Natural Refrigerant Training Summit

Building a Sustainable Workforce

Co2 Installation and Service

Dale Sizemore

Kysor Warren/Epta

NORTH AMERICAN Sustainable Refrigeration Council

NORTH AMERICAN Sustainable Refrigeration Council

CO2 REFRIGERATION
TRANSCRITICAL BOOSTER SYSTEM
Installation and Service

Dale Sizemore
Director, Technical Services

KYSOR WARREN
eptarefrigeration

TABLE OF CONTENTS

CASE SET UP

KYSOR WARREN
eptarefrigeration

Electronic Expansion Valve (EEV)

- Pulse – open-close
- Steeper – modulating*

Pressure Transducer (PT) Required

Superheat Control Required (TS)

Valve Stations

- Supply and Return

Case Controller

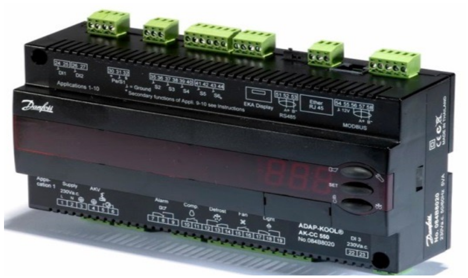
Defrost

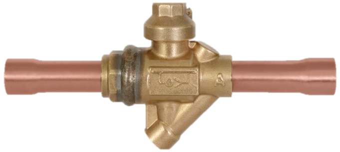
- Electric (LT commonly)
- Off Time (MT commonly)

Liquid Supply Temp

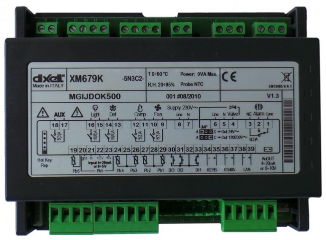
- MT & LT 36F (30F-38F)

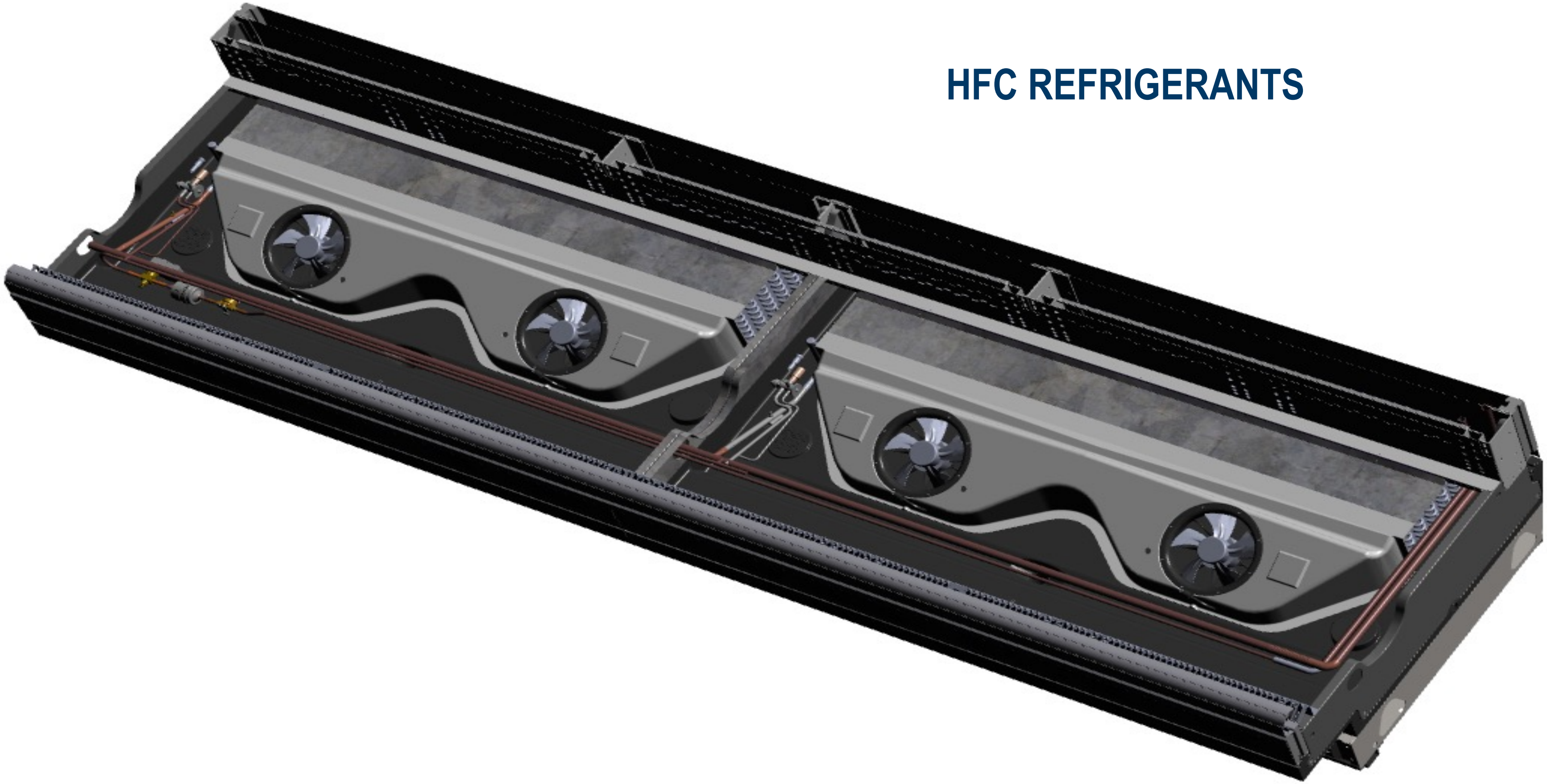
Design Pressure 655 Psi (45 Bar)





Ball valve with check bypass
- Supply
- Return



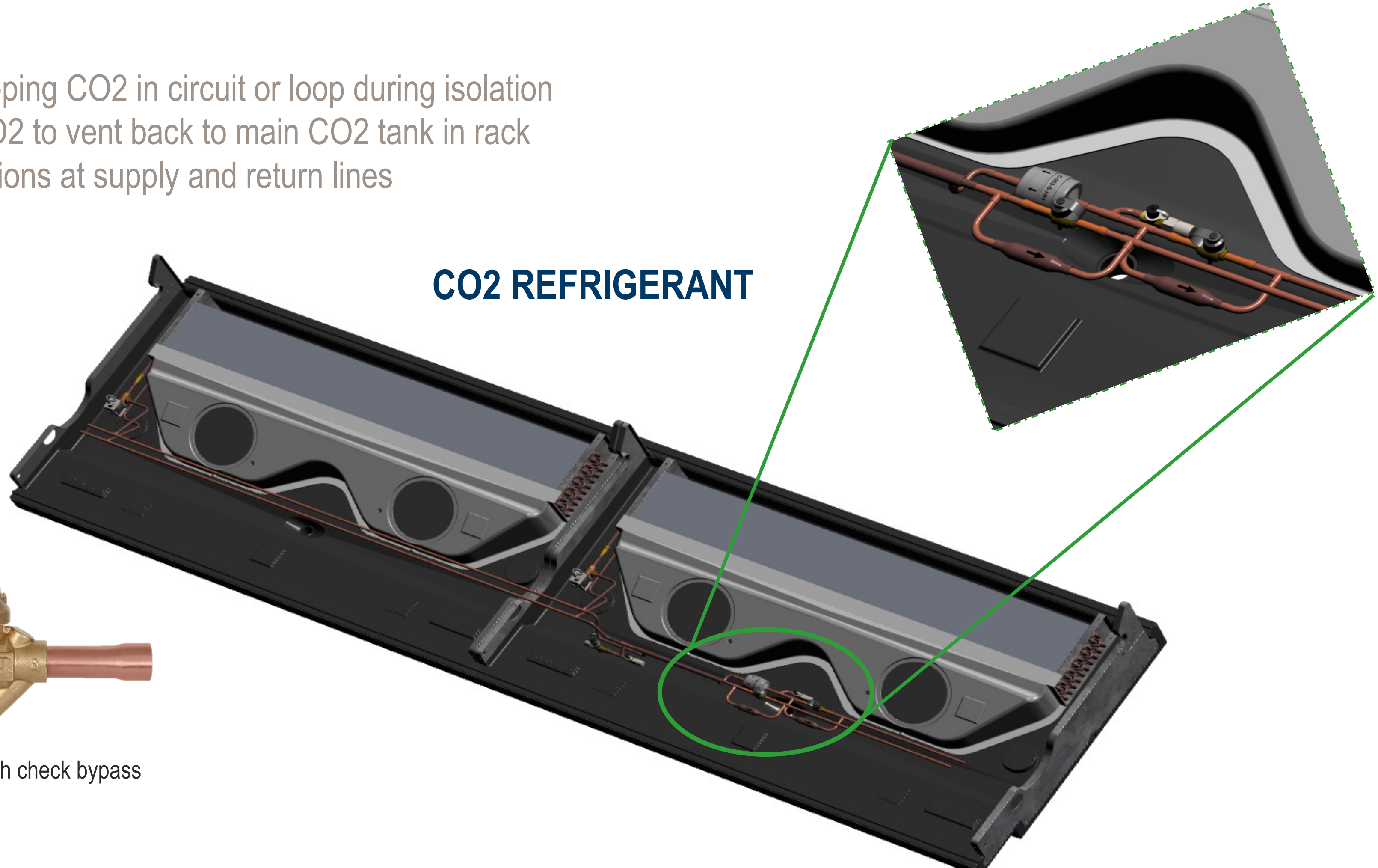


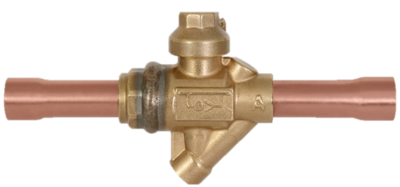
HFC REFRIGERANTS

SAFETY

- Avoid trapping CO_2 in circuit or loop during isolation
- Allows CO_2 to vent back to main CO_2 tank in rack
- Valve stations at supply and return lines

CO_2 REFRIGERANT



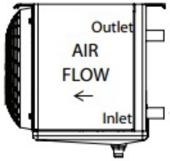


Ball valve with check bypass
- Supply
- Return

CASE & UNIT COOLER COILS

SUBSYSTEM AND COMPONENTS

- Because CO_2 systems operate at higher pressures than other refrigerant systems
- Tubing and pipe used in the evaporator is the main determinant of its pressure bearing capability
- Case and unit coils are optimized specifically for CO_2 applications



SYSTEM INSTALLATION

KYSOR WARREN
eptarefrigeration

DOCUMENTATION

The following are general guidelines for installing the CO_2 Transcritical Booster Refrigeration system:

- "Safety Standard for Refrigeration Systems" (ANSI/ASHRAE Standard 15)
- "Refrigeration Piping Standard" (ASME B31.5)

GENERAL INSTRUCTIONS

- ☑ A minimum of 1" insulation recommended for all Medium and Low temperatures lines
- ☑ Straps and support tubing are used to prevent excessive line vibration and noise (where required)

PIPING LINE SIZE

- ☑ Piping lines are installed according to the drawings, customer specs.

PICTURES

CO2 as a refrigerant has a higher density and pressure compared to other conventional refrigerants. Thus the pipe sizes are smaller compared to other refrigerant systems.

Section	Max Pressure psi (bar)	Max Temp °F (°C)	Material
MT Discharge to HPV Inlet	1740 (120)	+320°F (+160°C)	CuFe2P (C19400 Alloy) 120 Bar rated tubes supplied as Wieland K65™ or Mueller XHP™
HPV Outlet to EEV (Cases & Unit Coolers)	655 (45)	+35°F (+1.7°C)	Mueller Streamline Copper rated to 700 psi (48 Bar) @250°F up to OD1-1/8" - L type Soft OD1-3/8" - L type Hard OD1-5/8" to 2-5/8" - K type Hard
Flash Tank	655 (45)	+35°F (+1.7°C)	
Medium Temp. Suction Line	655 (45)	+25°F (-3.9°C)	
Flash Gas Return Line	655 (45)	+35°F (+1.7°C)	
Liquid Supply	655 (45)	+35°F (+1.7°C)	
Low Temperature Suction Line *	435 (30)	-22°F (-30°C)	

Mueller Streamline ACR Piping can be used for all store piping; otherwise, the installer must have the following provisions:

- ☑ Pipe and fitting material identification in inventory
- ☑ Pipe and fitting material identification of installed piping
- ☑ Callout of pipe and fitting material in store drawings
- ☑ Copper Tube can be rated for 435 psig (30 bar)
  - ☑ **up to OD1-3/8" - L type Soft**
  - ☑ **up to OD2-1/8" - K type Soft**

DESIGN PRESSURE REQUIREMENTS
SYSTEM INSTALLATION

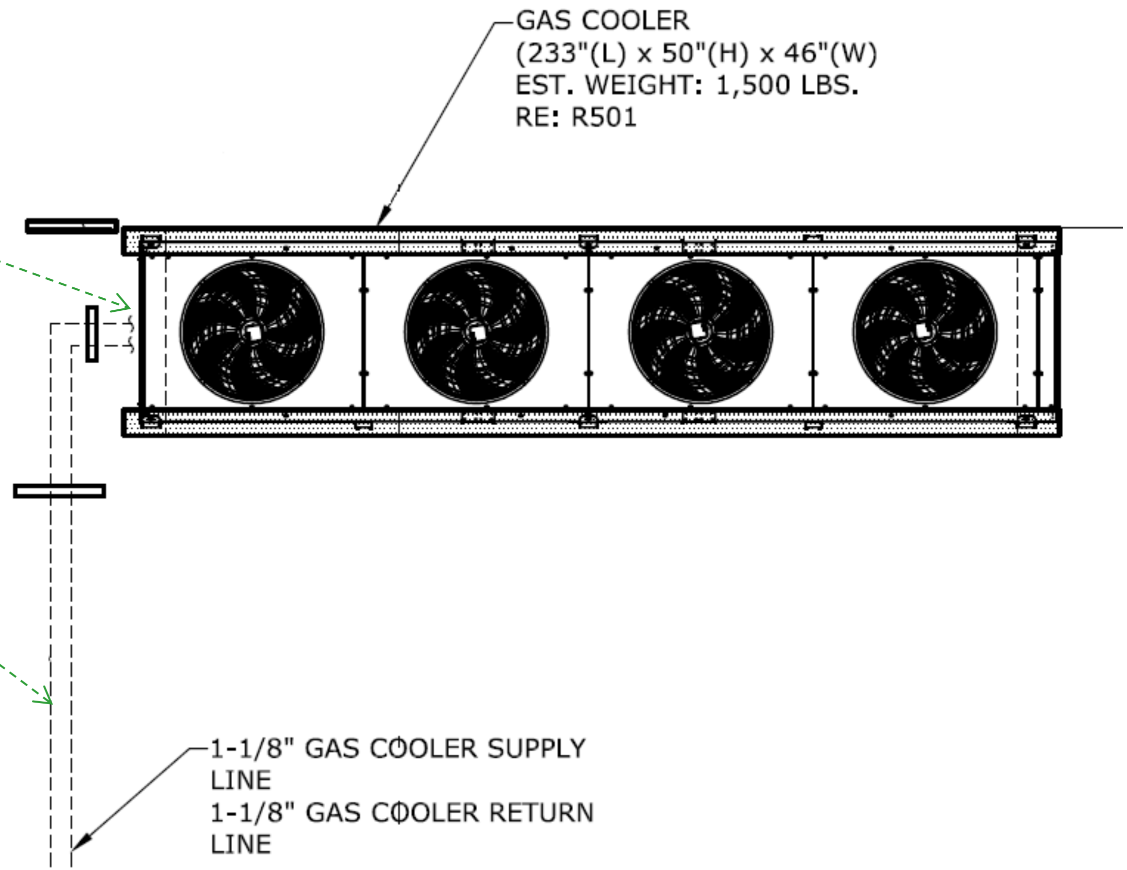
Description	Working Pressure	Components	Design Pressure
Low Side	188 to 218 psig (13 to 15 bar)	• LT Cases • LT Suction Piping	435 psig (30 bar, 28 bar for scroll compressors)
IM Press Stage – MT Suction	377 to 435 psig (26 to 30 bar)	• MT Cases • MT Suction Piping • LT Discharge Piping	652 psig (45 bar, 43 bar for scroll compressors)
IM Press Stage – Liquid Line	493 to 551 psig (34 to 38 bar)	• Case EEVs • Liquid Supply Piping	652 psig (45 bar)
High Side	652 to 1495 psig (45 to 103 bar)	• Gas Cooler • MT Discharge Piping	1740 psig (120 bar)

GAS COOLER PIPING

SYSTEM INSTALLATION

Pressure Relief Valve, Angle Valve and Ball Valve installation

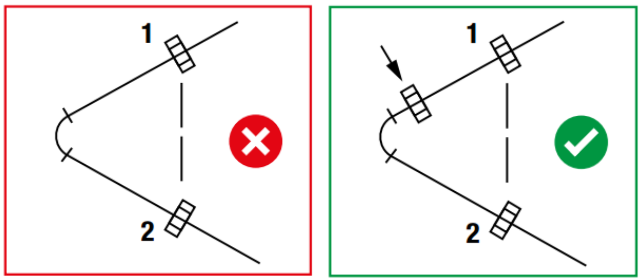
Gas cooler supply & return lines. Refrigeration contractor to source Mueller Industries XHP or Weiland K65 120BAR Copper-Iron piping for installation on “high-side” of system



PIPING INSTALLATION TIPS

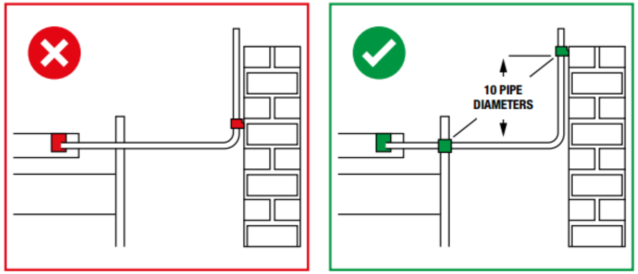
PIPING

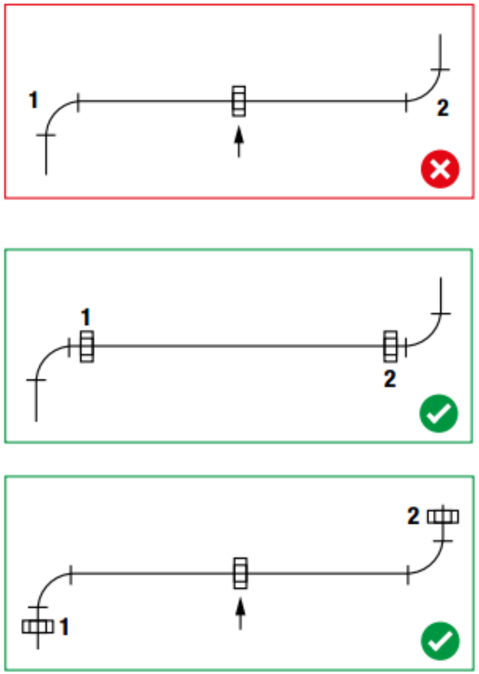
Piping dimensions and capacities meet or exceed maximum operating pressure and temperatures



There is adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection

Pipe sleeves are used through walls, floors, and ceilings, electrical





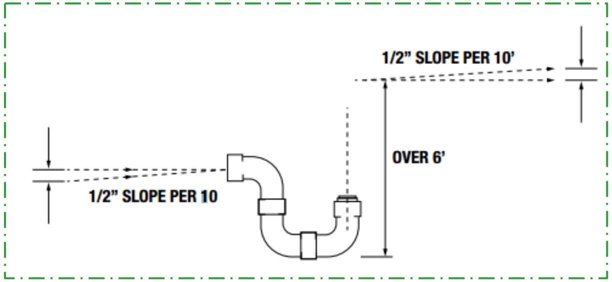
CO2 Case and Unit Cooler piping is similar to the other existing conventional refrigeration systems.

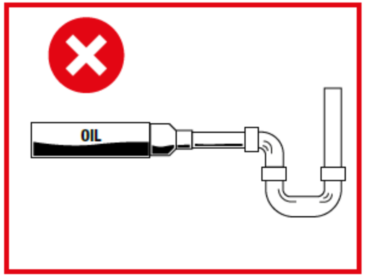
LIQUID LINES

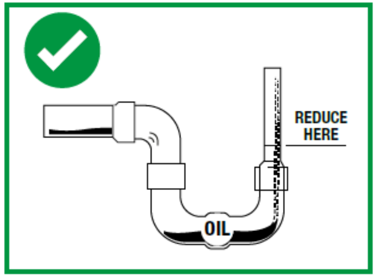
Liquid lines are sized for a minimum pressure drop to prevent flashing that would create additional pressure drop and poor expansion valve operation

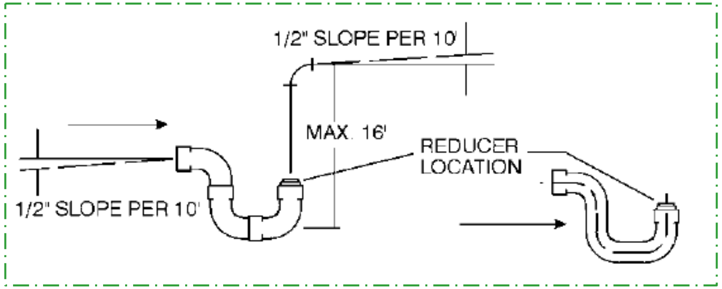
SUCTION LINES

- ☑ Any suction line that travels vertically and the direction of refrigerant flow inside it is against gravity, is called a suction riser
- ☑ Refrigerant flowing through suction risers are unable to carry the lubrication oil through the pipes to the compressor due to the low flow velocity. Oil traps are designed into the suction risers.

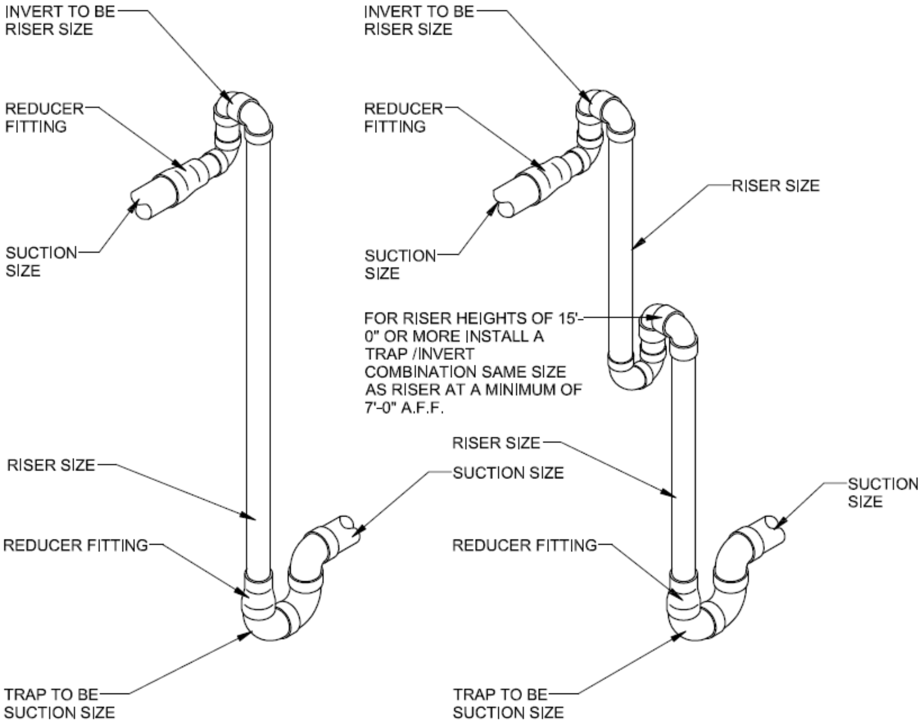






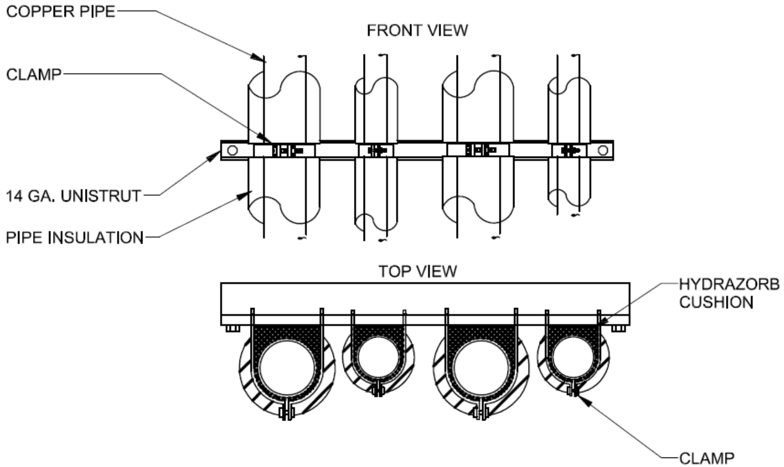


TYPICAL TRAP AND INVERT



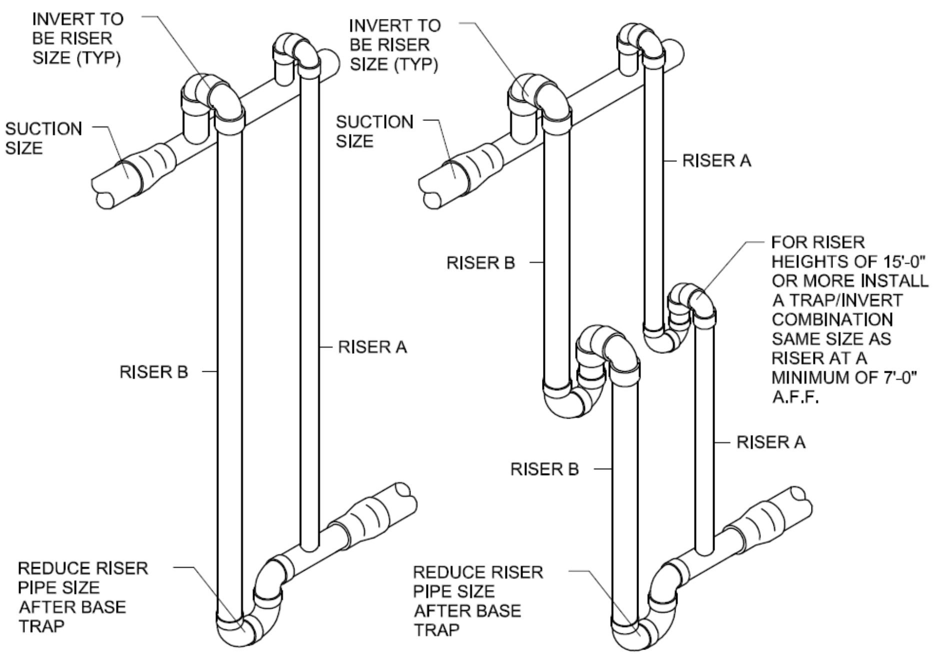
NOTE:
1. FITTED TRAPS SHALL BE SUCTION SIZE. ONE PIECE FIELD SHAPED TRAPS SHALL BE RISER SIZE.

TYPICAL VERTICAL WALL CLAMP DETAIL



NOTE:
1. REFRIGERATION TO SUPPLY AND INSTALL ONLY HYDRAZORB CUSHION CLAMPS.
2. CLAMPS SHALL CORRESPOND EXACTLY WITH PIPING SIZE.
3. REFRIGERATION CONTRACTOR TO ENSURE NO DIRECT CONTACT BETWEEN COPPER PIPE AND METAL CLAMP.

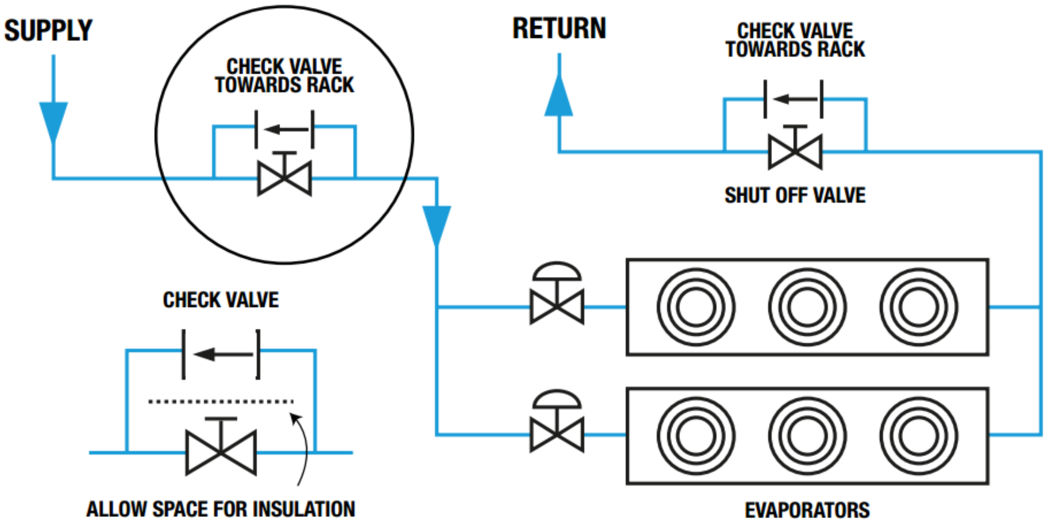
VERTICAL SUCTION DOUBLE RISER

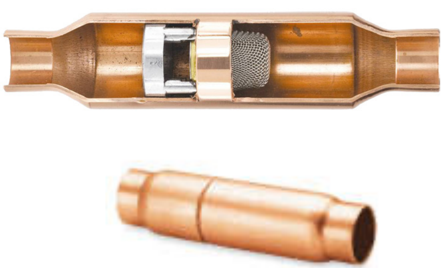


NOTES

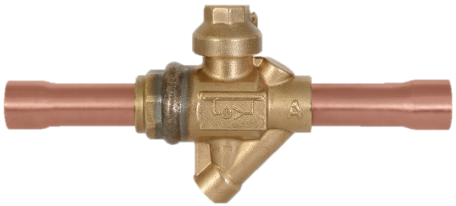
1. Where vertical suction risers are scheduled, the smaller size is designated “A” and the larger size “B”
2. For further piping clarification see typical trap and invert detail

ISOLATION VALVES
PIPING





- ☑ Full port ball valves with return check valves and rated for minimum design pressure of 652 psig
- ☑ Direction of check valve should point towards the rack
- ☑ The bypass check valves are required for instances when the isolation valves are closed while the pressure of the refrigerant can build up in the system

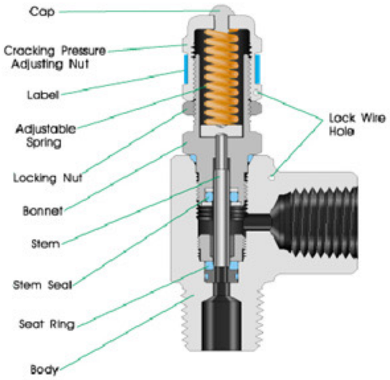


RELIEF VALVE

- Pressure relief valves should exhaust to exterior locations to comply with ASHRAE 15.
- Valves must be at a location and orientation such that they can discharge pressurized refrigerant safely without releasing refrigerant in a direction towards personnel.

EXPANSION JOINTS

- Expansion joints should be designed into the system to provide **strain relief**
- Expansion joints are designed by adding a **"Z-bend"** or change in direction at areas of concerns
- **Long straight runs** of pipe should include extra changes in direction to accommodate expansion.

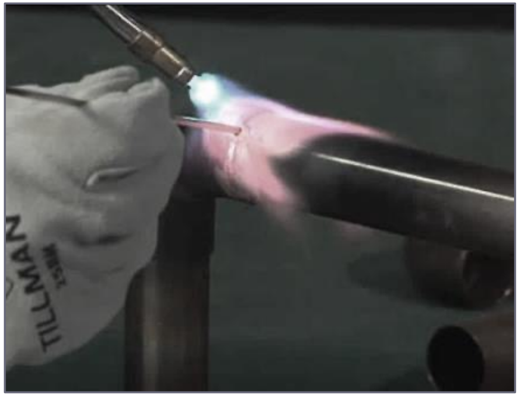


Copper joints are brazed with minimum 15% silver brazing alloy (filler) and for dissimilar metals use minimum 45% silver brazing alloy (filler)

While brazing, must flow nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed.

Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture

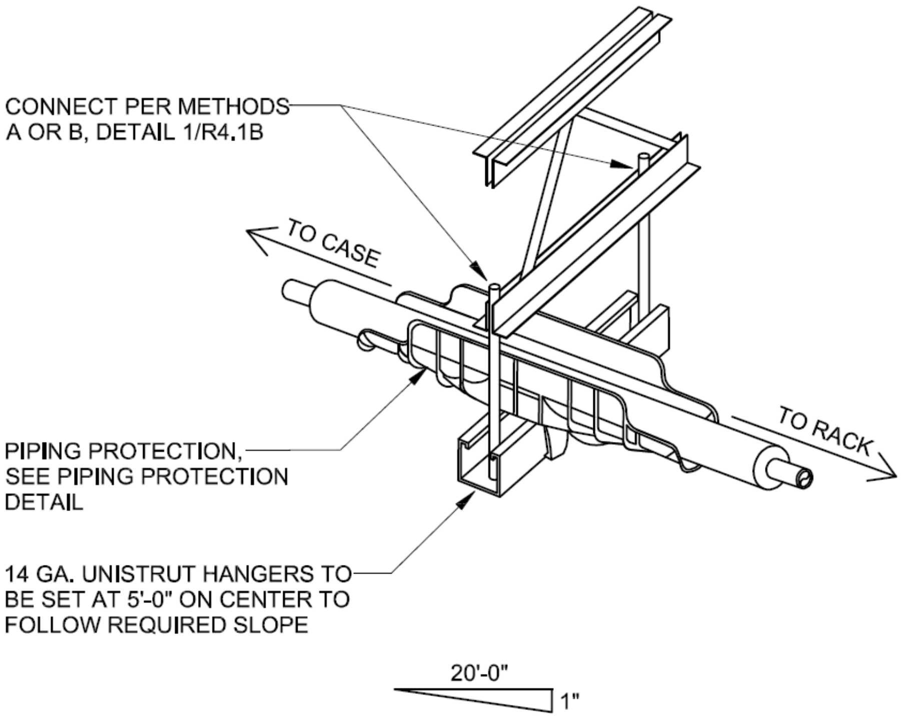
Limit the soldering paste or flux to the minimum required in order to prevent contamination on dissimilar metal



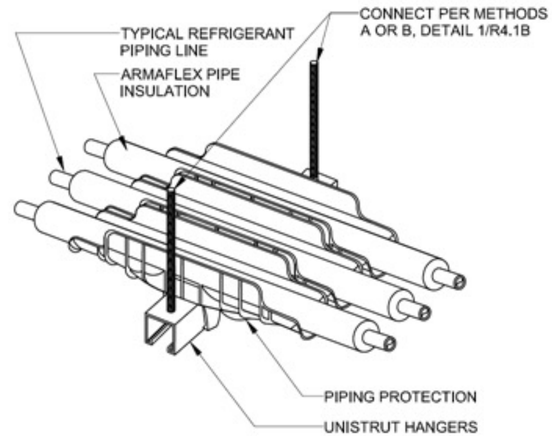
Special instructions for copper K65

- 15% silver
- Good brazing technique
- Natural cooling without water
- Wet rags OK for heat sink ONLY

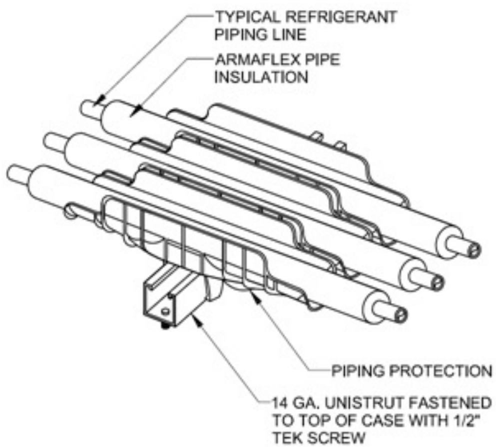
STANDARD OVERHEAD PIPE SLOPE DETAIL



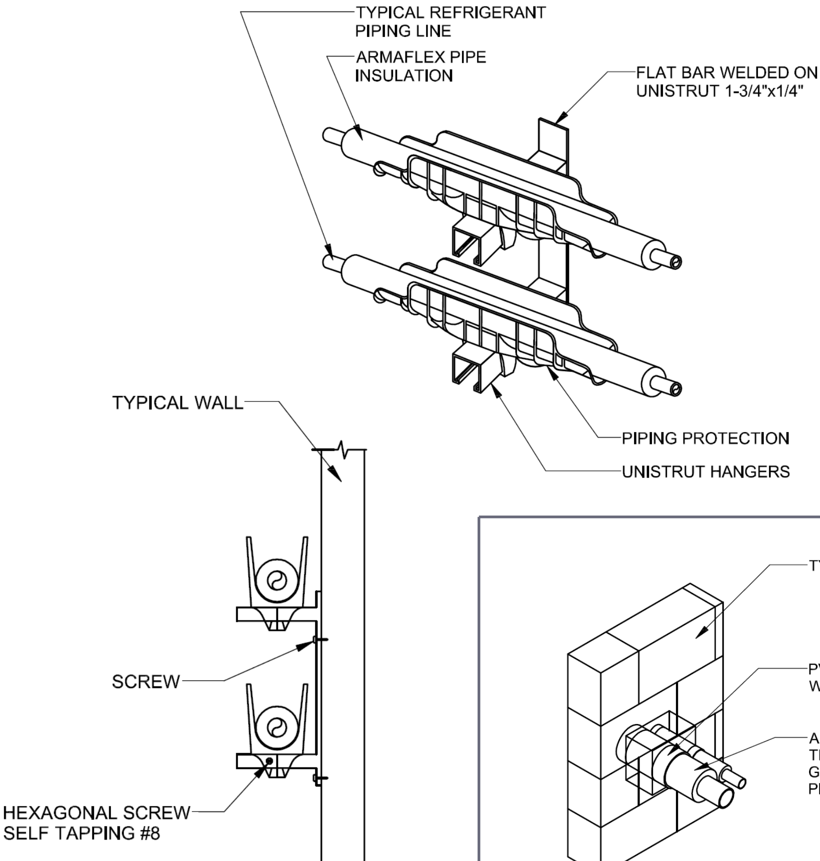
PIPING PROTECTION DETAIL



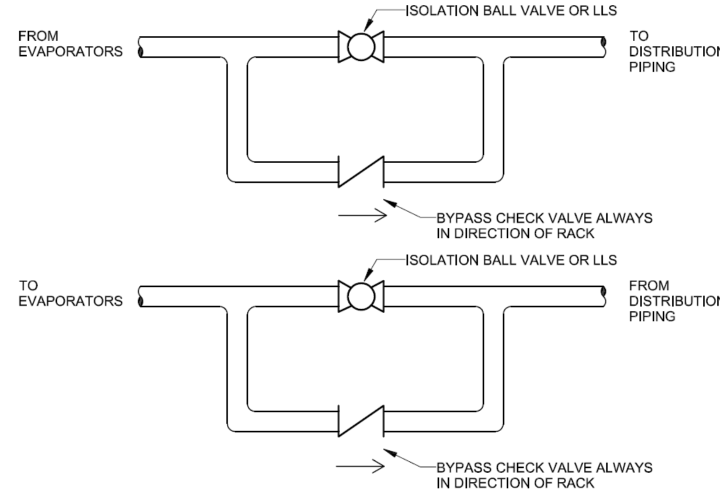
NOTE:
PVC saddles 12" length and 6" diameter or pre-manufactured saddles



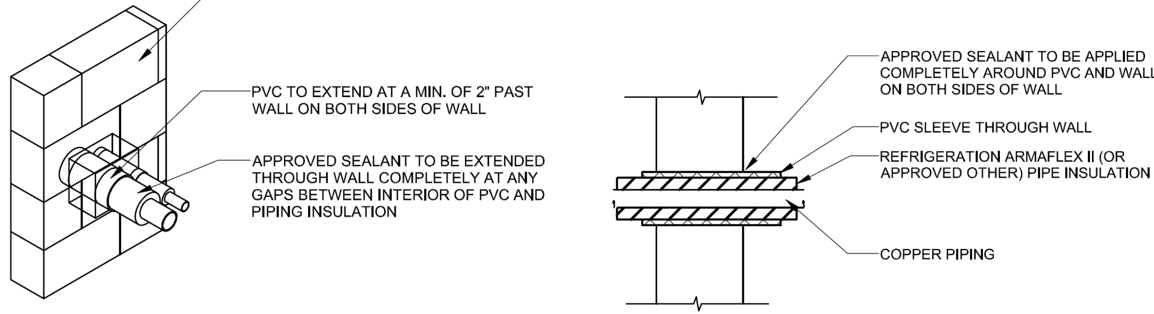
WALL MOUNTED PIPE PROTECTOR



CO2 PIPING ISOLATION VALVE WITH BYPASS CHECK VALVE



PVC PIPE CHASE THROUGH WALL



LABELING

PIPING LABELING

- Arrows indicating direction of flow
- In addition, some piping should provide labels to show:
  - Fluid type (i.e., Carbon Dioxide)
  - Origin of Flow
  - Typical Operating Pressure

STEPS
TESTING AND EVACUATION

Kysor Warren recommends pressure testing and triple-evacuation to ensure proper elimination of moisture and non-condensable gases.

STEP 1
Pre-check

STEP 2
Isolate components not suitable for pressure levels

STEP 3
Disconnect or bypass all defrost heaters

STEP 4
Open valves

STEP 5
Check for leaks

STEP 6
Pre-evacuation

STEP 7
Tripe Evacuation
1st evacuation
2nd evacuation
3rd evacuation

1. PRE-CHECK

- ☑ Visually inspect refrigerant lines and joints for proper piping assembly and installation.
- ☑ Proper bracing is used throughout.
- ☑ Inspect for any metal to metal contact points.
- ☑ Manually verify that all mechanical joints are tight.
- ☑ Ensure all electrical connections are tight.
- ☑ Check phase monitor for correct polarity.

☐ 2. ISOLATE COMPONENTS NOT SUITABLE FOR THE PRESSURE LEVELS

☐ 3. DISCONNECT PR BYPASS ALL DEFROST HEATERS

☑ 1. PRE-CHECK

2. ISOLATE COMPONENTS NOT SUITABLE FOR THE PRESSURE LEVELS

☑ All components not designed to withstand the induced pressures are isolated from these pressures.

☐ 3. DISCONNECT PR BYPASS ALL DEFROST HEATERS

☑ 1. PRE-CHECK

☑ 2. ISOLATE COMPONENTS NOT SUITABLE FOR THE PRESSURE LEVELS

3. DISCONNECT PR BYPASS ALL DEFROST HEATERS

4. OPEN VALVES

- ☑ Ball valves to circuits, branches, satellites, condenser, heat reclaim, receiver, etc.
- ☑ Both sides of condenser and heat reclaim piping
- ☑ De-energize the solenoid valves (which are normally open).

☐ 5. CHECK FOR LEAKS

☐ 6. PRE-EVACUATION

☑ 4. OPEN VALVES

5. CHECK FOR LEAKS

☑ Verify pressurization at multiple system access points.

☑ System pressure is brought to a minimum of 300 psig.

☐ 3. DISCONNECT PR BYPASS ALL DEFROST HEATERS

☑ 4. OPEN VALVES

5. CHECK FOR LEAKS

IF LEAK IS IDENTIFIED:

- ☑ Leak is isolated from rest of system
- ☑ Leak is repaired
- ☑ Area of repair is retested
- ☑ Area is re-pressurized to a minimum 300 psig
- ☑ All valves are re-opened
- ☑ After all leaks are repaired and retested, system stands unaltered for 24 hours with no greater than a +- 1 PSIG change
- ☑ When system is ready to be evacuated, the nitrogen charge is released.

☐ 6. PRE-EVACUATION

☑ 4. OPEN VALVES

☑ 5. CHECK FOR LEAKS

6. PRE-EVACUATION

- ☑ System is depressurized
- ☑ Evacuation pump and sensors working properly
- ☑ Evacuation pump is connected to as many as possible access points on the rack.
- ☑ Copper lines or special vacuum hoses are required
- ☑ Vacuum pump is rated at 8cfm as a minimum and can reach all parts of the system.
- ☑ Vacuum pump oil as recommended by manufacturer and is new and clean.
- ☑ Electrical connections are secure and uninterrupted
- ☑ There are no leaks at the vacuum pump connections.

☑ 4. OPEN VALVES

☑ 5. CHECK FOR LEAKS

6. PRE-EVACUATION

LINES AND VALVES

☑ Copper lines or suitable hoses are used.
☑ Packless valves are used
☑ All schrader valve caps are tightened and checked.
☑ All access valves are capped tightened
☑ Make sure pressure transducers are valved-off while under vacuum

NOTE:
Never use more than one vacuum pump at the same time

MICRON VACUUM GAUGE

☑ Gauge is properly calibrated
☑ Verify with gauge that pump can pull a vacuum of at least 300 microns
☑ Vacuum is measured at a minimum of two points which are at extreme points within the system

7. TRIPLE EVACUATION PROCEDURE (1ST EVACUATION)

- ☑ Ball valves to circuits, branches, satellites, condenser, heat reclaim, receiver, etc.
- ☑ Both sides of condenser and heat reclaim piping
- ☑ De-energize the solenoid valves (which are normally open).

☐ 8. CHARGING

☐ 9. FINAL CHECK

7. TRIPLE EVACUATION PROCEDURE (2^{ND} EVACUATION)

- ☑ Pull a second vacuum to a minimum of 500 microns
- ☑ Close vacuum header valves
- ☑ If the 500 micron vacuum holds for a minimum of 30 minutes, then break the vacuum with the refrigerant to be used in the system to a pressure of 2 psig
- ☑ Install system suction and liquid drier cores

☐ 8. CHARGING

☐ 9. FINAL CHECK

7. TRIPLE EVACUATION PROCEDURE (3RD EVACUATION)

- ☑ Pull a third vacuum to a minimum of 300 microns
- ☑ Close vacuum header valves and allow system to stand for a minimum of 24 hours
- ☑ System is ready to be charged with refrigerant If the 300 micron vacuum holds for 24 hours with a maximum drift of 100 microns over the 24 hour period
- ☑ Break the vacuum with the refrigerant to be used in the system and charge the system with refrigerant
- ☑ Add oil to the compressors, oil separator and oil reservoirs, if equipped before starting compressors.

☐ 8. CHARGING

☐ 9. FINAL CHECK

STEPS
STARTUP CHECK LIST

Electric power supply	Wired	Terminated	Powered
Rack			
Cases (fans, lights and case controller)			
Gas Cooler fans and controller			
Defrost and control panels (for every walk-in)			
Network	**Wired**	**Terminated**	**Communicating**
Case controllers			
Rack			
Gas cooler			
Defrost and control panels (for every walk-in)			

Other		Yes	No
Store piping complete and insulated			
Refrigeration piping pressure and leak checked			
System has been evacuated per specification (triple vacuum)			
Water supply and drain (for Adiabatic gas coolers)			
All cases and case controller configured in main controller			
CO2 Instrument grade at store			
Correct amount of CO2 at store			
Charging station			
Scale for weighing in charge on site			
All cases and walk ins drains installed and traps primed with water.			
EVAC System installed			
Oil added to compressors, oil separator and oil reservoir			
Suction filters installed			
Liquid drier core installed			
All cases cleaned with deck pans and shelves installed			
Verify all control wiring is to the correct case or walking according to POP sheet.			
Verify proper measurements of temperature sensors (ice bath)			
Pressure transducers installed on rack and display cases			
VFD properly programmed			
Case controllers have been programmed			
Case controllers have been addressed			

SYSTEM OPERATION

Kysor Warren recommends pressure testing and triple-evacuation to ensure proper elimination of moisture and non-condensable gases.

STEP 1
Commissioning

STEP 2
System Power

STEP 3
CO2 Initial Charging

- Oil Charge
- CO2 Vapor Change

STEP 4
Starting Compressors

- Start ACU (optional)
- Controls/Instrumentation Check
- Liquid CO2 Charge to Flash Tank
- Start MT compressors
- Pull Down MT Cases & Walk-ins
- Start LT compressors
- Pull down LT Cases & Walk-ins

STEP 5
Evaporator Temp. Control

STEP 6
Defrost Setup

STEP 7
Walk-In Door Switches

1. SYSTEM POWER (Prior to charging the system or starting compressors)

- ☑ Power has been turned on to each subsystem
- ☑ Control Panel is energized
- ☑ Panel switches are set with compressor OFF
- ☑ Check operation of cooling fans
    - ☑ Gas Cooler Fans Operating
    - ☑ Case Fans Operating
- ☑ Control System is installed and programmed according the System SOO set points
- ☑ Controls, gauges, and thermometers are displaying temperatures and pressures (Check values expected without refrigeration system operating)

☐ 2. INITIAL CHARGING

☐ 3. STARTING COMPRESSORS

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.1 – REQUIRED EQUIPMENT AND MATERIALS

- ☑ CO_2 Vapor Cylinders
- ☑ CO_2 Liquid Cylinders (w/dip tube)
- ☑ Charging Hoses
  - ☑ 3/8” hose for faster charging
  - ☑ rated for 1740 psig working pressure

Instrument or Coleman Grade CO_2 vapor to break vacuum and pressurize the system to 150 psig

Instrument or Coleman Grade CO_2 for remainder of charge – reference refrigeration legend for estimated charge

☐ 3. STARTING COMPRESSORS

KYSOR WARREN

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.1 – REQUIRED EQUIPMENT AND MATERIALS

- ☑ CGA-320 Adapter Fitting
- ☑ Filter/Dryer
- ☑ Refrigerant Scale
- ☑ POE Oil
- ☑ Manual Oil Pump

CO2 cylinders (liquid and vapor) have CGA-320 fittings. An adaptor is required to connect the CO2 cylinder to a flare connection on charging hoses for liquid charging

Use on the charging port for both liquid and vapor charging. Provide one core for about every 600lb. CO2

- Emerson Copeland CO2 Compressors use POE Oil – **EMKARATE RL68HB**
- BITZER CO2 compressors use POE oil – **BSE85K**

☐ 3. STARTING COMPRESSORS

KYSOR WARREN

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.2 – OIL CHARGE

Oil charge to the **Oil Reservoir**

- ☑ Confirm that oil is compatible with compressors
- ☑ Close valves to isolate oil reservoir
- ☑ Fill reservoir with oil 50%
- ☑ Open valve between oil reservoir and compressors

This step need to be done between 2nd and 3rd evacuation

☐ 3. STARTING COMPRESSORS

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.2 – OIL CHARGE

Oil charge to **Compressor**

- ☑ Check that compressor oil is at the proper level
- ☑ Confirm that the compressor crankcase heaters are energized for 24h before start up

Oil level requirement may vary with compressor manufacturer
Crankcase heater must be operating to warm the oil prior to starting the compressor.

☐ 3. STARTING COMPRESSORS

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.3 – CO2 VAPOR CHARGE

- ☑ Break the vacuum with Vapor CO2 to 150 psig
- ☑ Leave all valves open - complete system and piping distribution network with vapor charge
- ☑ Close compressor suction and discharge valves
- ☑ Continue charging vapor CO2 to 150 psig
- ☑ Check that any rack gauges and control pressures read 150 psig

PRESSURE RATINGS

Less 150psig
- some valves might be closed, or faulty pressure transducer

Greater 150psig
- faulty pressure transducer reading

CO2: Tsat = -34F @ 150 psig

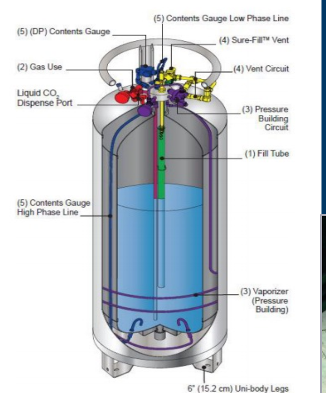
☐ 3. STARTING COMPRESSORS

☑ 1. SYSTEM POWER

2. INITIAL CHARGING

2.3 – CO2 VAPOR CHARGE

- ☑ As vapor is drawn from the CO2 cylinders, pressure and temperature inside the cylinder will decrease
- ☑ Frosting on the bottom exterior → some CO2 liquid evaporated inside
- ☑ Pressure reduction → slower flow rate of vapor into the system
- ☑ Cylinder flow slowed to a low level, the cold cylinder should be disconnected and allowed to warm
- ☑ After the cylinder warms, additional CO2 can be removed. In the meantime, another warm tank can be connected to the system to continue the charging process



A typical full 100 lb. cylinder contains approximately 50 lbs. of useable CO2 that can be charged into the system. On the first attempt, 20-25 lbs. of CO2 vapor can typically be obtained from the cylinder before reaching a low-temperature/pressure of the tank

☐ 3. STARTING COMPRESSORS

☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.1 – START ACU (OPTIONAL)

- ☑ Check ACU Pressure Control setpoint
- ☑ Power up ACU by temporarily lowering the ACU Pressure Control setpoint until it closes
- ☑ Confirm that ACU compressor and fans are running
- ☑ Return ACU Pressure Control to its proper setpoint. The switch should open and the ACU compressor will cycle off on its low pressure control

1. With ACU

ACU is activated by ACU Pressure Control on the flash tank. When the flash tank pressure rises to the ACU set point, this control energizes the liquid line solenoid to the ACU heat exchanger

2. Without ACU

LT / MT loads should be gradually bought online; system operation and controls are validated prior to adding further charge under guidance of contractor/ technician

STEPS
SYSTEM OPERATION – START UP

☑ 1. SYSTEM POWER

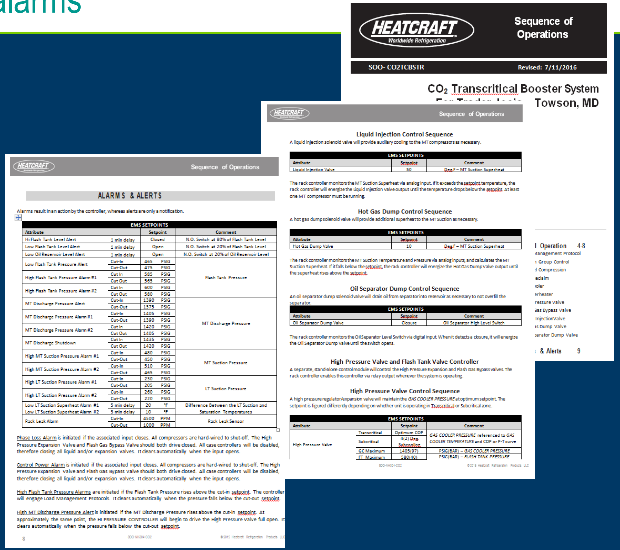
☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.2 CONTROLS / INSTRUMENTATION CHECK

- ☑ Mechanical Pressure Switches
- ☑ Pressure & Temperature Sensors
- ☑ Digital Input Verification
- ☑ Relay Output Verification
- ☑ Analog Output Verification
- ☑ VFD Set-up Verification
- ☑ Electrical Connections

SOO (Sequence of Operation) is provided for individual systems, providing information for programming of controls and various alarms



☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.3 LIQUID CO2 CHARGE TO FLASK TANK

☑ Close the main CO2 liquid line valve

☑ Check that EEVs at cases and walk-ins are also in the closed position

☑ Purge air from refrigerant tank supply hoses before attaching to the flash tank

☑ Fill liquid CO2 directly to the flash tank

When ACU is NOT present

- Close the isolation valves on all lines connected to flash tank
- Position PRV change over valve to pump-down position

When ACU is present

- Manually turn on ACU
- Check that compressor is running, fan is turning, and unit is cooling

☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.3 LIQUID CO2 CHARGE TO FLASK TANK

- ☑ Adjust the flow by the valve on the tank
- ☑ Check design specification for initial charge level
- ☑ Do not exceed the second sight glass (~50%) during charging
- ☑ Frost should form on the base of the tank when the tank is close to empty
- ☑ Check to purge air from hoses when adding new refrigerant tank(s)
- ☑ Change the core of the filter drier on the charging port for every 500 lbs. of refrigerant added.

KYSOR WARREN

☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.4 START MT COMPRESSORS

- ☑ MT compressors should be powered on in "stand-by"
- ☑ Change panel switch for compressors to ON
- ☑ Turn on case controllers for the first section of MT loads to be started (Never start at full load)
- ☑ Slowly open main CO2 liquid line valve(s) to MT loads
- ☑ MT compressors begin running and pulling down case pressures and temperatures.
- ☑ Add CO2 Liquid Charge to maintain the flash tank level just above first site glass (no more than 25%) after cases are running at operating temperatures

When ACU is NOT present:

- Open isolation valve between HPEV and Flash Tank
- Open isolation valve between FGBV and Flash Tank

KYSOR WARREN

☑ **1. SYSTEM POWER**

☑ **2. INITIAL CHARGING**

3. STARTING COMPRESSORS

3.5 PULL DOWN MT CASES & WALK-INS

☑ Confirm that MT Cases and Walk-Ins are meeting the required temperatures

KYSOR WARREN

☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.6 START LT COMPRESSORS

- ☑ Open main CO_2 liquid line valve(s) to the LT loads
- ☑ LT Compressors should be powered on in “stand-by”
- ☑ Change panel switch for compressors to ON
- ☑ Turn on case controllers for the first section of LT loads to be started (Never start at full load)
- ☑ Slowly open main CO_2 liquid line valve(s) to the LT loads
- ☑ LT compressors begin running and pulling down case pressures and temperatures
- ☑ Add CO_2 Liquid Charge to maintain flash tank level after cases are running at operating temperatures

<u>CO_2 Charge Capacity</u> - The CO_2 Flash tank has sufficient volume for various operating conditions. The final charge should be checked when the system is stable, and when the cases and walk-ins are pulled down to their set-point temperatures

☑ 1. SYSTEM POWER

☑ 2. INITIAL CHARGING

3. STARTING COMPRESSORS

3.7 PULL DOWN LT CASES & WALK-INS

- ☑ Continue bringing all cases and walk-ins online and adjusting charge as needed
- ☑ Confirm that LT Cases and Walk-Ins are meeting the required temperatures

4. EVAPORATOR TEMPERATURE CONTROL

- ☑ Verify temperature sensor locations indicated by the controller
- ☑ Validate temperature readings on the controller with a known temperature source. This is done using "ice bath" method, or using a calibrated thermometer
- ☑ Some adjustment may be required on controller settings.

☐ 5. DEFROST OPERATION

☐ 6. WALK-IN DOOR SWITCHES

☑ 4. EVAPORATOR TEMPERATURE CONTROL

5. DEFROST OPERATION

- ☑ Defrost should be programmed to operate with 10% to 20% of system load/capacity at a time
- ☑ Defrosting CO2 evaporators is similar to conventional systems
- ☑ Defrosting the evaporators is accomplished in (3) sequential stages, referred to as operating modes:

STEP 1
Pump down mode
10-12min

›

STEP 2
Heating mode
45-60min

›

STEP 3
Drip mode
10min

☐ 6. WALK-IN DOOR SWITCHES

☑ 4. EVAPORATOR TEMPERATURE CONTROL

☑ 5. DEFROST OPERATION

6. WALK-IN DOOR SWITCHES

Door switches should be installed to walk-ins, set to cut-off fans during door openings and refrigeration after delay.

Door switches are wired to the system controller where door openings are recorded. Extended door openings set an alarm at the controller.

MAINTENANCE & TROUBLESHOOTING

PUMPING-DOWN THE SYSTEM FOR SERVICE

1. Close liquid CO2 supply ball valve from flash tank *(valves A01 & A02)*

2. System starts to self-pump-down Wait until there is no pressure rise in LT and MT suction. Pressure rise in LT and MT suction is the indication of liquid present in the system. When MT and LT compressors stays off for 10 minutes continuously move to step 3.

(MT pump-down pressure set point is 350 psig and LT pump-down pressure set point is 160 psig)

3. Turn OFF compressors using their switches on control panel.

4. Isolate flash tank. Close valves to FGBV, Oil reservoir, and from HPEV *(B01, L18, A18)*

5. Use change over valve (*A12*) on the flash tank to switch from the 650 psig PRV (*R03*) to the 1305 psig PRV (*R02*). Check the pressure setting stamped on the PRVs to be sure the 1305 psig PRV is in use during pump down.

6. Turn OFF the breakers for all the LT and MT compressors.

7. System pump-down is complete.

RESTARTING THE SYSTEM AFTER PUMPING-DOWN AND SERVICE

1. Make sure gas cooler fans are operating or ready to operate.
2. Make sure all the compressors switches are OFF
3. Turn on all the breakers ON
4. Check to make sure controller is calling for open FGBV and close HPEV
5. Turn ON the switch for the lead MT compressor
6. Gradually open angle valve from HPEV *(A18)*. Since controller is calling for close HPEV there should be no increase in flash tank pressure

High pressure in FGT above the max pressure set point (580 psig) will make the controller open the FGBV and close the HPEV

Use only the lead MT compressor to operate in steps 4 to 12 by turning the switches OFF for remaining of compressors.

LT compressors switches have to be OFF during the steps 4 to 14

RESTARTING THE SYSTEM AFTER PUMPING-DOWN AND SERVICE

7. Gradually open the ball valve to FGBV *(B1).* Initially barely cracked B1 open till lead MT compressor starts running. This will cause the suction pressure of MT compressors to rise and controller should start the lead MT compressor. Let the pressure in flash tank decreases. **Do not let the MT suction pressure higher than (500)**

8. When operating the lead MT compressors to reduce the FGT pressure, pay attention to gas cooler pressure and do not let it rise **above 1400 psig.** In case of having plate HTX as Gas coolers where the internal volume is very small, the high side pressure is very sensitive.

9. Flash tank pressure should stabilize around 520 psig

10. Use change over valve *(A12)* on flash tank to switch to 650 psig pressure relief valve *(R2)*

Caution: Opening the ball valve fast can result in releasing refrigerant charge from MT suction PRV (A9)

KYSOR WARREN

RESTARTING THE SYSTEM AFTER PUMPING-DOWN AND SERVICE

11. Open the valve that connects flash tank to oil reservoir *(L15)*

12. Turn ON switches for the rest of MT compressors and make sure they are ready to operate

13. Gradually open Liquid CO2 supply angle valve *(A1)*. The system should start running and pulling down MT cases

14. After MT cases are stable turn ON LT compressor switches. Controller should start LT compressor and start pulling LT cases down

15. Double check to make sure the valves from HPEV, oil reservoir, FGBV to flash tank and liquid CO2 supply are fully open *(A18, L18, B1, A1)* and 650 psig PRV on flash tank is in service *(R2)*.

Caution: Opening the ball valve fast can result in releasing refrigerant charge from MT suction PRV (A9)

STARTUP

- ☑ Change all filters and driers (end 1st week of startup)
- ☑ Change the filter driers (2nd time after 90 days)
- ☑ Remove the suction line filter core
- ☑ Replace oil coalescing media

☐ WEEKLY

☐ MONTHLY

☐ ANNUALLY

KYSOR WARREN

☑ STARTUP

WEEKLY

- ☑ Visually inspect equipment.
- ☑ Check refrigerant charge.
- ☑ Check compressor oil level and color.
- ☑ Check compressor crankcase heater operation.
- ☑ Check main power and control voltage.
- ☑ Check appearance of area around the unit.
- ☑ Check system pressures.
- ☑ Check moisture indicator in liquid sight glass.

☐ MONTHLY

☐ ANNUALLY

☑ STARTUP

☑ WEEKLY

MONTHLY

- ☑ Check the system for leaks.
- ☑ Check suction filters and liquid line filter driers for pressure drop.
- ☑ Check all flanged connection bolts, fittings and line clamps for tightness.
- ☑ Inspect condenser fan blades and motor mounts for cracks, loose set screws or mounting bolts.
- ☑ Tighten all electrical connections.
- ☑ Check operation and condition of contactors.
- ☑ Check operation of auxiliary equipment.

☐ ANNUALLY

KYSOR WARREN

☑ STARTUP

☑ WEEKLY

☑ MONTHLY

ANNUALLY

- ☑ Obtain oil sample for analysis; change oil if required.
- ☑ Change liquid line filter drier and suction filter cores.
- ☑ Test all operating and safety controls and record in service log book

Share Your Feedback!

SCAN ME

To receive an electronic training certificate:

1. Scan or visit nasrc.org/session-surveys
2. Provide your name and email at the end of the survey

Please Note: *You will not receive a certificate unless you share your name on the survey form.*

Co2 Installation and Service

Dale Sizemore

Director, Technical Support Kysor/Warren

NORTH AMERICAN Sustainable Refrigeration Council

THANK YOU!!

WWW. KYSORWARREN.COM

KYSOR WARREN
eptarefrigeration