to bring down the gas cooler outlet temperature and vice versa to maintain the design delta temperature (typically 10°F). The gas cooler outlet temperature is usually limited to around 45°-50° help maintain to a minimum discharge pressure. Also, the gas cooler outlet temperature is typically capped to around 80° to try to limit the amount of time in Transcritical. There may also be a setpoint (ambient or gas cooler outlet or pressure) to force the gas cooler fans on to 100 percent.

Most Gas Coolers are designed with fans that utilize VFDs or EC motors to allow for variable speed regulation. It is recommended to incorporate a 10-0v (rather than 0-10v) analog control signal to modulate the gas cooler fans. That way, if the control signal is lost, the gas cooler fans will be failsafe to 100% of their rated speed.

Some Gas Cooler manufacturers will provide a digital signal in the event of a general gas cooler fan alarm. This alarm should be communicated through the refrigeration controller to notify the refrigeration service provider. If the gas cooler alarm is the result of an EC gas cooler fan failure, the refrigeration controller typically commands the remaining operable gas cooler fans to run at 100 percent of their nominal speed.

Parameter	Value	Unit	Remarks
Gas Cooler Outlet TD Setpoint	3-9	°F	Typical Setting
Gas Cooler Outlet Temperature	41-100	°F	Typical Operating Range

Table: 5, Typical Gas Cooler Parameters

HIGH PRESSURE VALVE (HPV)

The HPV is controlled by the Rack Controller or dedicated controller such as the iPro or 326a.The controller will monitor the Gas Cooler Outlet Temperature and Gas Cooler Outlet Pressure. The HPV will switch control modes depending on the temperature or pressure leaving the Gas Cooler. The following modes of operation are ordered from high ambient to low ambient.

- **High Discharge -** If the pressure is at or above its maximum pressure setpoint, the HPV will abandon its COP Algorithm and maintain a high pressure setpoint (e.g., 1522psi).
- **Transcritical -** If the pressure and temperature indicate the system is in Transcritical, the HPV will maintain a pressure setpoint for optimal performance. This COP curve varies per manufacturer.
- **Transition -** If the pressure and temperature indicate the system is near the Transcritical and Subcritical region of CO_2, the controller will smoothly transition from one mode to the other.
- **Subcritical -** if the pressure and temperature indicate the system is sub-critical, the HPV will maintain a sub-cooled liquid in the Gas Cooler. The HPV will typically maintain a value between 3°F and 9°F.
- **HoldBack -** if the pressure is below the minimum pressure setpoint, the HPV will abandon the sub-critical algorithm and maintain the pressure setpoint (e.g., 650psi).

The HPV may also have features to protect the rack from a pressure relief event.

- **High Flash tank Pressure -** if the flash tank pressure is above the high-pressure limit, the HPV will start to close to give the flash tank pressure a chance to decrease. If the flash tank pressure is excessive, the HPV may close completely to prevent a pressure relief.
- **Low Flash tank Pressure -** if the flash tank pressure is below the low-pressure limit, the HPV will start to open to give the flash tank pressure a chance to increase. If the flash tank pressure is dangerously low, the HPV may open completely to try to pressurize the flash tank.
- **If the gas cooler outlet pressure is lost, failsafe to the remote discharge pressure.**
- **If the gas cooler outlet temperature is lost, failsafe the valve position to current position or the average position.**
- **If in the event either pressure transducer or temperature sensor is lost and the average HPV position is not known, set valve OD% to 50%.**

FLASH TANK

Most Flash Tanks are equipped with monitoring to determine how much liquid is in the tank(e.g.,analog level) or if the tank is low on liquid (e.g., low level switch). The low liquid level indication is accomplished using an optical sensor that is calibrated to sense liquid CO_2. This sensor provides an electrical signal (e.g., digital input)to the rack controller. The low-level switch is installed near the bottom of the flash tank (e.g., 20%) but above the dip tube where liquid is drawn from the tank. An alarm should trigger if the switch indicates low liquid.

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- **Low Flash tank Pressure -** if the flash tank pressure is below the low-pressure limit, the HPV will start to open to give the flash tank pressure a chance to increase. If the flash tank pressure is dangerously low, the HPV may open completely to try to pressurize the flash tank.

- **If the gas cooler outlet pressure is lost, failsafe to the remote discharge pressure.**

- **If the gas cooler outlet temperature is lost, failsafe the valve position to current position or the average position.**

- **If in the event either pressure transducer or temperature sensor is lost and the average HPV position is not known, set valve OD% to 50%.**

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FLASH GAS BYPASS VALVE (FGB)

The FGB Valve has a static flash tank pressure setpoint. The valve will open to relieve pressure from the flash tank. It is common for this valve to be closed under low load and low ambient conditions, opening periodically to relieve any pressure once above the flash tank pressure setpoint. It's recommended that the flash tank pressure maintain at least 75psi above the MT Suction Pressure to ensure proper oil pressure.

Parameter	Value	Unit	Remarks
Flash Tank Pressure Setpoint	500-530	psig	Typical Flash Tank Setpoint
Flash Tank Pressure	480-550	psig	Typical Operating Range

Table: 6, Typical Flash Tank Setpoints and Operating Ranges.

PARALLEL COMPRESSION

What is Parallel Compression?
Parallel compressor systems feature multiple compressors that work together simultaneously, each handling a portion of the system's refrigerant load.

The purpose of parallel/interstage compressors in a transcritical CO_2 system is to increase system efficiency, primarily in warmer ambient locations. In geographical locations where temperatures are around or above 87.8° F (31° C) for majority of the year, parallel/interstage compression could be an option.

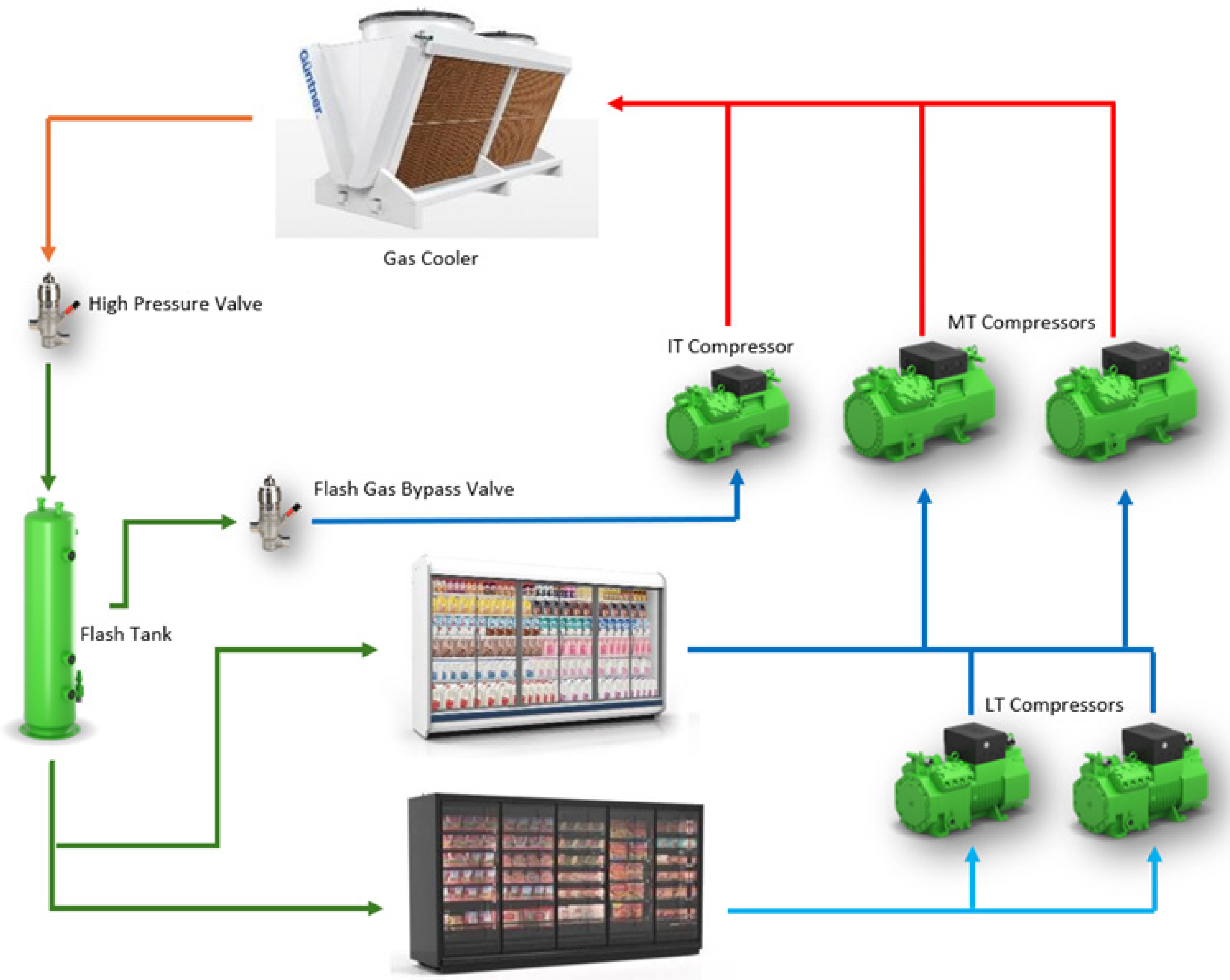
How Does Parallel Compression Work?
CO_2 refrigerant has a relatively low critical point in comparison to other refrigerants. A refrigerants critical point is the point at which it can no longer be condensed into a liquid. CO2 has a critical point of 87.8° F (31° C), meaning when the ambient temperature reaches around 87.8° F (31° C) (with a 10° F [5.6° C] temperature differential), the condenser/gas cooler will start producing flash gas (CO_2 vapor) rather than liquid. This is because the CO_2 is operating above its critical point, where the pressure and temperature are higher than those of the subcritical cycle. This results in a supercritical state where CO_2 behaves both like a gas and a liquid.

Because transcritical CO_2 systems produce flash gas in very warm ambient conditions, the system will see an energy penalty. Traditionally, the flash gas would flow from the flash tank through the flash gas bypass valve to the MT compressors to be compressed again. However, this results in additional work being placed on the MT compressors. One way to mitigate this is through parallel compression. When a parallel compressor is installed on a transcritical CO_2 system, instead of flowing the flash gas from the flash tank back to the MT suction, it will divert to the designated PC/Interstage (IT) compressors.

Utilizing parallel compressors enhances electrical efficiency by reducing the differential between suction and discharge pressures. The suction pressure for the MT compressors is approximately 425 psi, with a discharge pressure of around 1,200 psi. In comparison, the suction pressure for the IT compressor is higher, at approximately 580 psi, while the discharge pressure remains the same at 1,200 psi. Since the IT compressor operates with a smaller pressure differential, it requires less energy to compress the refrigerant, resulting in improved overall efficiency.

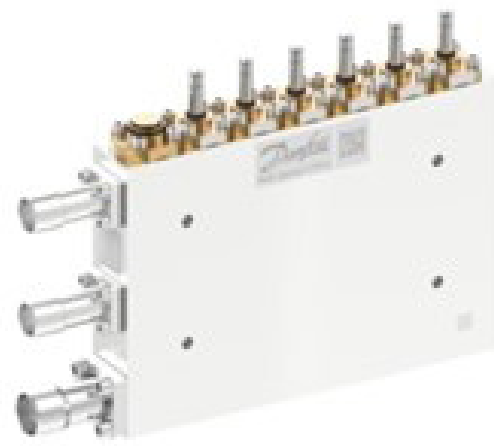
Parallel Compression System Diagram

Example:



DANFOSS CO_2 MULTI-EJECTOR

What is a Multi-Ejector?
Ejectors are used in transcritical CO_2 systems to improve energy efficiency across different climates based on system type.



An ejector is a device that utilizes the energy from the high-pressure work. The ejector converts the high-pressure potential energy in the motive flow (primary flow - gas cooler) into kinetic energy, drawing a flow from the suction port (secondary flow – MT evap outlet / suction accumulator).

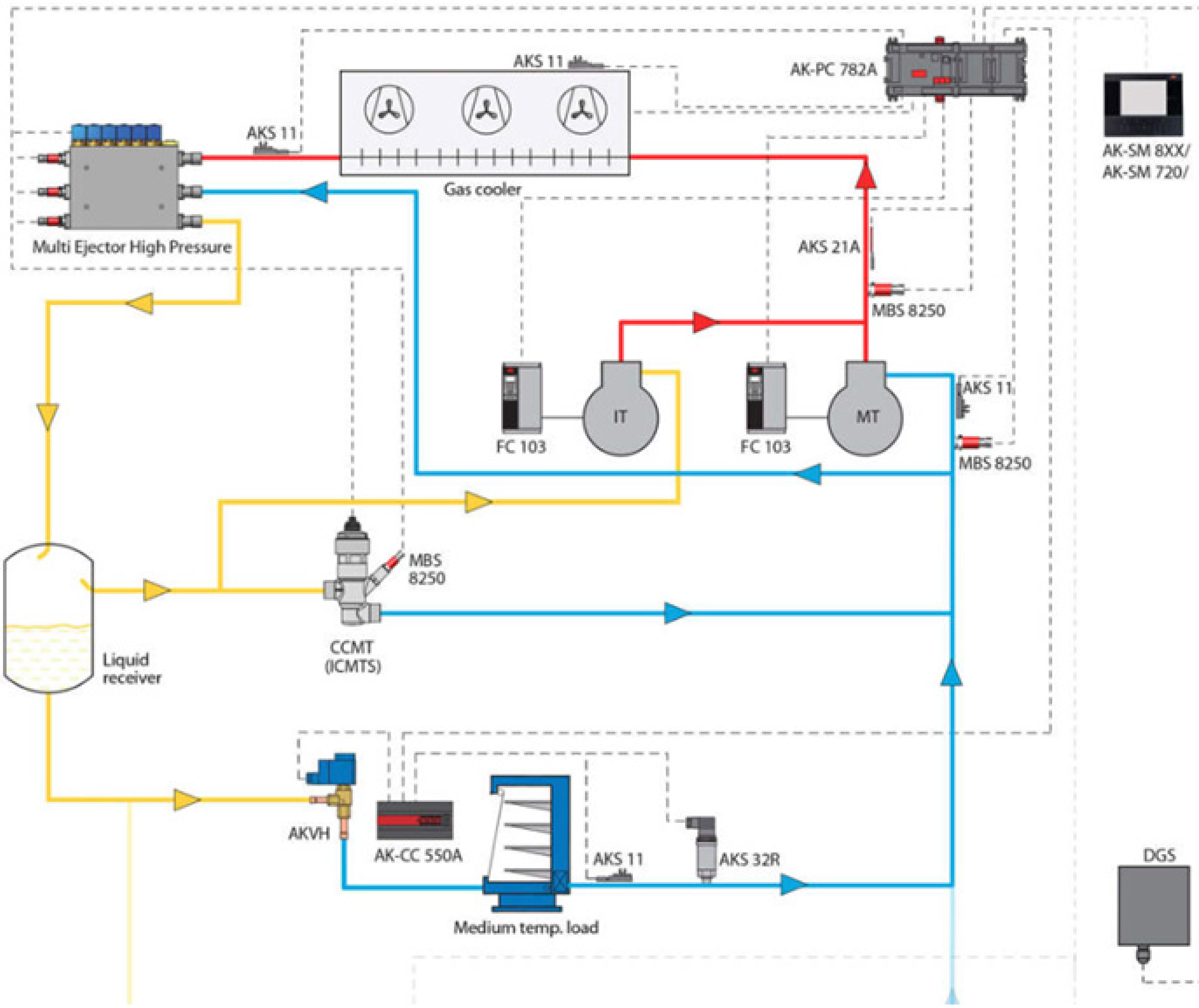
Ejectors are available in different types like low pressure (LP), high pressure (HP), liquid ejector (LE) and combi (HP/LE). Ejectors can be applied on CO_2 systems based on system configuration type—booster system or parallel compression system—and installation ambient type—warm or cold environment.

Combi-ejectors consist of both a liquid and high-pressure ejector on single block. Combi-ejectors can also exist as a combination of separate vapor and liquid blocks in the same system. Combi-ejector solutions are designed for CO_2 transcritical systems to lift gas and liquid from the MT suction accumulator and mix it with the gas coming from the gas cooler at a medium pressure level.

The CTM 6 multi-ejector consists of up to six cartridges built into one block. CTM multi-Ejector valves are approved for use only with Danfoss controller types AK-PC 782 A/B, AK-CC55, and AK-SM 8XXA.

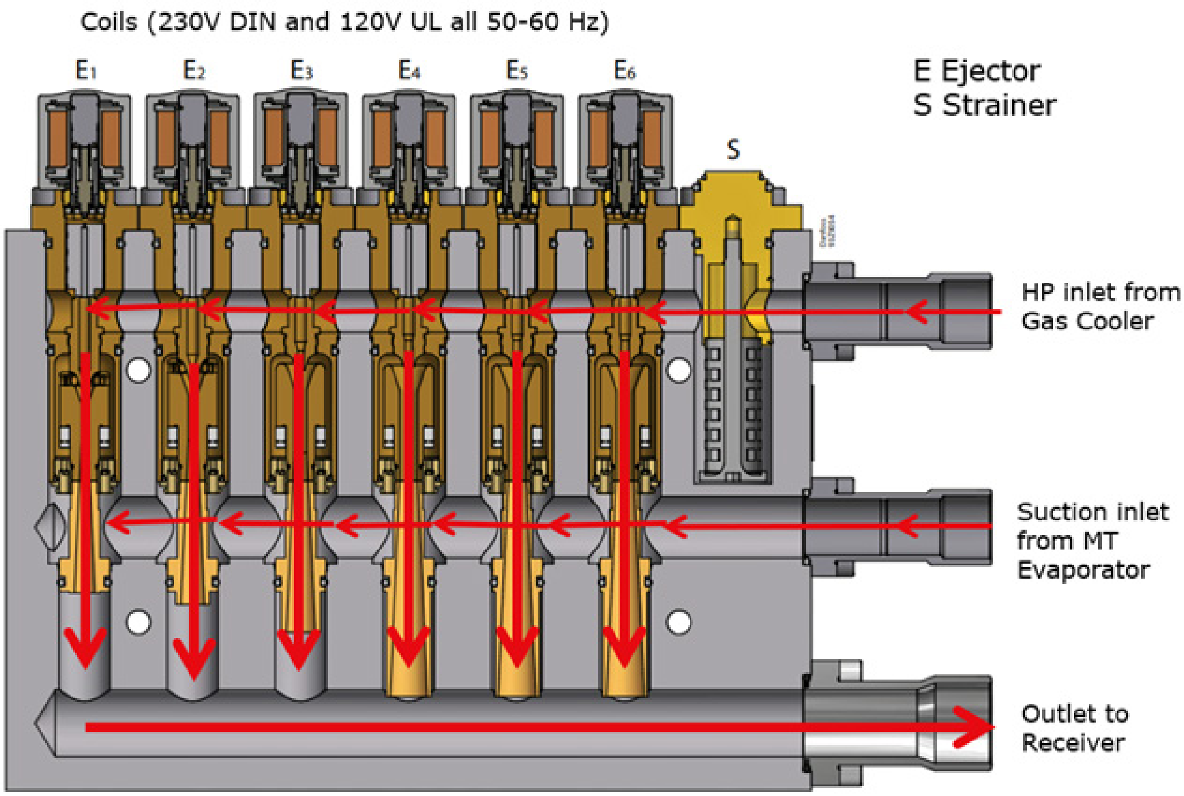
How Does a Multi-Ejector Work?

Example diagram:



How Does a Multi-Ejector Work? (cont.)

The high-pressure flow helps "lift" the low-pressure refrigerant, creating a mixture at a medium pressure. This process reduces the load on the main compressor since only a portion of the refrigerant is sent to it while the rest is directed to the parallel compressor, also known as the interstage (IT) compressor. By redistributing the refrigerant flow in this way, the multi ejector improves energy efficiency, reduces the work required from the main compressor, and ensures optimal system performance with lower overall energy consumption.



- The top port is the high-pressure inlet from the gas cooler
- The middle port is the suction inlet from the MT evaporator
- The bottom port is the outlet where the mixed refrigerant will leave the ejector and head to the flash tank

Operating Instructions
Regular monitoring and control are vital for maintaining optimal performance. Check pressure gauges and temperature readings routinely to ensure they are within the operational range. Utilizing a digital controller or monitoring system can help track performance metrics and facilitate adjustments as necessary.

Each individual ejector and the strainer are easily serviced by simply removing the four mounting screws, using a screwdriver to lift the ejector or strainer, and pulling it out of the block. The strainer can easily be taken apart for cleaning or replacement.

It is mandatory to clean the strainer after two days of running the system. O-rings need to be replaced with the two new ones placed on the strainer top. Removed O-rings need to be placed on the strainer top and reused after return to initial shape during next strainer maintenance. Strainer cleanliness is important for proper operation of the multi-ejector and cleaning should be repeated if necessary, every 2–3 weeks, to remove the dirt circulating in the system.

Please refer to the Danfoss CTM 6 Ejector Installation Guide for more information related to service on strainer and ejector.

Maintenance Guidelines
Conduct visual inspections monthly, looking for signs of leaks, unusual noises, and vibrations while regularly checking gauge readings. A more detailed inspection should take place quarterly, which includes checking connections, examining refrigerant lines, and cleaning the ejector. An annual comprehensive maintenance check should also be performed, involving the replacement of worn parts and recalibration of settings according to manufacturer specifications.

Keeping the ejector and surrounding areas clean is essential for proper airflow and to prevent overheating. Regular cleaning contributes to the overall efficiency of the system.

Troubleshooting Common Issues
Low efficiency can occur for various reasons, such as refrigerant leaks, blockages in piping, or incorrect refrigerant charge. Inspect for these issues, repairing leaks and clearing blockages as necessary to restore efficiency.

Unusual noises may indicate loose fittings or foreign objects within the ejector. Tightening connections and inspecting the ejector for debris can help resolve this issue. If pressure fluctuations are observed, they may result from an incorrect system charge or malfunctioning components. In this case, verifying the system charge and testing all components for functionality is essential.

Danfoss Contact Information
For further assistance, refer to the Danfoss HP Ejectors Product Guide or contact Danfoss customer support for specialized help.

LIQUID INJECTION

The Liquid Injection valve connects the Liquid Line to the MT Suction Header. The expansion valve will energize to help maintain the MT Suction Superheat or Discharge Temperature. A pulse width modulation expansion valve(e.g., Danfoss AKV, Sporlan SPW) is used to meter liquid refrigerant into the MT suction line. Control of this valve is based on the calculated MT Suction Superheat.

Ensure that during high superheat conditions the duty cycle(and valve selection)is appropriate to lower the suction superheat at full-load. For example, a cycle of 15s open with 45s closed may be sufficient.

Parameter	Value	Unit	Remarks
MT LI Superheat Setpoint	54	°F	Typical Superheat Setpoint
MT Discharge Temp Setpoint	280	°F	Typical Discharge Setpoint
MT Suction Superheat	20-40	°F	Typical Operating Range
MT Discharge Temperature	150-230	°F	Typical Operating Range

Table: 7, Typical Liquid Injection Setpoints and Superheat Operating Ranges.

HOT GAS DUMP (SUPERHEAT)

The Hot Gas Dump connects the MT Discharge to the MT Suction Header. The expansion valve will energize to help maintain the MT Suction Superheat. A pulse width modulation expansion valve (e.g., Danfoss AKV, Sporlan SPW) is used to meter hot gas into the MT suction line. Control of this valve is based on the calculated MT Suction Superheat.

Ensure that during low superheat conditions the duty cycle (and valve selection)is appropriate to increase the suction superheat at full load. For example, a cycle of 15s open with 45s closed may be sufficient.

Parameter	Value	Unit	Remarks
MTHGSuperheatSetpoint	20	°F	TypicalSuperheatSetpoint
MTSuctionSuperheat	20-40	°F	TypicalOperatingRange
SuperheatAlarmSetpoint	10	°F	Suctiongroupalarmonly

Table: 8, Typical Hot Gas Setpoints and Superheat Operating Ranges.

HOT GAS DUMP (FLASH TANK)

The secondary Hot Gas Dump Valve connects the MT Discharge to the flash tank. The valve will energize to help maintain the pressure in the tank under low load or low ambient conditions. A solenoid or expansion valve (e.g., Danfoss AKV, Sporlan SPW) is used to meter hot gas into the tank. Control of this valve is based on the flash tank pressure.

Ensure that during low ambient conditions when the HPV is nearly closed and flash tank pressure is decreasing, that the duty cycle (and valve selection) is appropriate to increase the flash tank pressure. For example, open the valve at or below 460psig and ensure it can raise the pressure by at least 30psig.

Parameter	Value	Unit	Remarks
Flash tank HG Setpoint	460	psig	Typically, 30psig below min. rec.SP
Flash tank HG Setpoint Diff	30	psig	Typical Differential

Table: 9, Typical Flash tank Hot Gas Setpoints

PHASE LOSS (MAIN FEED)

The PLM provides a digital input to the Rack Controller anytime the voltage is outside the nominal range of the system. When a PLM provides a contact closure, the rack goes into an emergency event. It is recommended that the digital input closure be provided with a 1-3 second programmed delay to prevent any false trips due to transient voltage on the cable or input board. A longer delay may be required to prevent an intermittent shutdown when the rack switches to generator power. It is recommended that the PLM module does not include any significant delays. The rack controller should incorporate those delays as part of its stage up sequence.

An emergency event can be triggered by multiple scenarios but all result in the same action. For example, a phase loss, high discharge pressure or all MT Compressors locked out for any reason results in an emergency event. During an emergency event all compressors will be kept off until the event clears, until which the system is allowed to go through the Circuit Stage-Up scenario. During this period, it is typical to have the HPV and FGB remain close, defrosts disabled, evaporator fans off and EEVs closed. This is to limit heat exposure (excess pressure) to the system and prolong the containment of CO_2 inside the Rack until the event clears.

PHASE LOSS (GENERATOR FEED)

When the Rack is equipped with a Generator Phase Loss Monitor, additional sequencing must be done in lieu of the typical Phase Loss Monitor sequence.

The refrigeration controller will monitor both the Main and Generator PLM. When the Main PLM indicates improper nominal voltage, the rack will shut down for a minimum period (typically 1 minute). During this emergency, any of the case controllers still powered will disable any defrosts, fans and close the EEV. After a short delay (typically 1 minute) of the Generator PLM indicating voltage is present, the rack will resume operation and follow its standard Stage Up sequence. When the rack is powered by the generator, the rack controller will disable any compressors not powered by the generator. When utility power is restored, the rack and case controllers will shut down to follow its normal stage up sequence momentarily (typically after a 1-minute delay).

COMPONENT OVERVIEW

CONTROL PANEL

The control panel contains all the necessary energy management components and motor controls factory-wired to the compressors. The interconnected compressors are cycled on and off by a central controller to match refrigeration capacity with load requirements.

Factory-wired control panel has:

- **Pre-wired distribution power block**
- **Individual component circuit breakers and contactors**
- **Color-coded wiring system**

Items supplied separately for field installation:

- **Liquid drier cores**
- **Vibration isolation pads**
- **Loose shipped items for accessories**
- **Suction filter cores**

ELECTRONIC OIL LEVEL REGULATORS

For any brand of electronic oil level regulator to work accurately, the unit and each compressor must be level. A sight glass filled with oil may indicate a damaged regulator.

GLOSSARY OF TERMS

Refrigerant
A fluid used to freeze or chill (as food) for preservation. A refrigerant, such as Carbon Dioxide (CO_2), is used to remove heat from cases and unit coolers and transfer the heat to the gas cooler.

Compressor
This is a device that compresses the refrigerant from a low pressure low temperature gas to a high pressure high temperature gas and provides mass flow of refrigerant throughout the system.

Pressure Relief Valve
The main pressure relief valves (652 psi/45 bar) and are designed to vent CO_2 at a low rate through a small orifice. Piping should not be added to the outlet of this device to prevent the possibility of dry ice from forming and reducing the ability for this valve to vent. These are ASME calibrated to vent and are also designed to re-seat after the pressure has reduced to approximately 586 psi (10% blow-down). This valve should not be replaced if it vents, only if it is not able to re-seat.

Liquid/Suction Heat Exchanger
This is a device built for efficient heat transfer between the liquid line and suction line of the primary refrigerant. This device also sub-cools the liquid refrigerant and aids in the complete evaporation of the suction gas.

Flash Tank
The flash tank is designed to separate the vapor and liquid phases of CO_2. Gravity causes the liquid to settle to the bottom of the Flash Tank where it is withdrawn to enter the inlet of the Liquid Line .

Electronic Expansion Valve
This is a device built to control the amount of superheat at the evaporator and the air temperature.

Liquid Filter Drier
This is a device designed to filter impurities.

ELECTRICAL INFORMATION

ELECTRICAL OVERVIEW

Custom wiring schematics are located on the doors of each rack. Racks are wired for 460/3/60. The control circuit is separately fed 120 VAC. Refer to the serial plate located on the control panel to determine MCA MOPD. Refer to merchandiser Data Sheets for electrical supply requirements for cases.

FIELD WIRING

Rack components are wired as completely as possible at the factory with all work completed in accordance with the National Electrical Code (NEC). All deviations required by governing electric codes will be the responsibility of the installer.

The lugs on the circuit breaker package in the compressor control panel are sized for copper wire only. All wiring must be in compliance with governing electrical codes.

REQUIRED FIELD WIRE SIZE

Based on the full load amps of the system, select the largest connectible wire size from the table. (Based on no more than three wires in the wireway and 30°C environment per NEC.) Total Connected FLA Largest Connectible Wire:

140A (max) 00 per 248A (max) 350 mcm
408A (max) 2x (250 mcm) per 608A (max) 2x (500 mcm) per

Include control circuit amps if single point connection transformer option is used. 12A for 208V systems 6A for 460V systems (Refer to NEC for temperature duration factors.)

MERCHANDISER ELECTRICAL DATA

Technical data sheets are included with this manual. The data sheets provide merchandiser electrical data, electrical schematics, parts lists and performance data. Refer to the technical data sheets and merchandiser serial plate for electrical information.

MERCHANDISER FIELD WIRING

Field wiring must be sized for component amperes stamped on the serial plate. Actual ampere draw may be less than specified. Field wiring from the refrigeration control panel to the merchandisers is required for defrost termination thermostats and for optional refrigeration thermostats. When multiple display cases are on the same defrost circuit, the defrost termination thermostats are wired in series.

ALWAYS CHECK THE SERIAL PLATE FOR COMPONENT AMPERES.

ELECTRICAL CONNECTIONS

All wiring must be in compliance with NEC and local codes. All electrical connections are to be made in the electrical wireway or Handy Box.

ELECTRICAL DIAGRAMS

All electrical schematics reflect the standard ladder diagram. Electrical schematics are included with each rack. Please keep in mind all diagrams in this manual are only examples! Wiring may vary, refer to the diagram included with each rack. To focus on circuit logic the diagram may separate a relay coil and its contacts. Electrical terminal connections are clearly numbered and aid in trouble shooting should a problem arise.

Cooler Door Switch Wiring
Check the store legend for door switch requirements. The switch must be mounted to the cooler door frame and must be wired to control the electronic expansion valve and the fan circuit.

COMPONENT WIRING GUIDELINES

Check the store legend for components requiring electrical circuits to either the panel, which may include:

- **Remote alarm**
- **Electronic temperature probe**
- **Defrost termination thermostat**
- **Heat reclaim contact or 24V supply**

1. Disconnect all power sources, and if the equipment has a dual power source, disconnect both and follow NEC guidelines when installing wires or changing components.
2. When running control wires for a 120 V separate power circuit, the voltage rating of the wire should be at least 600V.
3. Use caution not to damage any assembled wires during installation and when removing the knockouts. Use appropriate bushings so that no nick or burr could cause insulation damage.
4. Ensure the appropriate length of wire is used, and when running the wires, allow adequate spaces and creepage distances as permitted by NEC.

All thermostat wires should be sized for rack control circuit breaker. Temperature sensor wiring should refer to the controller manufacturer’s literature. Check field wiring requirements for appropriate quantity of wires.

Sizing Wire and Over-current Protectors Check the serial plate for minimum circuit ampacity (MCA) and maximum over-current protective devices (MOPD). Follow NEC guidelines.

Other Controls
Refer to the wiring schematics included with the rack, when other controls are used.

COMPRESSOR CONTROL

Each control panel is wired with independent compressor control circuits so any compressor can be electrically isolated without causing the other compressors to be shut down. A typical compressor control will consist of the following:

- **Electrical control**
- **Low pressure switch**
- **High pressure switch**
- **Oil pressure switch**
- **Overload contact (if used)**
- **Contactor coil**
- **Crankcase heater (optional)**
- **Lighted toggle switch**

- Terminal pins will be used between control points for easy testing and troubleshooting.

ELECTRONIC CONTROLLER

The electronic controller uses a suction transducer to "read" the suction manifold pressure. From this, sequence compressors on or off through a relay board to achieve the target suction pressure.

TIME DELAY

Automatic time delays are built into most electronic controllers. This helps avoid short cycling.

PRESSURE SWITCHES

There are basically two pressure switches in the compressor control circuit. A low-pressure switch is used to close the control circuit during high suction and open the circuit during low suction pressure. A high-pressure switch is used to open the control circuit during a critical high discharge pressure state. The high pressure switch is available in automatic reset.

*For proper setting of switches see control settings section.

CRANKCASE HEATERS

A crankcase heater is used to alleviate liquid migration to the compressor during off cycle periods. The crankcase heater is interlocked through the compressor contactor and is to be powered when the compressor is not running.

DEFROST CONTROLS

There are many types of defrost circuits and they are usually controlled by the case controller.

TEMPERATURE CONTROLS

Refrigeration

The control of the evaporator is performed via case controller. The case controller is capable of managing both the air temperature and the superheat of the coil using the electronic expansion valve. When a stepper type expansion valve is used, it's recommended to install a liquid line solenoid prior to the valve in case of power failure so the evaporator does not flood back to the rack.

ALARM CONTROL

Alarm System
The rack basic alarm package includes alarms for:

- **Oil Failure (each compressor)**
- **Phase Loss**
- **Low Liquid Level***
- **High Suction Pressure***
- **High Discharge Pressure**
- **Compressor Failure**
- **High Flash Tank Pressure**
- **Low Flash Tank Pressure**

Ladder diagrams emphasize the circuit continuity and logic. They aid troubleshooting and testing by identifying point-to-point connections, and color coding rather than just physical location. A ladder diagram normally moves from left to right so the user can "read" the series of switches, relays, terminals and components that make up a circuit.

Alarm Control (Electronic)
When an Electronic Rack Controller is utilized all alarm functions are performed by the rack controller. High suction and high discharge pressures are "read" by transducers connected to the rack controller. The liquid level is a digital input.

Phase loss, oil failure, and the compressor failure alarms are connected to the rack controller through a digital input. An optional modem can be installed to allow the rack controller to call out any refrigeration alarms.

Alarm Systems

The following alarms are available for use with the CO_2 system:

1. Refrigerant Loss Alarm/Indicator: An alarm trips if the refrigerant level in the flash tank drops below a set level. This alarm automatically compensates for changes in liquid level occurring during heat reclaim.

2. Single Phase Protection: This shuts down the control circuit during single phasing of the power circuit; automatically resets when three phase power is restored.

3. Remote Alarm: In event of a power outage or any alarm condition, an alarm will sound at another location, such as a burglar alarm monitoring station or answering service.

INVERTER CONTROL

An inverter is used to vary the speed of a compressor which in turn varies the capacity of that compressor. With the ability to vary the capacity of a compressor, refrigeration requirements can be better matched to the load.

EVAPORATOR MOUNTED LIQUID LINE SOLENOID

Power for a liquid line solenoid in the merchandiser can be picked up from the fan circuit. (Check fan motor and solenoid voltages first.)

COOLER DOOR SWITCH WIRING

Check the store legend or electrical plans, for door switch kits. The switch must be mounted to the cooler door frame and must be wired to control the electronic expansion valve and evaporator fans. Door switches are wired in series.

SIZING WIRE AND OVER-CURRENT PROTECTORS

Check the serial plate for Minimum Circuit Ampacity (MCA) and Maximum Over-current Protective Devices (MOPD). Follow NEC guidelines.

COMPONENT REFERENCE DOCUMENTS

Parker Sporlan Literature Site

Mobile Apps for Emerson Product Support

Sporlan MTW Valve

Sporlan EEV

Emerson OMB Oil Control

Westermeyer Liquid Level

Danfoss

Kriwan / Delta Oil Switch

Kriwan / Delta Oil Sensor

Temprite Coalescent Oil Separator

Standard Filter Install

Temprite Clean up

CPC

VFD M-400 Parameter Sheet

POP-OFF Pressure Relief Valves

- **Refrigera** A15504-650 - Hussmann p/n 3084831
- **Bitzer** Compressors 30bar (435psi) Bitzer Part number 361100-34 and 148 bar (2146psi) Bitzer Part Number 361114-08

MAINTENANCE & SERVICE

OIL CHANGES

Oil Changes should be accomplished following the procedure below: See Temprite step by step instructions for 133A, 135A, 137A, 138A, 139A Series Coalescent Oil Separators and the following page.

AFTER STARTUP 8-12 HOURS

1. After the rack has run loaded 100%, clean the oil supply line strainer.
2. Verify all evaporators and compressor superheats for any flood-back and resolve.
3. Check for excessive pressure drops (assuming all circuits are running).
4. Under normal operating conditions, measure and record compressor amp draw.
5. Measure and record defrost electric heaters.
6. Review compressor cycle counts not to exceed 6 starts per hour.
7. Review HPV & FGB for excessive modulation.
8. Verify Oil Separator Drain Solenoid is cycling and draining properly.
9. After a shutdown, verify circuits are staged sequentially without excessive increase in suction pressure. If excessive pressure increase occurs, adjust staging sequence accordingly.
10. Leak test the Rack, Gas Cooler and piping with a CO_2 Leak Detector.
11. Verify all defrost lengths, times, and scheduling across the 24 day is appropriate.
12. Always check that each case after defrost the temperature exceeds 32°F in the evaporator and the coil is clear.
13. If the coil is not clearing using the recommended defrost settings call Hussmann for review.
14. Ensure that all the programming is finished and well understood by the servicing contractor.
15. Ensure that all temperature sensors and pressure sensors are well calibrated.
16. Ensure all control panels are closed.
17. Record CO_2 level in flash tank for future reference (e.g., bottom sight glass, center sight glass etc.).
18. Fill out the startup form and send it to Hussmann no later than 3 weeks after start up.
19. Check the pressure drop across the oil separator. Replace if it exceeds 10psid.

AFTER STARTUP 48 HOURS

1. After the rack has run loaded 100%, clean the oil supply line strainer.
2. Verify all evaporators and compressor superheats for any flood-back and resolve.
3. Review compressor cycle counts, not to exceed 6 starts per hour.
4. Verify Oil Separator Drain Solenoid is cycling and draining properly.
5. Record CO_2 level in flash tank for future reference. e.g., bottom sight glass, center sight glass etc.
6. Replace both Liquid and Suction filters.
7. Test oil for moisture and acid contamination.
8. Check the pressure drop across the oil separator. Replace if it exceeds 10psid.

AFTER STARTUP 30 DAYS

1. After the rack has run loaded 100%, clean the oil supply line strainer.
2. Verify all evaporators and compressor superheats for any flood-back and resolve.
3. Review compressor cycle counts, not to exceed 6 starts per hour.
4. Verify Oil Separator Drain Solenoid is cycling and draining properly.
5. Record CO_2 level in flash tank for future reference. E.g., bottom sight glass, center sight glass etc.
6. Replace Liquid core.

TEMPRITE INSTRUCTIONS

Temprite®

Installation Instructions for Models 133A, 135A, 137A, 138A,139A Accessible Coalescent Oil Separators

130 Series coalescent oil separators have a factory-installed Standard Filter. Remember: Temprite Standard Filters pick up all dirt and particulates down to 0.3 microns; typical filters catch only 50 microns or larger.

1. Locate the separator in a warm, draft-free area, or wrap separator with insulation.
2. Install the separator in a vertical position, close to the compressor, in between compressor and condenser, upstream (before) any bypass piping.
3. Special consideration should be given to the location so that future filter replacement or service is not impeded.
4. Clamp and support the separator and piping properly to minimize vibration.
5. Discharge lines into and out of the separator must be the same size as the separator connection size.
6. Install pressure taps in these lines for reading pressure drop across the separator.
7. Charge the separator with the recommended amount of oil through the oil return connection before installing or starting the system.
8. If the oil separator is lower than the condenser, take precautions to keep liquid refrigerant out of the separator.
9. Frequently check oil level and pressure drop across the separator on new installations.
10. Change the filter after an initial 24 to 48 hours of operation or if the pressure drop across the separator exceeds 13 PSI/0.9 bar. See filter replacement instructions.
11. Change the filter if dirt loading causes a pressure drop of 13 PSI/0.9 bar differential across the separator.

For translations of these instructions, go to our website: click here or scan the QR code.

Questions? Call 1-800-552-9300 or 630.293.5910 or email us at temprite@temprite.com

COMPRESSOR REPLACEMENT

Since each machine room or rooftop unit tends to be unique, plan carefully as to how you will move the compressor without harming personnel, equipment or the building. Before beginning removal of an old compressor make replacement unit ready to install:

1. Verify replacement compressor electrical requirements, refrigerant, application, capacity, piping hookup location and design suction and discharge gaskets.

2. Mounting requirements: Have compressor in an easily accessible position, uncrated and unbolted from shipping pallets.

3. Disconnect electrical supply: Turn off motor and control panel power supplies to the Rack. Turn off control circuit and open all compressor circuit breakers. Tag and remove electrical wires and conduit from the compressor.

4. Isolate compressor from rack: Front seat suction and discharge service valves. Close oil supply and equalizing lines. Bleed compressor pressure through both discharge and suction access ports into an approved recovery vessel.

5. Remove oil supply and equalizing lines. Remove externally mounted components which will be re-used on the replacement compressor. Plug holes to compressor manufacturer's specifications.

6. Remove bolts from suction and discharge service valves.

7. Remove mounting bolts: When moving the compressor, use a come-along, hoist or hydraulic lift to carry the weight.

- **Do not use the rack piping or panel to support a hoist or come-along.**
- **Do not use ceiling trusses to support a hoist or come-along.**

The rear support channel on the rack or a properly constructed ceiling rail may be used to support a hoist or come-along. To make hookup and lifting easier, an eye bolt may be installed in the rear top of the compressor head.

If a compressor removal table is used, slide the compressor fully on to the table, then roll table to overhead hoist or hydraulic lift area. When the old compressor has been removed, clean the suction and discharge service valve gasket surfaces to shiny metal. Clean the gasket surfaces on the new compressor to shiny metal. Be careful not to groove or round the surfaces. Gasket surfaces must be clean to prevent leaking.

Install the new compressor in reverse order of removal. Do not open the new compressor to the system until after it has been leak tested and triple evacuated.

NOTE
Oil level regulator sight glasses are designed to provide a hermetic seal when internally pressurized. Some leaking may occur when a deep vacuum is pulled.

GENERAL MAINTENANCE

Regular inspection and upkeep is critical to operation of the rack. Because of the numerous options and accessories that are unique to each store, it is impossible to list all of the maintenance guidance for individual systems.

Maintenance must be performed by a well qualified technician to diagnose and prevent problems before they may occur. The information below is a general guideline. Recommended service intervals in your area may vary depending on the operating environment and equipment used. Contact your Hussmann representative for further information.

Generally, the following items should be checked on a weekly basis:

- **System Pressures**
- **Main Power Voltage**
- **Oil Levels**
- **Flash Tank CO_2 Level**

Generally, the following items should be checked on a monthly basis:

- **Oil separator pressure drop**
- **System pressures**
- **System leak tests**
- **All filters and drier cores**
- **Insulation, conduit, electrical boxes and control panels**
- **Secondary systems, and accessories**
- **Fan motors, contactors and electrical connections**
- **Check for tightness of fittings, fan blades and motor mounts**

Generally, the following items should be checked on a quarterly basis:

Investigate operating conditions for the following:

- **Suction, liquid, and discharge pressures and temperatures**
- **Sub-cooling, superheat and ambient temperatures**
- **Safety controls, operating controls and alarms**
- **Amperage coming from compressors**

Each year, check the following:

- **Clean the gas cooler coil or pads when applicable in accordance with the manufacturer's instructions.**
- **Straighten or replace all fan blades**
- **Change the filter drier and suction cores**
- **Get an oil sample and determine the quality and change if required**

DRIER AND FILTER CORES REPLACEMENT

Isolate the core to be replaced and bleed off pressure to outside. Open housing, replace core and close up. Pressurize, leak test and bring back into line.

WARRANTY INFORMATION

HUSSMANN®

To obtain warranty information or other support, contact your Hussmann representative or visit:
https://www.hussmann.com/services/warranty.

Please include the model and serial number of the product.

For questions about your equipment please contact our Technical Support Team 1-866-785-8499

For General Support or Service Calls contact our Customer Support Call Center 1-800-922-1919

For ordering Aftermarket Warranty Parts 1-855-Huss-Prt (1-855-487-7778)
Hussmann_part_warranty@hussmann.com

SQUARE D HOTLINE 888-SQUARED (888-778-2733)
Tech Support Line. Level One provides product initial tech support and can connect the caller to Level 2, if required.

REVISION HISTORY

Revision A - August 2023 - Original Issue
Revision B - October 2024 - Added charging and pressure relief valve images. Added pressure relief valve installation information. Added pre-startup checklist guide.
Revision C - December 2024 - Updated charging section.
Revision D - March 2025 - Updated piping diagram. Added CTR valve, parallel compression, and multi-ejector sections.