Polycold Fast Cycle (PFC)
Water Vapor Cryopump
Installation Manual

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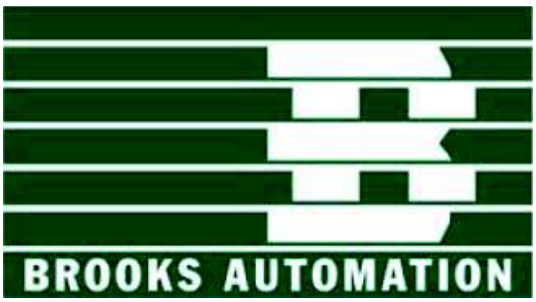

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This manual is available in the following formats: CD, Paper
This manual is available in the following languages: English.
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Printed in the U.S

Contents

CAUTION

This manual and all addendums and attachments are not controlled. Changes may have been made or additional documents or drawings added to the system documentation at any time. To identify the current revisions or to obtain a current set of drawings and documents, contact Brooks Automation Technical Support.

1. Introduction

Installation Checklist

Below is a checklist of tasks for installing a PFC. Perform the tasks in the order shown, and initial and date each task as you complete it.

Important Note: Before installing the PFC, refer to the section Specifications and Site Requirements in this manual.

Table 1. PFC Installation Checklist

Task	Name	Page	Completed (initials/date)
1.	Inspect and Unpack the PFC	7	Balance Pressure:
2.	Connect Cooling Water to the Refrigeration Unit	39	
3.	Connect Electrical Power to the PFC	41	
4.	Install the Cryosurface	48	
5.	Optional: Fabricate the Refrigerant Lines	50	
6.	Route and Install the Refrigerant Lines	53	
7.	Check the Refrigerant Line and Cryosurface for Leaks	59	
8.	Evacuate the Refrigerant Line and Cryosurface	65	
9.	Connect the Refrigerant Line Thermocouples	68	
10.	Preliminary Check of the PFC	74	
11.	Insulate Exposed Refrigerant Tubes and Couplings	78	
12.	Evaluate and Put the PFC Into Service	81	
13.	Install **the Remote Control (Optional)**	86	
14.	Install Remote Temperature Indication (Optional)	92	
End of procedure			

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Inspect and Unpack the PFC

Tools and materials:

- Tools and materials necessary to remove the PFC equipment and documentation from shipping container(s)

Note: Some refrigeration units are not shipped charged with refrigerant. If the refrigeration unit is not charged with refrigerant, cylinders of refrigerant are shipped with the unit with instructions for charging the unit.

	**WARNING** **HIGH PRESSURE RUPTURE** If a high pressure circuit is ruptured, such as a refrigerant circuit, equipment damage could occur. In addition, cuts and eye injury from flying objects could result in death or serious injury. Review this manual before performing any procedure including routine operation of Polycold's Cool Solutions ® Fast Cycle Water Vapor Cryopump. Inspect the refrigerant circuit and entire unit before continuing.
	**WARNING!** **LIFTING HAZARD, TIP OVER** Depending on the model PFC you are installing, the refrigeration unit weighs between 374 kg (825 lbs) and 544 kg (1200 lbs). Failure to properly lift or move this device may result in death or serious injury.

Step	Action
1.	Carefully inspect all surfaces of the shipping container (there may be more than one shipping container) for signs of damage or stress. **If there ARE signs of shipping damage to the container**, record the damage and notify the carrier immediately. Go to Step 2. **If there are NO signs of shipping damage to the container,** go to Step 3.
	Continued on next page

Inspect and Unpack the PFC, Continued

Step	Action
2.	With the carrier, assess the damage to the shipping container and determine if the PFC is damaged. **If the PFC is damaged, STOP THIS PROCEDURE!** Make the necessary arrangements with the carrier and Brooks Automation to repair the damage or replace the unit. Refer to the Brooks Automation contact information at the front of this manual. **If the PFC is not damaged,** go to step 4. **Note:** Retain the bolts and the shipping containers in reusable condition for returning the equipment to the factory in the future.
3.	Remove the PFC refrigeration unit from the shipping container and inspect it for damage. **If the refrigeration unit is NOT damaged, go to step 4.** **If the refrigeration unit IS damaged, go to step 2.**
4.	Remove the rear panel of the refrigeration unit in order to inspect the spare parts kit that was shipped inside the unit. Verify that all of the parts were shipped with the unit.
5.	**Record the balance pressure:** Locate the two pressure gauges on the front of the refrigeration unit. On the discharge pressure gauge, read the balance pressure. The pressure should be within the ranges shown on the balance pressure graphs in Table 2 on page 9. Record the balance pressure in the space in Task 1 on page 5. If the equipment has recently been moved from an area where the temperature differs greatly from the present area, allow the components 24 hours to equalize to the new room temperature before verifying correct charge pressure. If the pressure is not within the ranges, contact the nearest Brooks Automation Polycold Service Center. **Note:** Refrigerant saturation temperature at system charge pressure is just below the freezing point of water. If the system is exposed to extreme cold during shipping, some of the refrigerant may condense. Depending upon the quantity of condensed refrigerant, it may take up to 48 hours at room temperature to recover the full system charge, and for the pressure gauge to show this.
6.	Go to the Installation Checklist on page 5 and initial and date this task, then go to the next task.
End of Procedure	

Continued next page

Inspect and Unpack the PFC, Continued

The table below shows the balance pressures for current models of PFC refrigeration units.

Table 2. Balance Pressures for PFC Refrigeration Units[1]	
Refrigeration Unit	**[2]Balance Pressure psig (bar)**
552 HC	135-160 (9.3-11.0)
672 HC	160-195 (11.0-13.4)
1101 LT	150-175 (10.3-12.1)
1102 HC	175-205 (12.1-14.1)

Notes:

[1]*These pressures are for the refrigeration units only. The balance pressure may drop 5-10 psig (35-70 kPa) after installing the refrigerant line and cryosurface and opening the isolation valves.*

[2]*Balance Pressure refers to the pressure of the unit when it is turned off and fully warmed up to room temperature. It is the balance of pressure on both sides (suction and discharge) of the compressor. Under operating conditions (when the compressor is running) the unit creates a pressure difference between the suction and discharge sides of the compressor.*

2. Specifications and Site Requirements

Overview

This section includes the technical specifications of the PFC as well as the site requirements for installing a PFC.

The main components of the PFC are:

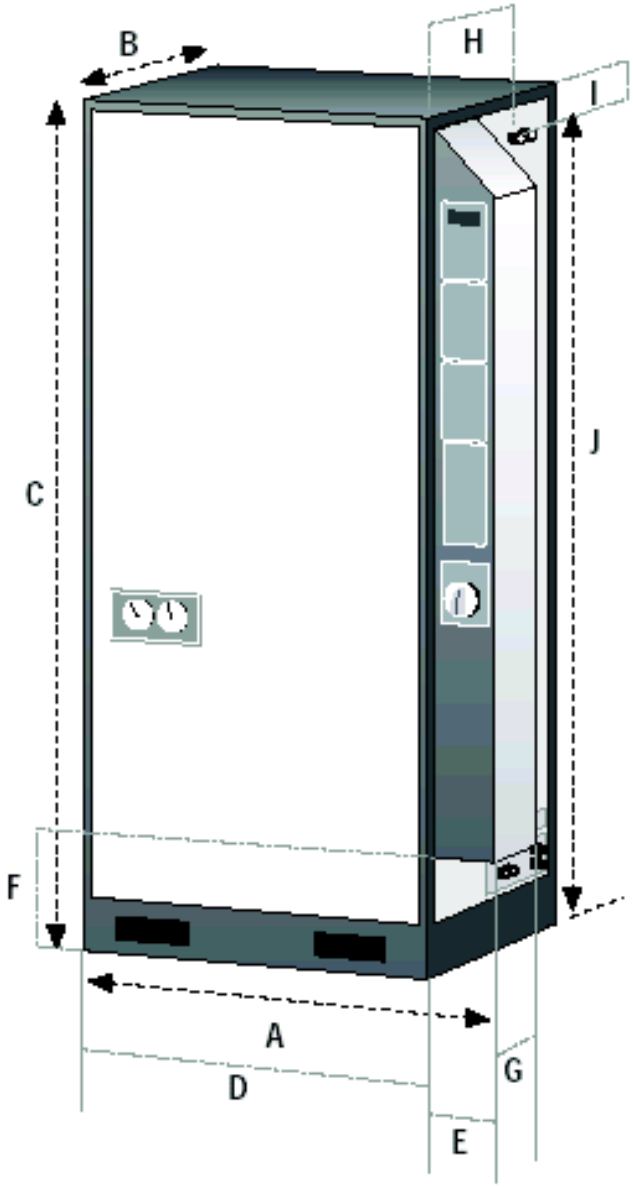
- Refrigeration Unit
- Refrigerant Line
- Cryosurface; this is one of two types:
  - Coil – for water trapping)

  or
  - Baffle – to minimize oil backstreaming
- Cryogenic feedthrough: routes the refrigerant lines through the vacuum chamber wall

The specifications and site requirements for each of these components are covered in this section.

Mechanical Specifications

Figure 1. PFC Refrigeration Unit Dimensions (see Table 3 on the next page for legend)



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Mechanical Specifications, Continued

Table 3. Refrigeration Unit Dimensions – mm (inches)										
Model	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
552 672	953 (37.5)	660 (26)	1842 (72.5)	812 (32)	140 (5.5)	254 (10)	203 (8)	432 (17)	114 (4.5)	1727 (68)
1101-LT 1102	1054 (41.5)	711 (28)	1689 (66.5)	914 (36)		102 (4)		457 (18)		1562 (61.5)

Table 4. PFC Weights and Refrigerant Line Length All weights ± 11 kg (25 lbs)			
Model	**Weight – kg (lb)**	**Shipping Weight – kg (lb)**	**Standard Refrigerant Line Length, meters (feet)**
552	386 (850)	420 (925)	2.4 (8)
672	442 (975)	476 (1050)	2.4 (8)
1101-LT 1102	533 (1175)	567 (1250)	2.4 (8)

Continued next page

Mechanical Specifications, Continued

Table 5. Sound Pressure of Refrigeration Units	
Model	**Maximum Sound Pressure Level dB(A)** See Notes below
552	71
672	72
1101	73
1102	73

Notes:
Units were tested in a manufacturing environment while under maximum load in the COOL mode. Measurements were made on each side of the unit at a distance of 39 inches (1.0 m) and at a height of 63 inches (1.6 m).
Measurements taken from each side of the unit did not vary significantly. However, measurements did vary with the specific acoustics of the environment in which the unit was placed. For example, the maximum sound pressure level of a unit in an anechoic chamber reduced by 14dB(A).
The abbreviation dB(A) means decibels with an "A" weighting.

Continued on next page

Cooling Water Requirements

The cooling water supplied to the PFC must meet temperature and flow requirements. The temperature of the cooling water must be between 55 – 85° F (13 – 29° C). Minimum flow rates and water temperatures are shown in Table 6. It is also recommended to filter the cooling water in order to remove dirt and abrasives from it. Any chemical impurities in the cooling water must be compatible with copper.

To minimize downtime during maintenance, it is recommended that two parallel, redundant water filters with valves be installed for the PFC. Then, when performing maintenance on one filter, water can be routed through the backup water filter, with no interruption of water flow through the PFC.

It is also recommended that a water flow rate meter be installed for the PFC as a means for monitoring water flow through the PFC.

Note: Cooling water may be warmer in the summer than in the winter.

Table 6. PFC Cooling Water Requirements

Refrigeration Unit	Water Inlet Temperature °F (°C)	Minimum Flow Rate gpm (L/min)	Internal Pressure Drop Psi(kPa)	Pressure Drop in Supply Line[1] Psi/ft(kPa/m)	Heat Rejection Btu/Hour (kW)
552	55 (13) – Min.	1.3 (4.9)	0.3 (2.1)	No data	23,900 (7.0)
	65 (18)	1.7 (6.4)	0.6 (4.1)	No data	23,900 (7.0)
	75 (24)	2.6 (9.8)	1.3 (9.0)	No data	23,900 (7.0)
	85 (29) – Max.	5.2 (19.7)	5.3 (36.6)	0.06 (1.4)	23,900 (7.0)
672	55 (13) – Min.	1.8 (6.8)	0.5 (3.4)	No data	33,400 (9.8)
	65 (18)	2.4 (9.1)	0.8 (5.5)	No data	33,400 (9.8)
	75 (24)	3.6 (13.6)	1.8 (12.4)	No data	33,400 (9.8)
	85 (29) – Max.	7.3 (27.6)	7.6 (52.4)	0.11 (2.5)	33,400 (9.8)
1101 1102	55 (13) – Min.	3.6 (13.6)	1.6 (11.0)	No data	65,500 (19.2)
	65 (18)	4.8 (18.2)	2.8 (19.3)	No data	65,500 (19.2)
	75 (24)	7.2 (27.3)	6.3 (43.4)	No data	65,500 (19.2)
	85 (29) – Max.	14.3 (54.1)	24.8 (171)	0.15 (3.4)	65,500 (19.2)

[1]For 552s and 672s these numbers assume a 1/2-inch (15 mm) standard pipe size. For 1101 and 1102s, these numbers assume a 3/4-inch (20 mm) standard pipe size. The maximum working pressure of the unit's cooling water circuit is 200 psig (1380 kPa).

Continued next page

Installing a Refrigeration Unit to Meet ASHRAE Requirements

The following information helps to comply with ANSI / ASHRAE 15-1994 "Safety Code for Mechanical Refrigeration". ANSI is the acronym for the American National Standards Institute. ASHRAE is the acronym for the American Society of Heating, Refrigeration, and Air Conditioning Engineers.

Normally, the manufacturer provides the type and amount of refrigerant used in the refrigeration unit. However, Polycold considers their mixtures of refrigerants to be proprietary. Therefore, the following information complies with the above standards.

- The amount of refrigerant mixture, the minimum room size and the refrigerant safety group classification are included next to the refrigeration unit's name-plate. The nameplate is located on the back of the low voltage box.
- Polycold determined the refrigerant safety group classification of the refrigerant mixture by evaluating the safety group classifications of the individual components. This evaluation used ANSI / ASHRAE-34 as a guide.
- The cryopump is a "direct (refrigeration) system". It is only intended to be installed above ground in an industrial environment.
- If the minimum room size indicated on the nameplate is not obtainable, the refrigeration unit must be installed in a "refrigerating machinery room". Consult local or national building codes for machinery room requirements.
- Some models have a PRESSURE RELIEF OUTLET with a 3/4-inch female NPT fitting. By connecting tubing or hose to this fitting, the customer can direct escaping refrigerant to an appropriate location. See section 9.7.8 of ANSI / ASHRAE 15- 1994 for location requirements. See Table 7 for piping requirements.
- All models have this PRESSURE RELIEF OUTLET, except models PFC- 552, 672, and 1102 manufactured after March 2003. These models use a refrigerant that does not require pressure relief outlet plumbing.

Table 7. Pressure Relief Piping Requirements to Comply with ANSI/ASHRAE 15-1994

Refrigeration Unit	Recommended Discharge Capacity[1] (pounds of air per minute)	Maximum Length of 1/2-inch Diameter Pipe[2] (feet)
552, 672	4.75	113
1101, 1102	7.7	42

[1]The discharge capacity recommended by Polycold is based on actual relief requirements from the refrigeration system. The pressure relief devices on the refrigeration unit are oversized. Discharge capacities based on the pres-sure relief devices are 23.9 pounds of air per minute for 552s and 672s; 30.3 pounds of air per minute for 1102s.

[2]Maximum length of piping is based on the recommended discharge capac-ity using standard wall steel pipe and pressure relief devices set at 300 psig (2070 kPa).

Continued next page

Electrical Specifications

Notes regarding the electrical specifications in the following tables:

- RLA is the current drawn by the compressor at rated load. It may also be referred to as the maximum full load amps.
- A Bussman FRS-R dual element, current limiting fuse or equivalent is recommended to protect the branch circuit for the PFC.
- Actual protection must comply with local codes.
- “Worst Case low Volts” refers to the lowest amount of voltage available. Typically power fluctuates by 10% within a given area, so the lowest voltage amount would be 90% of the nominal voltage.
- LRA = Locked Rotor Amps. This refers to the current that the compressor motor uses when the compressor is not able to rotate because the rotors are locked.
- Gould TRS, Littlefuse FLSR. MCA=minimum circuit ampacity = should be at least 125% RLA. This value is to assist the site electrician in determining the dimensions of the electrical system.
- Compressors are provided with over current and over temperature protection which comply with UL and NEC definitions of inherent thermal protection.

kVA = (Test Volts) X (RLA) X (1.732/1000)

kW = (kVA) X Power Factor (Power Factor is 90% in this case.)

Continued next page

Electrical Specifications, Continued

Table 8. 552 HC Refrigeration Unit Electrical Characteristics			
Nominal Compressor Voltage	**Transformer Tap Setting and ID Label**	**Common Worldwide Voltage-Phase-Frequency**	**Voltage Range**
230 Vac	200-3-50/60	200-3-50 200-3-60 208/230-3-60	180-220 @ 50 Hz 187-220 @ 60 Hz
	230-3-50/60	208/230-3-60 220-3-50 230-3-60	207-230 @ 50 Hz 207-253 @ 60 Hz
460 Vac	380-3-50	380-3-50	342-418 @ 50 Hz
	400-3-50	400-3-50 415-3-50	360-440 @ 50 Hz
	460-3-50/60	440-3-50 460-3-60	414-460 @ 50 Hz 414-506 @ 60 Hz
	480-3-60	480-3-60	432-528 @ 60 Hz
575 Vac	575-3-60	575-3-60	518-632 @ 60 Hz

Table 9. 552 HC Refrigeration Unit Electrical Protection Requirements					
Transformer Tap Setting and ID Label	**RLA Amps**	**MCC Amps**	**LRA Amps**	**Fuse Size Amps**	**Power Input kVA**
200-3-50/60	22.3	44	160	60	7.7
230-3-50/60	20.4				8.1
380-3-50	11.9	22	80	25	7.8
400-3-50	11.3				
460-3-50/60	9.8				
480-3-60	9.4				
575-3-60	7.8	17.6	64	20	7.8

Continued next page

Electrical Specifications, Continued

Table 10. 672 HC Refrigeration Unit Electrical Characteristics			
Nominal Compressor Voltage	**Transformer Tap Setting and ID Label**	**Common Worldwide Voltage-Phase-Frequency**	**Voltage Range**
230 Vac	200-3-50/60	200-3-50 202-3-50/60 208/230-3-60	180-220 @ 50 Hz 184-220 @ 60 Hz
	230-3-50/60	208/230-3-60 220-3-50 230-3-60	207-230 @ 50 Hz 207-253 @ 60 Hz
460 Vac	380-3-50	380-3-50	342-418 @ 50 Hz
	400-3-50	400-3-50 415-3-50	360-440 @ 50 Hz
	460-3-50/60	440-3-50 460-3-60	414-460 @ 50 Hz 414-506 @ 60 Hz
	480-3-60	480-3-60	432-528 @ 60 Hz
575 Vac	575-3-60	575-3-60	518-632 @ 60 Hz

Table 11. 672 HC Refrigeration Unit Electrical Protection Requirements					
Transformer Tap Setting and ID Label	**RLA Amps**	**MCC Amps**	**LRA Amps**	**Fuse Size Amps**	**Power Input kVA**
200-3-50/60	35.1	44	160	60	12.6
230-3-50/60					
380-3-50	14.5	22	80	25	9.6
400-3-50	13.8				
460-3-50/60	12.0				
480-3-60	11.5				
575-3-60	9.6	17.6	64	20	9.6

Continued next page

Electrical Specifications, Continued

Table 12. 1101 LT Refrigeration Unit Electrical Characteristics			
Nominal Compressor Voltage	**Transformer Tap Setting and ID Label**	**Common Worldwide Voltage-Phase-Frequency**	**Voltage Range**
230 Vac	200-3-50/60	200-3-50/60 208/230-3-60	180-220 @ 50 Hz 187-220 @ 60 Hz
	230-3-50/60	208/230-3-60 220-3-50 230-3-60	207-230 @ 50 Hz 207-253 @ 60 Hz
460 Vac	380-3-50	380-3-50	342-418 @ 50 Hz
	400-3-50	400-3-50 415-3-50	360-440 @ 50 Hz
	460-3-50/60	440-3-50 460-3-60	414-460 @ 50 Hz 414-506 @ 60 Hz
	480-3-60	480-3-60	432-528 @ 60 Hz
575 Vac	575-3-60	575-3-60	518-632 @ 60 Hz

Table 13. 1101 LT Refrigeration Unit Electrical Protection Requirements					
Transformer Tap Setting and ID Label	**RLA Amps**	**MCC Amps**	**LRA Amps**	**Fuse Size Amps**	**Power Input kVA**
200-3-50/60	50.7	62	228	80	17.6
230-3-50/60	44.1				
380-3-50	22.9	31	114	35	15.1
400-3-50	21.7				
460-3-50/60	18.9				
480-3-60	18.1				
575-3-60	16.4	25	90	30	16.3

Continued next page

Electrical Specifications, Continued

Table 14. 1102 HC Refrigeration Unit Electrical Characteristics			
Nominal Compressor Voltage	**Transformer Tap Setting and ID Label**	**Common Worldwide Voltage-Phase-Frequency**	**Voltage Range**
230 Vac	200-3-50/60	200-3-50/60 202-3-50/60 208/230-3-60	180-220 @ 50 Hz 185-220 @ 60 Hz
	230-3-50/60	208/230-3-60 220-3-50 230-3-60	207-230 @ 50 Hz 207-253 @ 60 Hz
460 Vac	380-3-50	380-3-50	342-418 @ 50 Hz
	400-3-50	400-3-50 415-3-50	360-440 @ 50 Hz
	460-3-50/60	440-3-50 460-3-60	414-460 @ 50 Hz 414-506 @ 60 Hz
	480-3-60	480-3-60	432-528 @ 60 Hz
575 Vac	575-3-60	575-3-60	518-632 @ 60 Hz

Table 15. 1102 HC Refrigeration Unit Electrical Protection Requirements					
Transformer Tap Setting and ID Label	**RLA Amps**	**MCC Amps**	**LRA Amps**	**Fuse Size Amps**	**Power Input kVA**
200-3-50/60	59.1	75	266	80	20.7
230-3-50/60					
380-3-50	25.8	31	114	35	17.0
400-3-50	24.5				
460-3-50/60	21.3				
480-3-60	20.4				
575-3-60	14.1	25	90	30	14.0

Refrigeration Location Considerations

The refrigeration unit should be installed in an environment that meets the following conditions:

- Indoors
- Above ground
- A well ventilated area
- A room temperature of 40-100° F (4-38 C)
- A relative humidity of 20-80%, no condensation

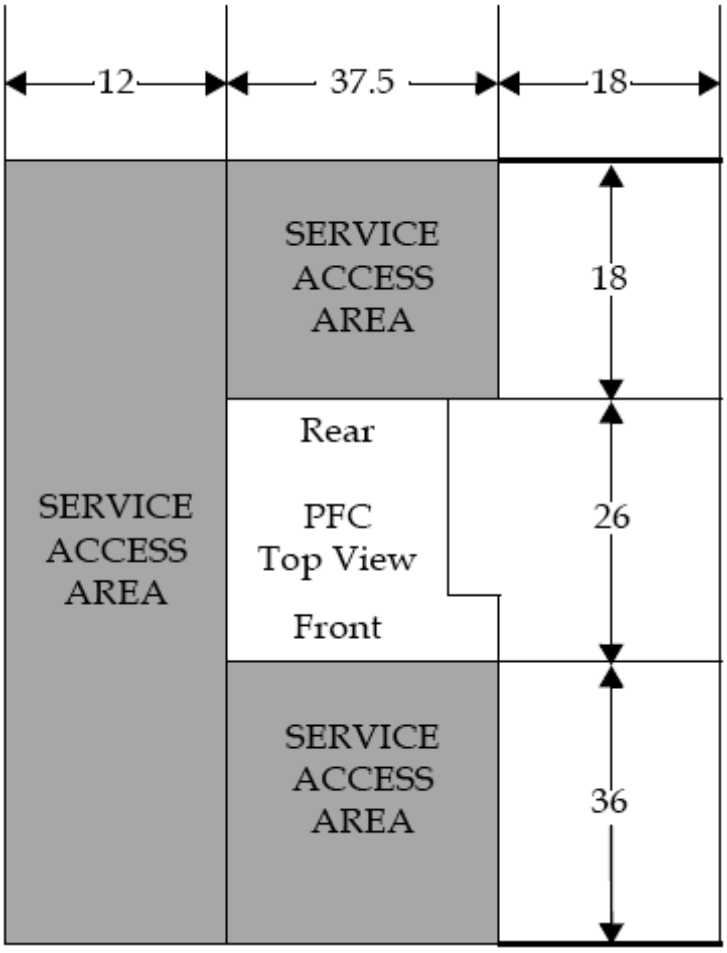
The refrigeration unit has a PRESSURE RELIEF OUTLET on the utility panel. This port has a 3/4-inch female NPT fitting. It allows the venting of refrigerant escaping from a pressure relief valve to another location. To install the unit to ASHRAE requirements, see Installing a Refrigeration Unit to Meet ASHRAE Requirements on page 15.

The unit must remain vertical. However, placement of the unit may be at any elevation relative to the cryosurface. The cryopumping system is not gravity-sensitive.

Refrigeration Unit Recommended Service Access Area

The PFC requires 18 inches of clear area at the back of the system and 36 inches at the front (see Figure 8). This is needed for access to switches, settings, and for safety reasons.
Service and maintenance are also slowed if the unit is installed in a confined area. For this reason we recommend that the unit be installed with as much clear service access area as the facility will allow.
Multiple units may be placed side by side as long as the rear of the unit is accessible.
When units are placed facing one another a 36-inch service area is required.

Figure 2. PFC Footprint (not to scale)



Refrigerants in the Refrigeration Unit

All refrigerant used in Polycold's PFC products have significant GWP values. Users and service providers should ensure that refrigerant is not released to the environment at any time. The refrigerant should be reclaimed and either recycled or destroyed in accordance with international regulations and the current best industry practices.

Calculations of the GWP as shown in Table 16 for the PFC refrigerant blends were calculated in accordance with the European Union's EC Regulation No 842/2006 on Certain Fluorinated Greenhouse Gases.

Table 16. GWP Values for PFC Refrigerants

Model	Refrigerants used in the Blend (see product I.D. Label for individual refrigerant component amounts)	Total Refrigerant Weight in kg (lbs)	Blend GWP
PFC-552 HC	R-236fa, R-125, R-23, R-14, Argon	3.79 (8.37)	7400
PFC-672 HC	R-236fa, R-125, R-23, R-14, Argon	4.90 (10.8)	7700
PFC-1101 LT	R-123, R-124, R-218, R-170, R-14, Argon	5.31 (11.7)	3223
PFC-1102 HC	R-236fa, R-125, R-23, R-14, Argon	7.86 (17.3)	7700

Feedthroughs

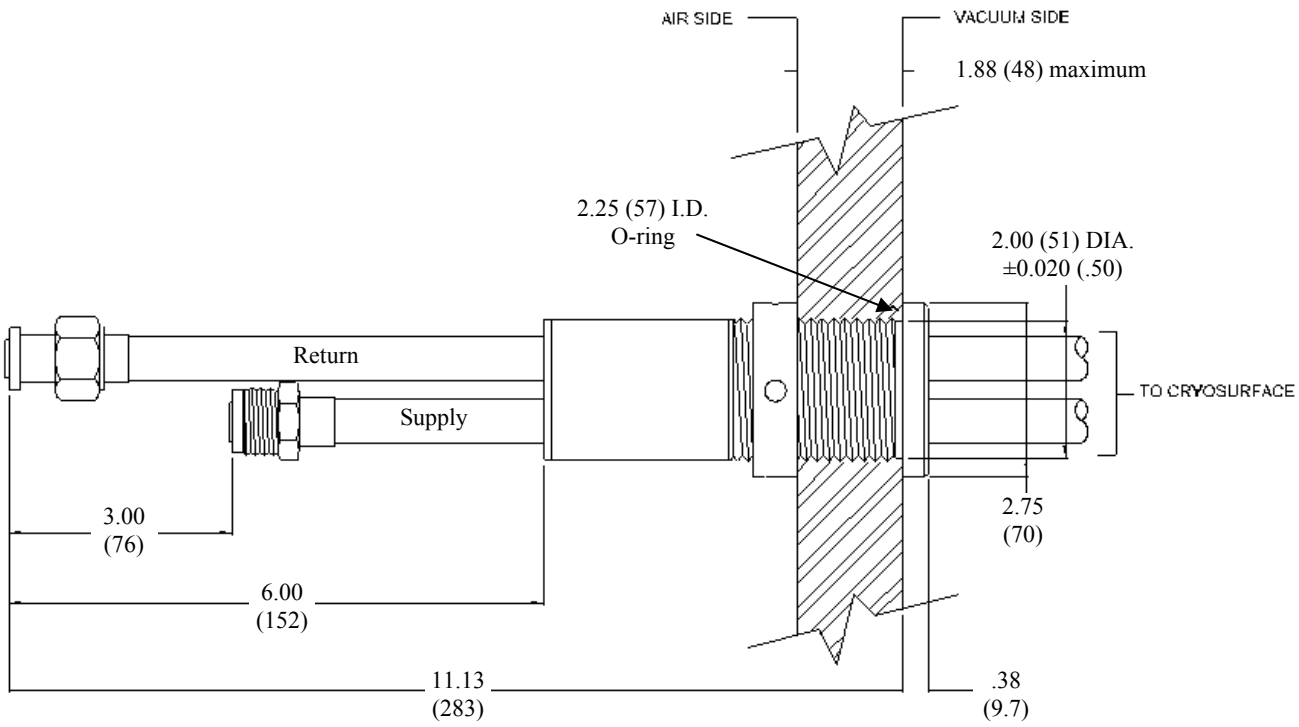
This section gives details about the Brooks Polycold feedthroughs that are used to provide refrigerant supply and return to the PFC cryosurface, through the vacuum chamber wall.

A single feedthrough incorporates both supply and return lines for the cryosurface.

All Brooks Polycold feedthroughs used with the PFC have a two-inch (50 mm) diameter barrel that fits into the vacuum chamber wall. Figure 4 is a close-up of a feedthrough, showing the diameter of the barrel of the feedthrough that fits into the hole in the vacuum chamber wall.

Note: Brooks Automation Polycold feedthroughs are designed to be installed from the inside of the vacuum chamber. This permits removal of the cryosurface when cleaning or servicing the vacuum chamber (see Figure 3).

Figure 3. Polycold's Two-Inch (50 mm) Feedthrough with Port Requirements



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Feedthroughs, Continued

Figure 4. Feedthrough Close-up of Barrel (Supply and Return Tubes not Shown)

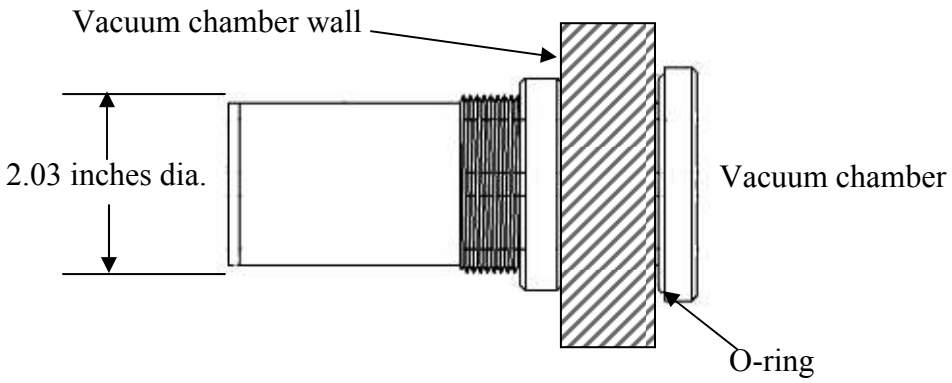
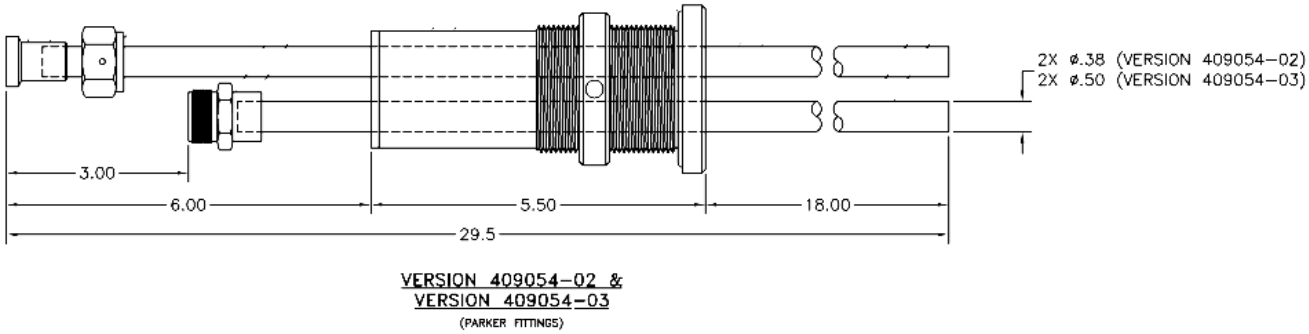


Figure 5, Figure 6, and Figure 7 are drawings of Brooks Automation Polycold feedthroughs for the refrigeration lines of a PFC.

Figure 5. Feedthrough; Version -2 and -03



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Feedthroughs, Continued

Figure 6. Feedthrough; Version -04

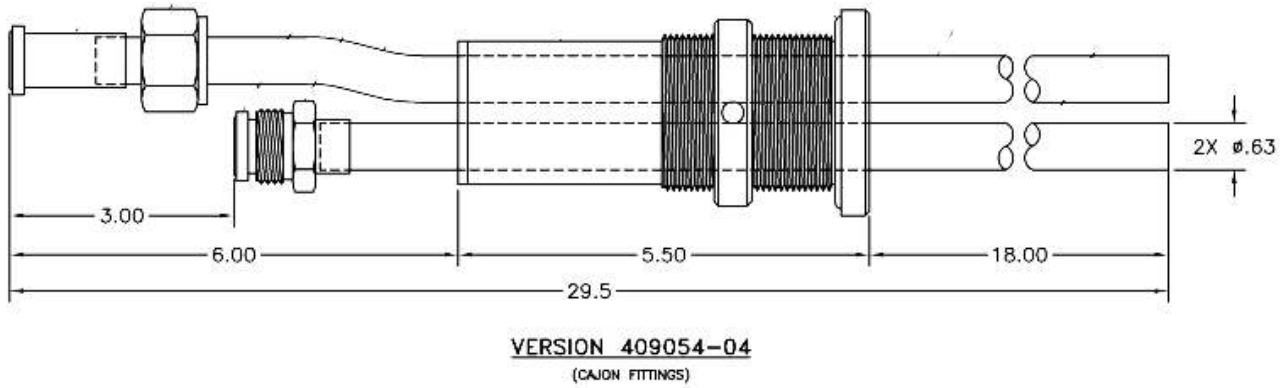


Figure 7. Feedthrough; Version -05

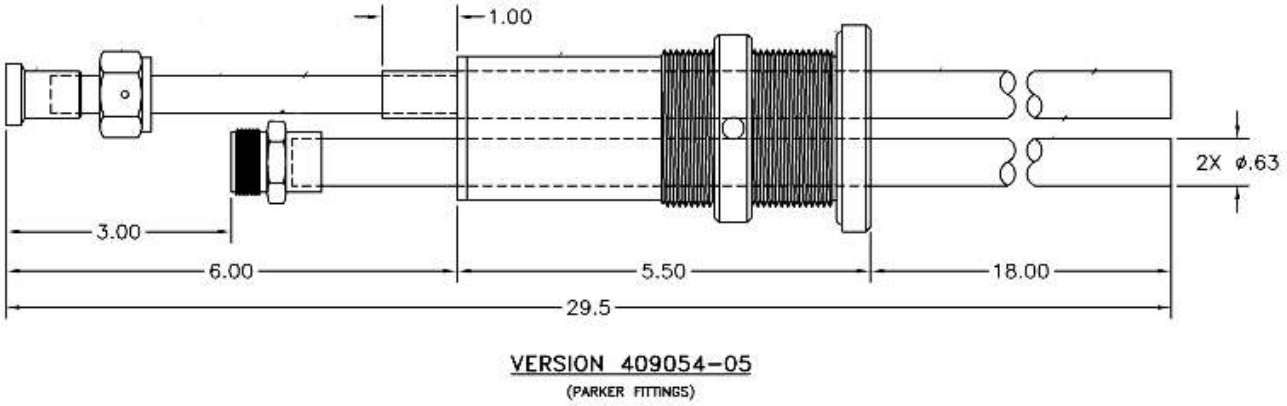


Table 17. Specifications for PFC Feedthrough	
Part	**Specification**
O-ring number 228	2.25 inches (57 mm) ID X 0.125 (3 mm) section
O-ring material	Buna-nitrile
O-ring surface	2.60 inches (66 mm) surface roughness not to exceed 32 micro-inch (0.000032 inch, or 0.81 micron); must be flat, clean, and free of scratches or deposits.

Cryosurface

The cryosurface is the "working end" of the PFC; it traps the material of interest. The cryosurface is one of two types:

- Cryocoil: used to trap water vapor
  or a
- Cryobaffle: used to trap backstreaming oil from an oil diffusion pump.

Cryocoil

There are two options for procuring a cryocoil:

- The customer fabricates their own
- Polycold fabricates one for the customer, based on information supplied by the customer

	CAUTION
	The cryocoil and feedthrough must be designed to sustain a working pressure of 450 psig (3100 kPa). The cryocoil and feedthrough are part of the refrigerant circuit of the cryopump. Failure to comply with the former specifications can result in damage to the equipment. Do not use reservoir-type or large volume cryocoils. Do not use large diameter tubing.

Cryocoil and Feedthrough Design Considerations

- The cryocoil must be a single continuous circuit (tube).
- Do not put branches in the circuit. It causes uneven distribution of the refrigerant mixture that degrades the performance of the cryopump.
- Do not add fins or panels to the circuit. The increased mass takes longer to cool and defrost the cryocoil and raises the cryocoil temperature.
- The cryocoil must be either stainless steel or refrigeration grade copper tubing.
- Stainless steel tubing is more durable and less chemically reactive. Minimum wall thickness is 0.020 inches (0.5 mm).
- Refrigeration grade copper tubing is easier to work with. Minimum wall thickness is 0.030 inches (0.76 mm).
- The cryocoil must have the proper surface area based on the diameter and length of the tubing. See Table 18 on page 28.
- The cryogenic feedthrough must be thermally isolated; a vacuum isolated feedthrough is preferred.
- If customer is providing a feed-through, mating couplings are shipped with the unit. The couplings must be offset 3 inches (76 mm) to be connected to the refrigerant line. (See Figure 3 on page 24.)

Continued on next page

Cryosurface, Continued

Cryocoil, Continued

Table 18. Cryocoil Size Specification			
Refrigeration Unit	**Total Surface Area ft^2 (m^2)**	**Tube Diameter in (mm)**	**Tube Length ft (m)**
PFC 552 HC (CE)	5.4 (0.50)	1/2 (12)	41.1 (13.3)
PFC 672 HC (CE)	7.5 (0.70)	5/8 (16)	46 (14)
PFC 1101 LT	5.4 (0.50)	1/2 (12)	41 (13)
PFC 1102 HC (CE)	21.6 (2.0)	5/8 (16)	132 (40)
Note: For PFC/PFC: The total surface area must be divided between the two cryocoils. Larger cryocoils may give faster pumping speeds, and can be used in some applications. However, if the heat load is too great, the cryopump will become less efficient and may be shut off by a protective device.			

Continued next page

Cryosurface, Continued

Cryocoil, Continued

	**CAUTION** Use of unauthorized, non-standard couplings will void your warranty. Improper use of, incorrect installation of, over-tightening of, or use of damaged o-rings in couplings will void your warranty.

It is preferable to weld or braze all connections inside the vacuum chamber. If this is not practical, use one of the couplings listed below. These couplings have been tested and found to be satisfactory. Other types of couplings may leak.

- Parker CPI UltraSeal compatible couplings with silver-plated stainless steel O-rings.
- Cajon VCR couplings with silver-plated stainless steel gaskets or un-plated nickel gaskets.

The supports for the cryocoil must allow for thermal contraction and expansion as the coil is cooled and defrosted. Also the supports must not add a significant heat load to the cryopump. Suitable supports can be made of thin stainless steel rods or tubing. Some plastics may be suitable for certain applications.

Guidelines for building cryocoils and feedthroughs:

- Use a tubing bender or mandrel so that the tubing is smooth and wrinkle-free. Follow the instructions in the Brazing Specification, found in the Appendix. Make certain the tubing is clean and free of corrosion, flux, and particle residue (inside and out).
- Pressure-test the cryocoil:
  - Pressure-test the cryocoil before you connect it to the refrigeration unit. The pressure relief valve for the refrigerant line and cryosurface may leak if it is pressurized above 335 psig (2310 kPa).
  - Use a helium mass spectrometer if one is available for leak checking
  - Pressure-test the cryocoil to 615 psig (4240 kPa) (gauge) (i.e., 6.895 X psig)

    Note: 615 psig = 1.43 x 430 psig.

	**CAUTION** The tubing must be free of oil and moisture before connecting it to the refrigeration unit. Failure to comply with the former specification can result in damage to the equipment.

Continued next page

Cryosurface, Continued

Cryocoil, Continued

Location of the Cryocoil

Where the cryocoil is installed must take into account the following considerations:

- Ensure that process material, such as deposition source material, is not deposited on its surface.
- It has unimpeded line-of-sight view of the surfaces most likely to emit water vapor.
- It is facing away (or can be shielded) from sources of heat greater than 50°C.
- It is not subject to damage from moving objects.
- It can be supported without significant thermal conductance from the vacuum chamber.

Additionally, If a vacuum isolated feed-through is used, it must be located so that water will not collect in it when the cryocoil is defrosted. Subsequent freezing of this water may damage the cryocoil and/or cause vacuum or refrigerant leaks.

Cryosurface, Continued

Cryobaffle

Purpose of a cryobaffle

When oil diffusion vacuum pumps are used in vacuum systems, a phenomenon known as "backstreaming" takes place. Backstreaming occurs when hot oil vapor from the diffusion pump migrates into the vacuum system and condenses onto cold surfaces in the vacuum system. This contamination will have a negative affect on vacuum processes.

Choose a Good Location for the Cryobaffle

The cryobaffle must be shielded from sources of heat greater than 50°C. The cryobaffle must not come in direct contact with the vacuum chamber wall.

	**CAUTION** The cryocoil, cryobaffle and feedthrough must be designed to sustain a working pressure of 450 psig (3100 kPa). The cryocoil, cryobaffle and feedthrough are part of the refrigerant circuit of the cryopump. Failure to comply with the specifications can result in damage to the equipment. Do not use reservoir-type or large volume cryobaffles. Do not use large diameter tubing.

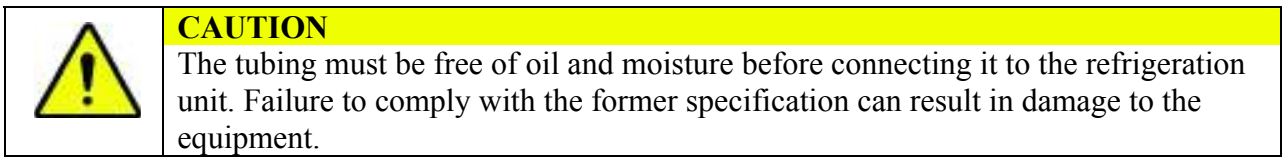
Continued next page

Cryosurface, Continued

Cryobaffle, Continued

Design requirements for cryobaffles and feedthroughs

- The cryobaffle must be a single continuous circuit (tube). Braze the fins of a baffle to this tube.
- Contact a Brooks Automation Polycold Systems for instructions on sizing the cryobaffle to the application and other information.
- Do not put branches in the circuit. It causes uneven distribution of the refrigerant mixture that degrades the performance of the cryopump.
- The cryobaffle should be made with refrigeration grade copper tubing and with OFHC (oxygen free, high conductivity) copper fins.
    - The refrigeration grade copper tubing must have a minimum wall thickness of 0.030 inches (0.76 mm).
    - The cryobaffle may be nickel-plated.
- The cryogenic feed-through must be thermally isolated; a vacuum isolated feed-through is preferred. **Note**: Some multi-coolant baffles do not have appropriate feedthroughs and should not be used. If the feed-through is not sufficiently insulated:
    - The additional heat load at the feedthrough can significantly degrade the performance of the cryopump.
    - The elastomeric seal (O-ring) may become too cold and cause a vacuum leak.
    - Ice may form on the outside surfaces of the vacuum chamber.
    - If customer is providing feedthrough, mating couplings are shipped with the unit. The couplings must be offset 3 inches (76 mm) to be connected to the refrigerant line. (See Figure 3 on page 24.)
- Use a tubing bender or mandrel so that the tubing is smooth and wrinkle-free.
- Follow the instructions in the Brazing Specification in the Appendix.
- Make certain the tubing is clean and free of corrosion, flux, and particle residue inside and out.
- Pressure-test the Cryobaffle to 615 psig 4240 kPa (gauge) (i.e., 6.895 X psig) This test must be done before connecting the cryobaffle to the refrigeration unit. The pressure relief valve for the refrigerant line and cryosurface may leak if it is pressurized above 335 psig (2310 kPa). **Note**: 615 psig = 1.43 x 430 psig
- Check the Cryobaffle for leaks using a helium mass spectrometer if one is available.



Refrigerant Lines

This section includes specifications and instructions for fabricating refrigerant lines for routing refrigerant from the refrigeration unit to the cryosurface, and back to the refrigeration unit.

CAUTION

Equipment caution

The refrigerant line must be designed to sustain a working pressure of 450 psig (3100 kPa). The refrigerant line is part of the refrigerant circuit of the cryopump. Improper design and/or handling can result in damage to the line or equipment. Design and handle the refrigerant line carefully.

WARNING

Use of unauthorized, non-standard couplings will void your warranty. Improper use of, incorrect installation of, over-tightening of, or use of damaged o-rings in couplings will void your warranty. See the CAUTION below.

CAUTION

GENERAL HAZARD

A common source for leaks is improper connection of the couplings. Internal leaks can result in damage to the equipment. Use a new O-ring or gasket each time the coupling is assembled. Do not use grease when assembling the couplings. Grease can contaminate the cryopump. It can also mask a leak during the leak-checking procedures. The coupling will leak when the grease gets brittle at cryogenic temperatures. Do not scratch or dent the sealing surfaces of the couplings. Always use the O-ring removal tool to remove an O-ring from the Parker CPI UltraSeal compatible couplings.

Note 1: Position the unit as close as possible to the cryosurface. The longer the refrigerant line, the warmer the refrigerant gets before it reaches the cryosurface.

Note 2: Braze the refrigerant line to the cryosurface unless the cryosurface will be removable. If so, use Parker CPI UltraSeal compatible or Cajon VCR couplings. These couplings have been tested and found to be satisfactory. Other types of couplings may leak.

3. Installation Steps

Place the Refrigeration Unit

Tools and materials:

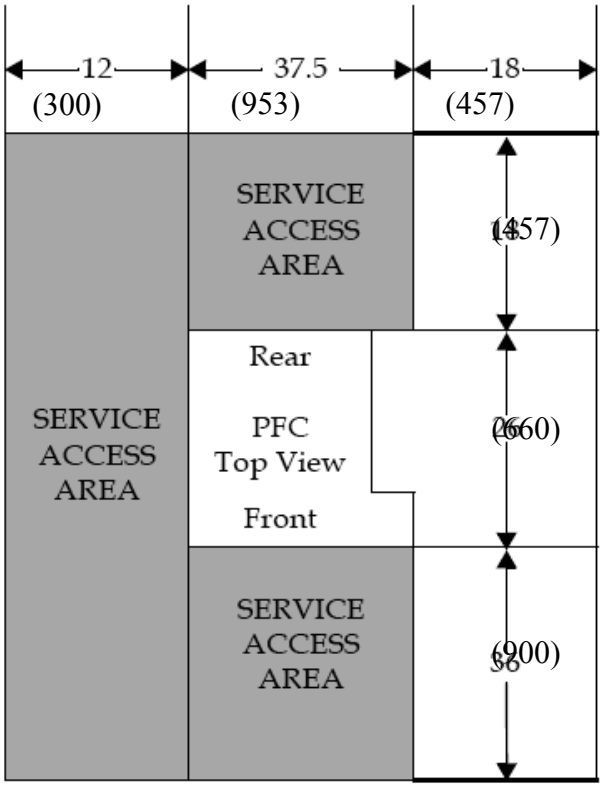
- Tools needed to lift and place the compressor unit – see Warning and Cautions below
- Phillips screwdriver, large
- 9/16-inch wrenches, two

Note: If the unit being installed includes the Lifting Eyes option, refer to addendum 825153-00. If viewing this manual on CD, the addendums can be found in the Addendums folder.

	**WARNING** PREVENT INJURY The refrigeration unit weighs between between 374 kg (825 lbs) and 544 kg (1200 lbs). Use care when lifting or moving the compressor unit. Failure to properly lift this device may result in serious injury or death.
	**WARNING** HIGH PRESSURE RUPTURE If a high pressure circuit is ruptured equipment damage could occur. In addition, cuts and eye injury from flying objects could result in death or serious injury.
	**CAUTION** GENERAL HAZARD These products contain fluorinated green house gases covered by the Kyoto Protocol.

Continued next page

Place the Refrigeration Unit, Continued

Step	Action
1.	For the space requirements of the refrigeration unit, refer to Figure 8 and Figure 9. Also, note the following: • Place the unit in an area where routing and connecting the water and electrical power will not pose a personnel or equipment hazard. • Place the refrigeration unit as close as possible to where the cryosurface will be installed. • Orient the refrigeration unit for ease of maintenance and connection of facilities and refrigerant lines. • Place the refrigeration unit indoors and above ground. • Place the refrigeration unit in a well-ventilated area. • Place the refrigeration unit in an environment where the temperature is between 40° – 100° F (4° – 38° C). **Figure 8. PFC Footprint (not to scale)** Measurements are in inches (millimeters) 
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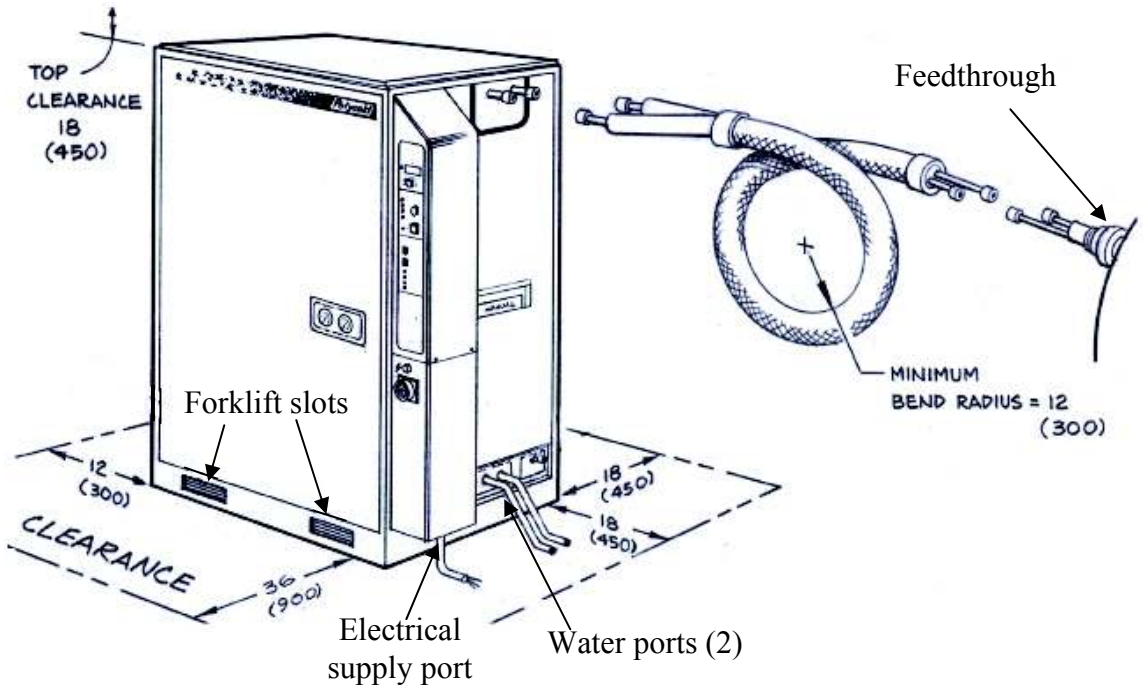
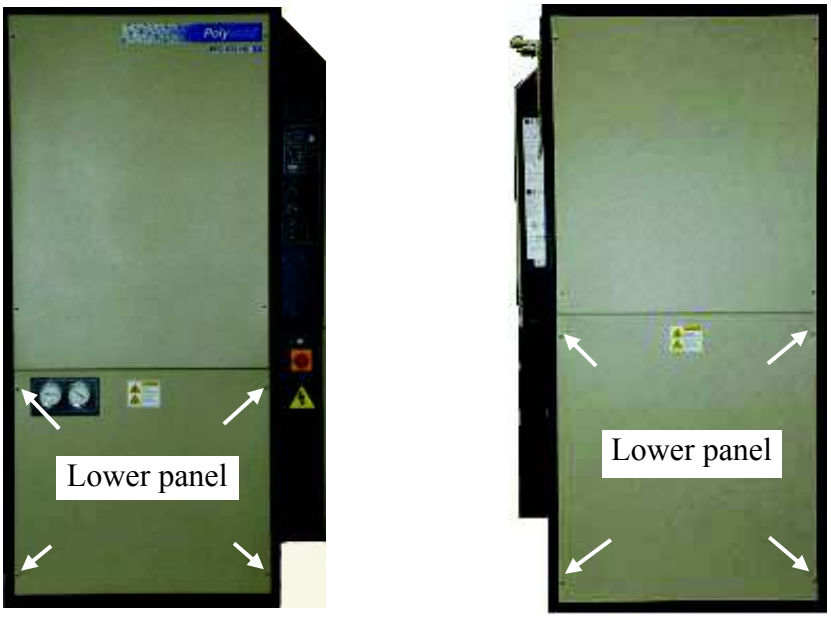
Place the Refrigeration Unit, Continued

Step	Action
2.	When moving and placing the refrigeration unit, review Figure 9 below. **Figure 9. Refrigeration Unit Placement Considerations**  Measurements are in inches (millimeters)
3.	Use a forklift or other appropriate machine to lift the refrigeration unit. Note the forklift slots in the bottom of the refrigeration unit in Figure 9.
	Continued next page

Place the Refrigeration Unit, Continued

Step	Action
4.	The refrigeration unit must remain vertical while being moved. However, placement of the unit may be at any elevation relative to the cryosurface. The cryopumping system is not gravity-sensitive.
5.	Place the refrigeration unit.
Remove the Compressor Hold-down Nuts	
6.	Use a Phillips-head screwdriver to remove the screws that retain the lower panels on the front and rear of the refrigeration unit. Figure 10 shows the location of the retaining screws for the lower panels. **Figure 10. PFC Refrigeration Unit Lower Panels** Front Rear 
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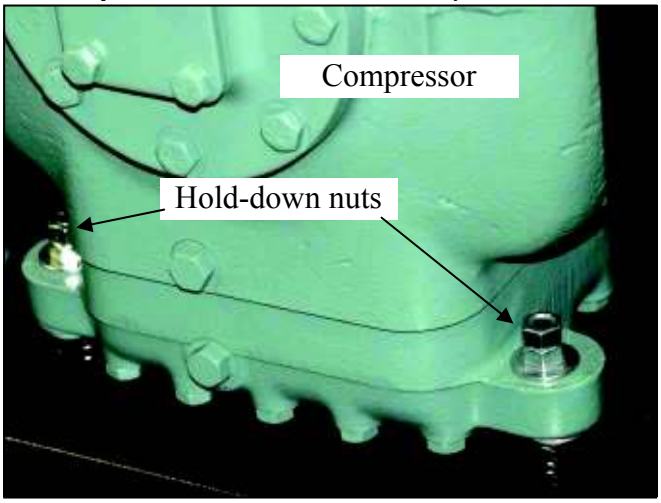
Place the Refrigeration Unit, Continued

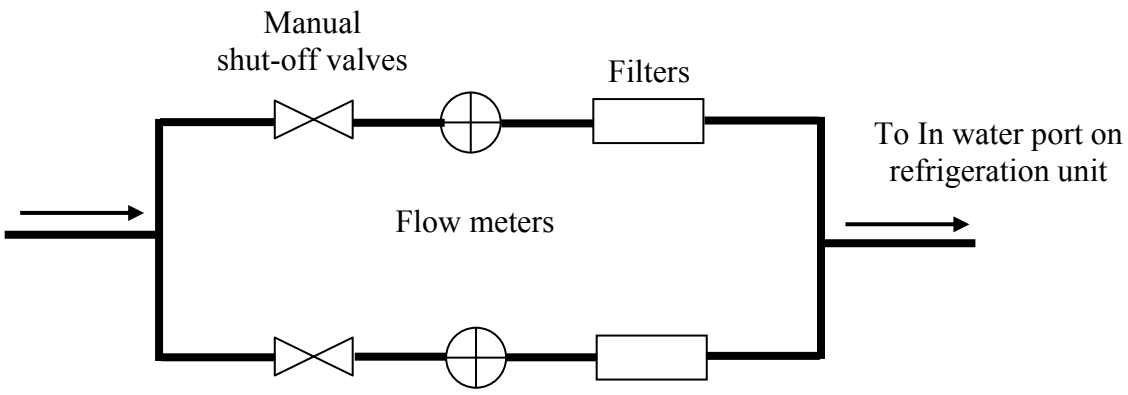
Step	Action
7.	In the bottom of the refrigeration unit, locate the compressor. Then locate the hold-down nuts on the compressor; see Figure 11. There are four hold-down nuts on the compressor. **Figure 11. PFC Compressor Hold-down Nuts (seen from rear of unit)** 
8.	Using two 9/16-inch wrenches, place one wrench on the lower nut, and the other wrench on the upper nut, then loosen the upper nut and remove it from the bolt.
9.	Use a 9/16-inch wrench to loosen and remove the lower nut.
10.	Perform steps 8 and 9 on the remaining three hold-down nuts. **Note:** Save the hold-down nuts for future use in case you need to move or ship the refrigeration unit.
11.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Connect Cooling Water to the Refrigeration Unit

Tools and materials:

- 552 and 672s:
  These have 1/2-inch female NPT fittings. Fabricate water lines from 1/2-inch (15 mm) standard pipe with compatible fittings.
- 1101 and 1102s:
  These have 3/4-inch female NPT fittings. Fabricate water lines from 3/4-inch (20 mm) standard pipe with compatible fittings.
- Pipe wrenches
- Thread sealant

	**CAUTION** GENERAL HAZARD If cooling water has not been connected, damage to the equipment can result. Verify that cooling water has been connected before turning on the unit.

Step	Action
1.	Ensure that the water supply for the PFC refrigeration unit meets the specifications in PFC Service Manual 825152-00.
2.	To avoid equipment shutdown during scheduled maintenance, it is recommended to install two parallel valves, water filters, and flow meters in the water supply line for the refrigeration unit (see Figure 12). This allows for shutting one valve to service a filter, while keeping the other parallel circuit open, providing water to the refrigeration unit during the procedure. **Note:** If using rotameter-type flow meters, their inherent restriction may reduce the actual flow rate delivered to the refrigeration unit. **Figure 12. Redundant Water Circuits in Supply Line** 
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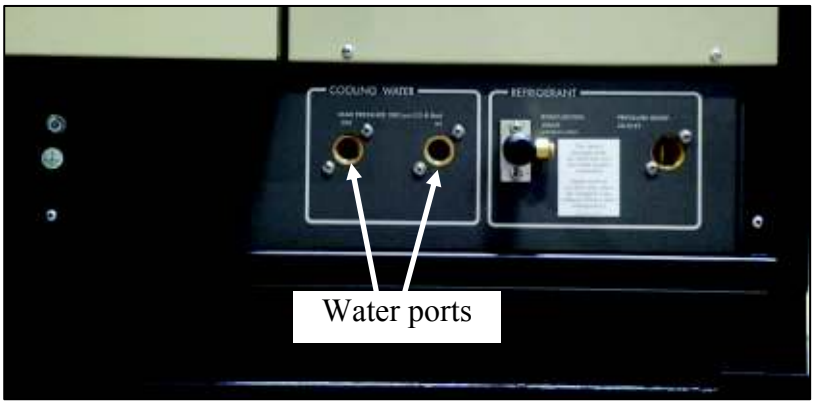
Connect Cooling Water to the Refrigeration Unit, Continued

Step	Action
3.	Route the supply and drain water lines to the In and Out water fittings on the lower right side of the refrigeration unit (see Figure 13). **Figure 13. Location of Water Ports on Refrigeration Unit** 
4.	Use Teflon tape or paste to seal the threads of the male fittings that will screw into the In and Out ports on the refrigeration unit.
5.	Connect the supply water line to the In water port, and the drain water line to the Out port on the refrigeration unit. **Optional:** Install pressure gauges on the water lines at the refrigeration unit in order to measure the pressure drop within the refrigeration unit. This will help you adjust the water flow for optimum operation of the PFC. It will also aid you in troubleshooting if there are water cooling problems.
6.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Connect Electrical Power to the PFC

Tools and materials:

- Wire cutter, heavy duty
- Wire stripper
- Tie-wraps or other material for dressing wires and cable
- Phillips torque screwdriver, #2
- Four-wire cable (three phases plus ground) for routing electrical power to the refrigeration unit; refer to the section Specifications and Site Requirements in the PFC Service Manual for the electrical specifications for the power cable for the model you are working on.

WARNING

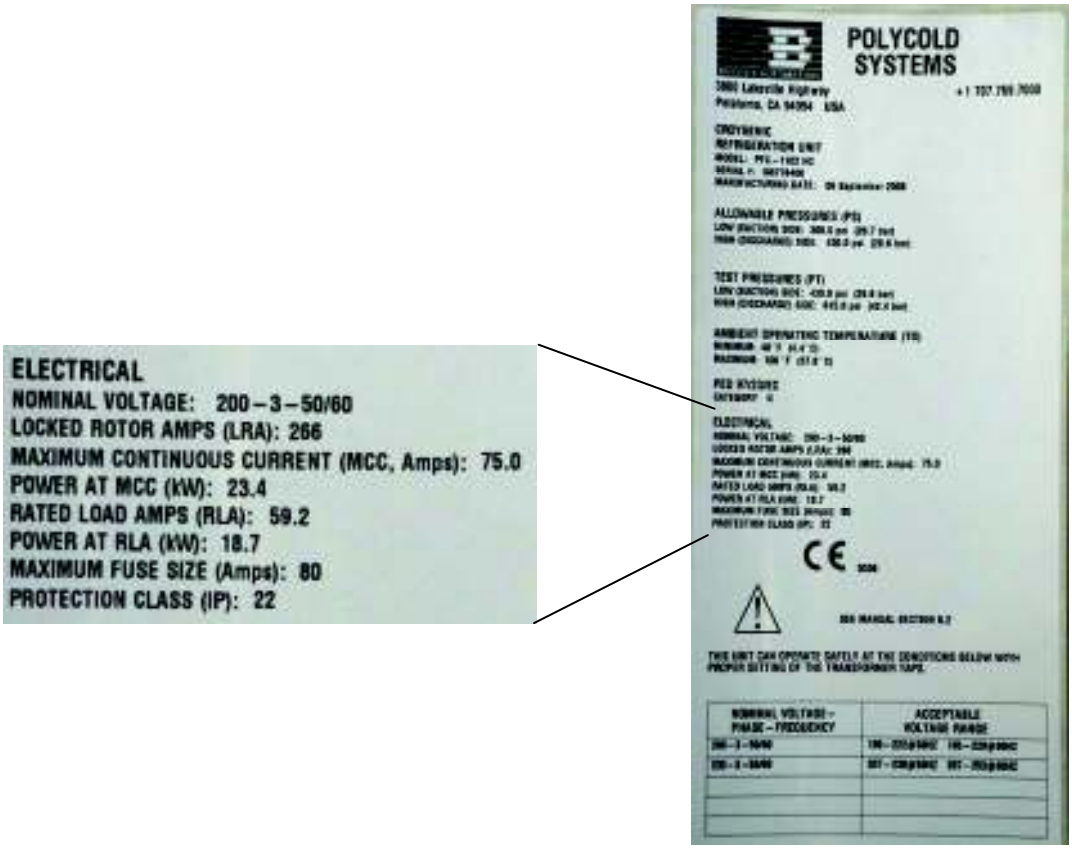
ELECTRICAL
Hazardous voltages exist. Failure to have a qualified electrician do all electrical work could result in death or serious injury.
Make sure the electrical supply is not energized. Do not reach inside the refrigeration unit. A qualified electrician must do all electrical work. Electrical work must be completed according to local codes.

Note: When determining the route for the electrical power cable for the PFC refrigeration unit, consider the following:

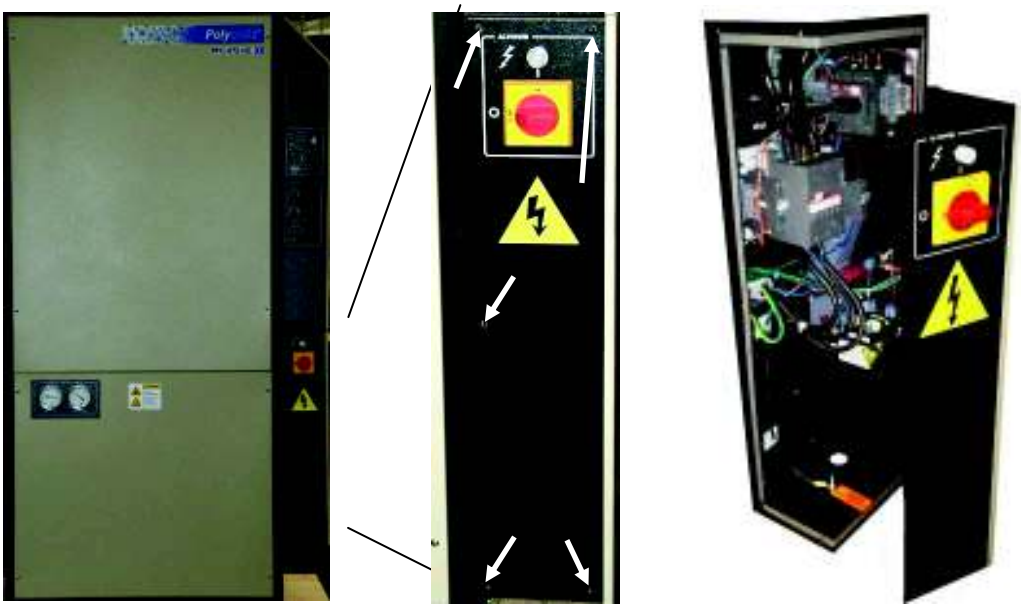
- Do not route of the power cable so that it presents a hazard or obstruction to people.
- Do not route the power cable so that it is an obstruction to performing maintenance on any equipment.

Continued next page

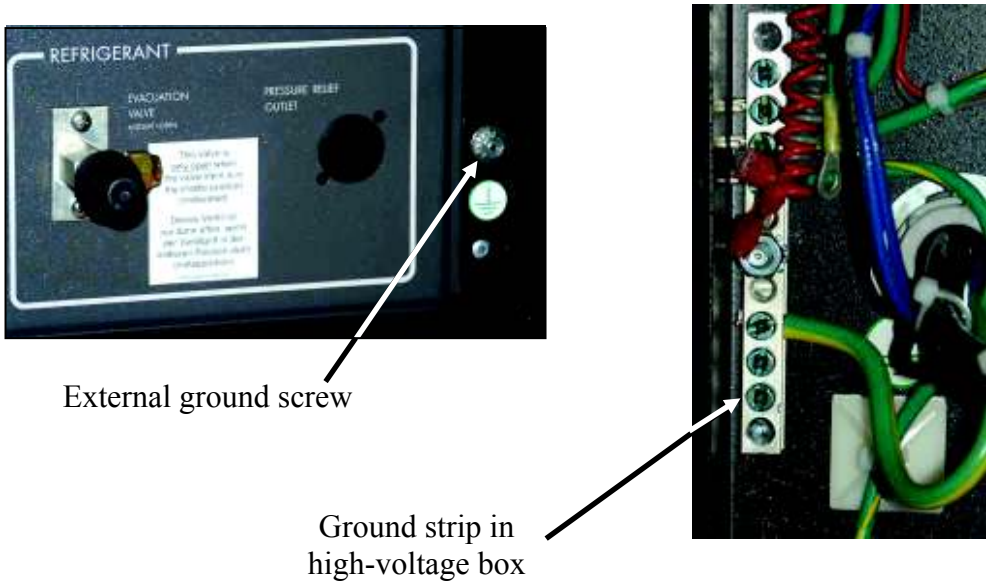
Connect Electrical Power to the PFC, Continued

Step	Action
1.	To find the nominal electrical requirements of the PFC you are installing, check the nameplate on the rear of the utilities panel on the refrigeration unit. See Figure 14. The unit should have a dedicated electrical supply that meets its electrical requirements.  **Figure 14. PFC Nameplate on the Refrigeration Unit**
2.	At the electrical power source for the PFC, make sure the power is switched off.
	Continued next page

Connect Electrical Power to the PFC, Continued

Step	Action
3.	Route a four-conductor cable from the power source for the refrigeration unit to the high-voltage box of the refrigeration unit (see Figure 15). Ensure that the cable is sized and insulated appropriately for the electrical specifications and environment.
4.	On the front of the PFC refrigeration unit, locate the high-voltage box (see Figure 15). Use a Phillips screwdriver to remove the five screws that retain the cover of the high-voltage box. Carefully pull the cover away from the high-voltage box to reveal the interior of the box (**C** in Figure 15). The cover has a cable that attaches to the interior of the high-voltage box. Temporarily support the cover to allow work within the high-voltage box. **Figure 15. Electrical Boxes on the PFC (front view)** **A** **B** **C**  Front of refrigeration unit Close-up of high-voltage box High-voltage box opened Shows location of retaining screws
	Continued next page

Connect Electrical Power to the PFC, Continued

Step	Action
5.	Ground the PFC refrigeration unit according to local regulations. The PFC refrigeration unit has two locations for connecting electrical earth ground (see Figure 16): **1101 and 1102s**: there is an external ground screw on the lower frame, to the right of the evacuation valve, and a ground strip inside the high-voltage box, on the left side. **552s and 672s**: inside the high-voltage box, on the left side, is a grounding strip that clamps un-terminated wires. There is no external ground screw on these units. Use the grounding method that best meets your local regulations for grounding. **Attaching methods:** • On the external ground screw, use a ring terminal. • On the internal ground strip, use dressed, un-terminated wire ends **Figure 16. Grounding the PFC Refrigeration Unit** 
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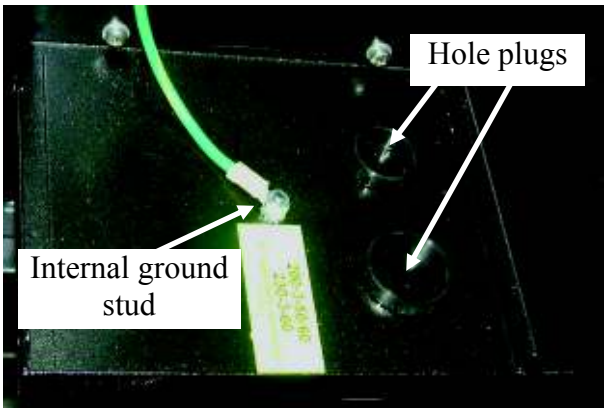
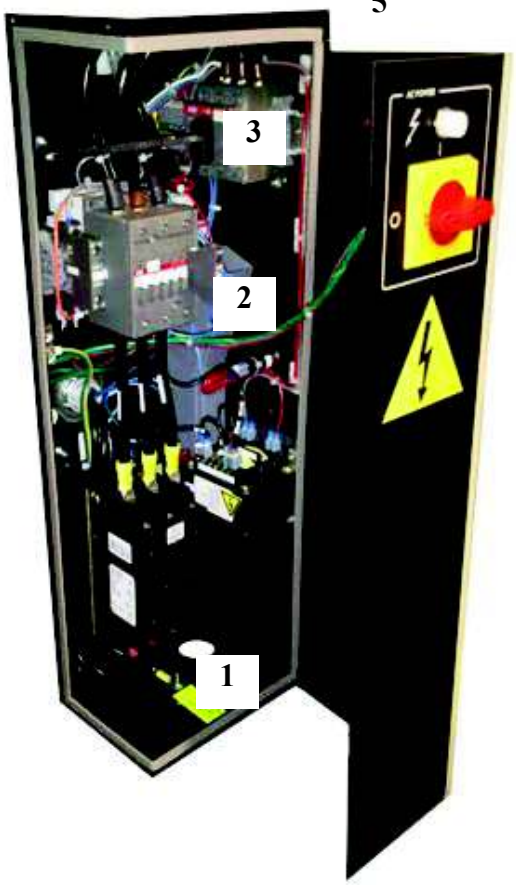
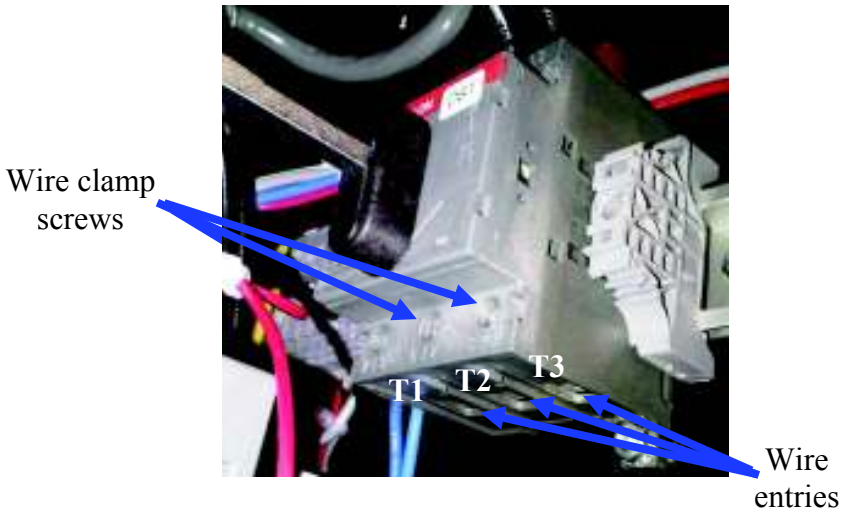
Connect Electrical Power to the PFC, Continued

Open the entry hole in the bottom of the high-voltage box	
Step	**Action**
6.	In the bottom of the high-voltage box, locate the hole plug (there may be more than one). See Figure 17. Push out the plug from one of the holes. This hole will be the entry point for the electrical supply wires. **Note:** The customer is responsible for providing a conduit elbow or other fitting for the entry hole in the high-voltage box to prevent abrasion of the power cable or wires. **Figure 17. Hole Plugs in Bottom of High-Voltage Box** 
	**CAUTION** GENERAL HAZARD If the internal ground stud is not used damage to the equipment can result. Verify that the nut holding the washers and terminal lugs is tight.
	Continued next page

Connect Electrical Power to the PFC, Continued

Route the power wires inside the high-voltage box	
Step	**Action**
7.	Route the power wires through the high-voltage box as shown in Figure 18. **Figure 18. Routing Electrical Power Wires Through the High-Voltage Box** Follow the numbers to route the power wires through the high-voltage box. See Addendum 1 for the 1102 230 VAC model. **1**: From the entry hole in the bottom of the high-voltage box, bend the power wires toward **2**. **2**: Route the wires up and through the upper wire guide. 1102 and 672 (230 VAC)  All other models 
	Continued next page

Connect Electrical Power to the PFC, Continued

Step	Action
8.	Connect the three phases of the electrical power to disconnect DS1 as shown in Figure 19. Back out the wire clamp screws part way to open the wire entry points, insert the wires into the wire entries, and then tighten the wire clamp screws. Torque wire clamp screws to 35 in-lbs (4.0 N-m). Pull slightly on each wire to make sure they are clamped securely in the disconnect. **Note**: Ensure that there are no stray wire strands near the wire entries that may short-circuit the incoming power. **Figure 19. Electrical Power Connections to Disconnect DS1** 
9.	Use tie-wraps of other approved material to dress the power cable and wires according to local practice.
10.	Replace the cover on the high-voltage box. Take care that the wires attached to the cover don't get caught between the cover and the box.
11.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task in the checklist.
End of Procedure	

Install the Cryosurface

This section describes how to install either a cryocoil (water vapor trapping) or cryobaffle (minimize backstreaming). Refer to the PFC Service Manual for descriptions of both, or contact Brooks Automation Polycold Systems for more information.
Other tasks in this Installation section describe how to install the refrigerant line that connects the cryosurface to the refrigeration unit.

Note 1: This task assumes that a cryosurface and standard 2-inch (50 mm) feed-through from Brooks Automation Polycold Systems are being installed. If not, see the Specifications and Site Requirements section in the PFC Service Manual before performing this task.

Note 2: See the section on feed-throughs in Specifications and Site Requirements in the PFC Service Manual for the requirements for the feed-through port in the vacuum chamber.

Note 3: If a cryobaffle or cryocoil and accompanying feed-through has been custom-fabricated, that is, has not been made by Brooks Polycold, verify that the part meets the specifications given in the section Specifications and Site Requirements in the PFC Service Manual before performing this task.

The feed-through on the Brooks Polycold Systems cryosurface is designed to be installed from the inside of a vacuum chamber. This allows removal of the cryosurface when cleaning or servicing the vacuum chamber.
Tools and materials:

- Spanner wrench †
- High-vacuum grease – must have an appropriate low vapor pressure (for optional use on the feed-through's O-ring)

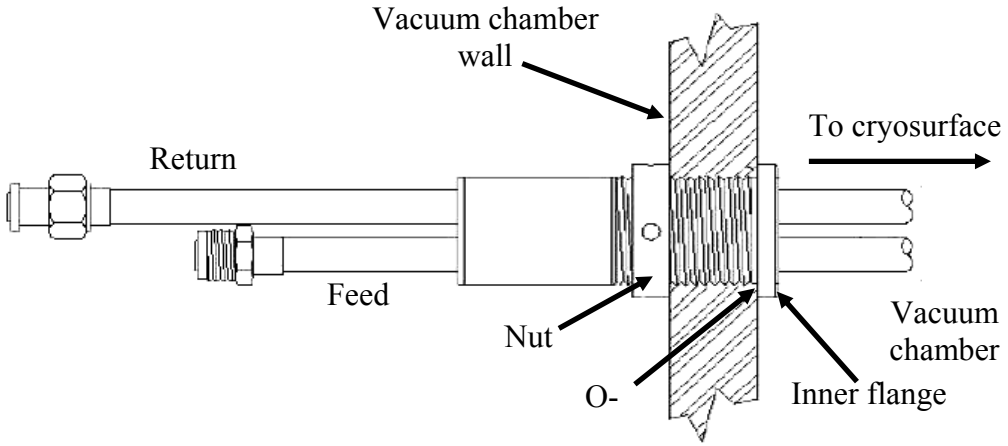
CAUTION

GENERAL HAZARD
Do not connect the refrigeration unit to a cryosurface without first verifying that the cryosurface meets specifications. The refrigeration unit's working pressure may exceed your cryosurface's working pressure, which may damage your vacuum system components and may result in minor or moderate injury (reservoir type cryosurfaces are not suitable.)
Verify all components meet specifications before connection.

Continued next page

Tools and materials:

- Spanner wrench, P.N. 810030-07 (found in cryocoil kit, or order separately)

Step	Action
1.	Inspect and clean the inner and outer surfaces of the feed-through port on the vacuum chamber wall where the cryosurface feed-through will be installed.
2.	On the feed-through, inspect and clean the O-ring groove and O-ring in the inner flange of the feed-through.
3.	Insert the O-ring into the groove in the inner flange. See Figure 20.
4.	From the inside of the vacuum chamber, insert the feed-through into the feed-through port. Tighten the feed-through nut finger-tight and position the cryosurface. If the cryosurface has fasteners, secure them at this time. See Figure 20. **Figure 20. Typical Feedthrough** 
5.	**If you are installing a cryobaffle:** If the cryobaffle is a Polycold "CB" type, carefully center it between the flange bolt holes to assure a good O-ring seal.
6.	Verify that no moving parts will hit the cryosurface. Make sure the cryosurface does not touch the vacuum chamber wall or anything else in the vacuum chamber. The cryosurface should be at least 5/8-inch (16 mm) away from the vacuum chamber wall.
7.	Hold the feed-through in place and tighten the nut with the spanner wrench included with the cryosurface assembly. Make certain the nut is tight. If the nut is loose, the O-ring will tend to lift from the vacuum chamber wall when under vacuum.
8.	Install a heat radiation shield if the cryocoil is in direct view of a source of heat greater than 50°C. Position the shield between the cryocoil and the heat source. The shield should be as close as possible to the heat source, and as far away as possible from the cryocoil. The cryocoil traps molecules best when it has maximum view of the vacuum chamber.
9.	Check the vacuum chamber for leaks. If any leaks are found, correct them before proceeding.
10.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task in the checklist.
End of Procedure	

Optional: Fabricate the Refrigerant Lines

Note 1: In this manual, the term *refrigerant line* refers to an insulated bundle that contains two lines (supply and return) that conducts a refrigerant between the PFC refrigeration unit and the cryosurface feed-through.

It is recommended that the customer utilize Brooks' Polycold experience to fabricate refrigerant lines for their PFC application. However, if you wish to fabricate your own refrigerant lines, this section gives you information for fabricating refrigerant lines to connect the PFC refrigerant unit to a cryosurface.

Please note: The content in this section is for informational purposes **ONLY!** The information for fabricating a refrigerant line may change without notice. Please contact your Brooks' Polycold customer representative for more information.

Note 1: Position the unit as close as possible to the cryosurface. The longer the refrigerant line, the warmer the refrigerant gets before it reaches the cryosurface.

Note 2: Braze the refrigerant line to the cryosurface unless the cryosurface will be removable. If so, use Parker CPI UltraSeal compatible or Cajon VCR couplings. These couplings have been tested as part of the design of Brooks' Polycold-manufactured refrigerant lines. Other types of couplings may leak.

⚠ CAUTION

GENERAL HAZARD
The refrigerant line must be designed to sustain a working pressure of 450 psig (3100 kPa). The refrigerant line is part of the refrigerant circuit of the cryopump. Improper design and / or handling can result in damage to the line or equipment. Design and handle the refrigerant line carefully.

⚠ CAUTION

Use only the couplings specified in this section in the fabrication of PFC refrigerant lines. The refrigerant lines manufactured by Brooks' Polycold are designed to use the couplings specified in this section.

Continued next page

Optional: Fabricate the Refrigerant Lines, Continued

Tools and materials:

- Closed-cell pipe insulation rated for cryogenic temperatures
- Type T (copper-constantan) thermocouple wire
- Wire stripper; a thermal wire stripper is preferred
- Soft drawn refrigeration grade copper tubing with a minimum wall thickness of 0.030 inches (0.76 mm)
- Feed line for PFC-552, 672, and PFC/PFC-1101 and 1102:
  - 5/16 inch (8 mm) OD tube brazed to a short 1/2 inch (12 mm) OD tube
- Feed line for PFC-1101, and 1102
  - 3/8 inch (10 mm) OD tube brazed to a short 5/8 inch (16 mm) OD tube
- Return line for PFC-552, 672, and PFC/PFC-1101 and 1102:
  - 1/2 inch (12 mm) OD tube
- Return line for PFC-1101, and 1102
  - 5/8 inch (16 mm) OD tube
- Couplings to connect refrigerant lines to the cryosurface (mating couplings are provided to connect the refrigerant lines to the refrigeration unit)
  - Standard::
    1/2-inch Parker CPI UltraSeal compatible couplings with silver-plated stainless steel O-rings
  - Optional:
    5/8-inch Cajon VCR couplings with silver-plated stainless steel gaskets or unplated nickel gaskets
- For soldering:
  - Sand paper
  - Propane torch
  - Lead-free rosin core solder
  - Rosin flux
- For Brazing: see the Brazing Specification on page 107.

Continued next page

Optional: Fabricate the Refrigerant Lines, Continued

Step	Action
1.	Construct the refrigerant line according to the needs of your application. **Note:** For lengths greater than 20 feet, contact Technical Support at Brooks Automation Polycold Systems.
2.	Clean the supply and return tubes inside and out so that they are clean and free of corrosion, flux, and particle residue.
Attach thermocouples to the feed and return lines	
3.	Remove 1/2 inch (13 mm) of insulation from one end of the thermocouple wires.
	**CAUTION** GENERAL HAZARD Make sure not to nick the thermocouple conductor. The wire may break with future vibration and can result in damage to the equipment.
4.	Twist the two wires together. Apply flux and pre-tin the twisted wires. Remove the flux residue with a wet rag while it is still hot.
5.	Use sand paper to remove oxidation from the copper tube. Apply flux to the tube. Position the thermocouple wire so that the first twist of wire (nearest the insulation) is against the tube. Solder the wire twist to the copper tube. Remove the flux residue with a wet rag while the joint is still hot. **Note:** Make certain the wire twist closest to the insulation is in contact with the copper tube. It is the first twist of wire closest to the insulation that senses and determines the temperature reading.
	**CAUTION** Be careful when attaching thermocouples to the feed and return lines. Do not overheat the flux. Do not melt or cut the plastic insulation on the thermocouple wire. It may create false readings and can result in damage to the equipment.
6.	Wrap the thermocouple wire tightly around the tube 3-4 times. Allow enough thermocouple wire to run along the refrigerant line to the unit, plus an additional 4 feet (1.2 m) to reach the terminal blocks inside the low voltage box.
Pressure test the refrigerant line to 615 psig (4237 kPa)	
7.	This test must be done before connecting the cryosurface to the refrigeration unit. The pressure relief valve for the refrigerant line and cryosurface may leak if it is pressurized above 335 psig (2310 kPa). **Note:** 615 psig = 1.43 x 450 psig
8.	Go to the Installation Checklist on page 5 initial and date this task, then go to Route and Install the Refrigerant Lines on page 53.
End of Procedure	

Route and Install the Refrigerant Lines

Tools and materials:

- Step ladder
- Torque wrench (optional)

For Parker CPI UltraSeal compatible couplings (standard fitting):

- Silver-plated stainless steel O-rings†
- 1 inch open end wrench
- 15/16 inch open end wrench

For Cajon VCR couplings (optional fitting):

- Silver-plated stainless steel gaskets or unplated nickel gaskets †
- 1-3/16 inch open end wrench
- 1-1/16 inch open end wrench

† Shipped with the unit.

NOTE: This section assumes that you are installing a refrigerant line from Brooks Polycold Systems Inc. If you are installing a refrigerant line not made by Brooks Polycold Systems, verify that the refrigerant lines meets the specifications in the PFC Service Manual 825152-00 before performing this task.

For PFC/PFC: This section assumes that both refrigerant circuits will be connected at the same time. At times, only one refrigerant circuit may be connected. Thus, when ready to connect the second refrigerant circuit, the refrigerant mixture must be drawn back into the unit. (This is because both refrigerant circuits are connected inside the unit.) See the section Disconnection, Storage, and Shipment in the PFC Service Manual.

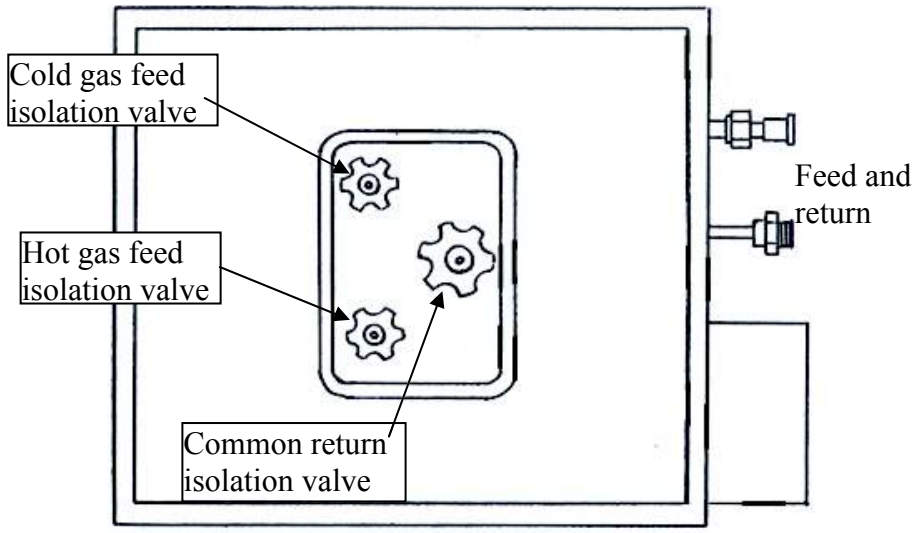
<table>
<tr><td rowspan="2">  </td><td>CAUTION</td></tr>
<tr><td>GENERAL HAZARD
A common source for leaks is improper connection of the couplings. Internal leaks can damage the equipment.
Use a new O-ring or gasket each time the coupling is assembled.
Do not use grease when assembling the couplings. Grease can contaminate the cryopump. It can also mask a leak during the leak-checking procedures. The coupling will leak when the grease gets brittle at cryogenic temperatures.
Do not scratch or dent the sealing surfaces of the couplings.
Always use the O-ring removal tool to remove an O-ring from the Parker CPI UltraSeal compatible couplings. See the section Disconnection, Storage, and Shipment in the PFC Service Manual.</td></tr>
<tr><td rowspan="2">  </td><td>WARNING</td></tr>
<tr><td>Use of unauthorized, non-standard couplings will void your warranty. Improper use of, incorrect installation of, over-tightening of, or use of damaged O-rings in couplings will void your warranty. (See the CAUTION on the previous page)</td></tr>
</table>

Continued next page

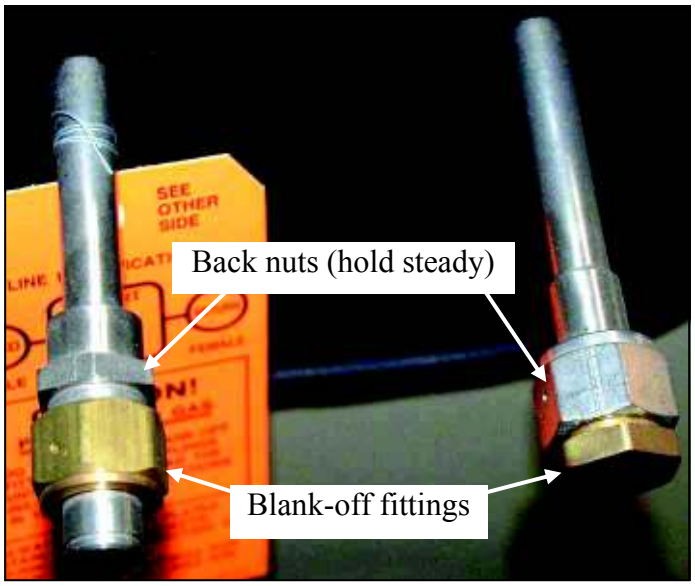
Route and Install the Refrigerant Lines, Continued

Step	Action
1.	Plan the route of the refrigerant line between the cryosurface and the top of the refrigeration unit with the following considerations in mind: • The refrigerant line should not be a hindrance, or hazard, to the movement of personnel. • The refrigerant line should not hinder access to, or maintenance of, any equipment. • Provide at least 1-1/4 inches (32 mm) wall thickness of insulation around the feed and return lines. The insulation must be airtight or the refrigerant line will cryopump water. If the system is not completely sealed and airtight, water vapor from the air will accumulate on some of the surfaces. • Support the line at mid-length and at three-foot intervals if it is a long line. Ensure that the line supports do not crush the insulation covering the lines. Use supports that are at least 4 inches (100 mm) wide. • When routing the refrigerant line, keep in mid that the line is made of soft refrigeration copper and has a minimum bend radius of 12 inches (300 mm). It is suitable for being bent only once to fit the planned layout. • Bend the refrigerant line so that the couplings are even when they get to the refrigeration unit (for example, the feed and return lines should have the same bend radius). **NOTE:** *The brand or type of tape, hangers, clamps, or cradles depends on what is available and acceptable at the installation site. Do not use supports that make direct contact with the exposed tubes or couplings. Do not allow the lines to be vibrated by the application.* Polycold recommends using a continuous line length from unit to cryocoil feed thru. Brooks Automation does not recommend or warranty use of intermediate fittings. If your line design has an intermediate set of fittings between the unit and chamber feed thru we recommend eliminating this and brazing the tubes together. However, if this cannot be done use only approved fittings. In addition the lines must be supported on each side of the intermediate fitting within 12 inches (300mm) of the fitting.
2.	Inspect the sealing surfaces of the couplings for the following: • Dirt and foreign material • Scratches • Dents Clean the sealing surfaces of the couplings. **If the sealing surfaces are scratched or dented, contact the Brooks Automation Polycold Service Department.** **NOTE**: Parker CPI UltraSeal compatible couplings are standard on all PFCs.
3.	It may be helpful to connect the refrigerant line to the cryosurface first. If so, finger-tighten the refrigerant line couplings to the feed-through couplings. Refer to Figure 23 on page 57.
	Continued next page

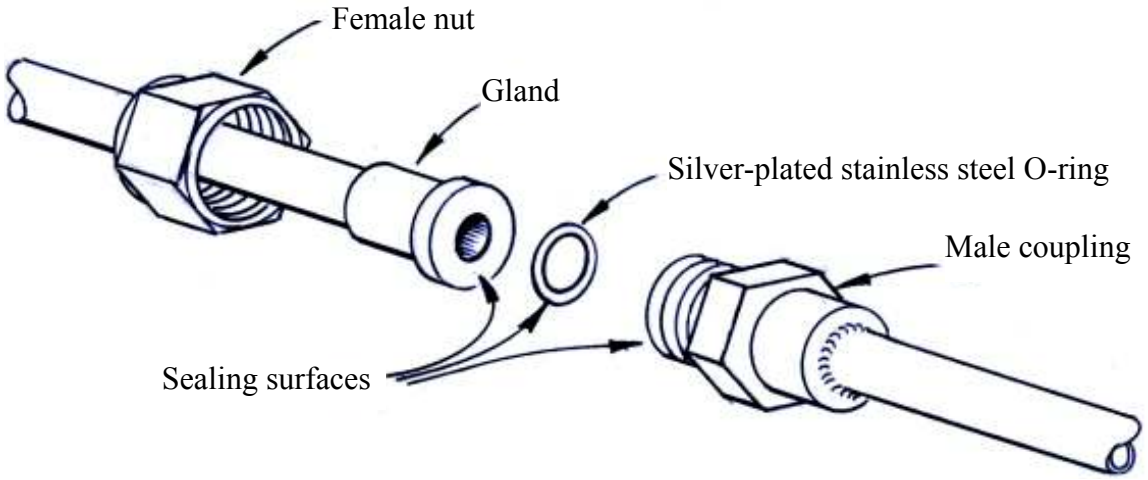
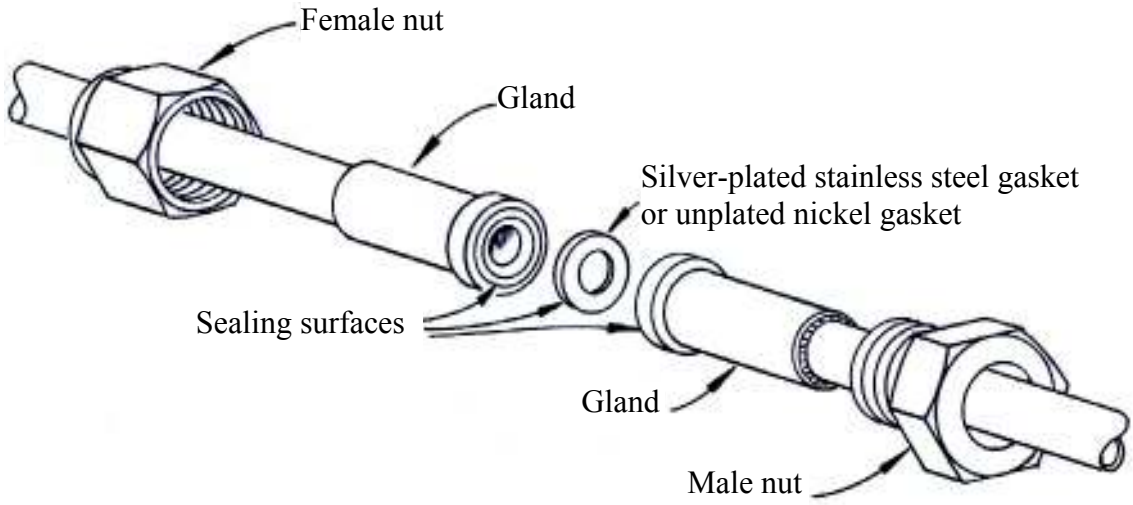
Route and Install the Refrigerant Lines, Continued

Step	Action
4.	Remove the top panel of the refrigeration unit. The isolation valves are in the box closest to the couplings. Loosen the screws to open the valve box lid. Locate the red hand valves labeled COLD GAS FEED, COMMON RETURN, and HOT GAS FEED. Turn each hand valve clockwise to make certain it is closed. See Figure 21 below. **Note**: The isolation valves are used to hold the refrigerant mixture in the refrigeration unit during shipping or whenever the cryosurface or refrigerant line is disconnected. These valves cannot be operated when they are at cryogenic temperatures. **Figure 21. Location of Isolation Valves (top view of refrigeration unit)** 
	Continued next page

Route and Install the Refrigerant Lines, Continued

Step	Action
5.	On the right side of the refrigeration unit, locate the feed and return couplings near the top of the unit. Remove the blank-off fittings as follows (see Figure 22). a. With one wrench, hold the back nut steady, and with a second wrench, slowly loosen the blank-off fitting. b. Slowly remove the blank-off fittings from the feed and return couplings on the right side of the unit. A brief hiss may be heard. However, if refrigerant continues to escape from the unit, quickly reinstall the blank-off fittings and make certain the isolation valves are closed. **NOTE:** For PFC/PFC, the upper set of couplings is for the first refrigerant circuit. The lower set is for the second refrigerant circuit. **Figure 22. Blank-off Fittings in Feed and Return Couplings** 
6.	Save the blank-off fittings with the unit. You must reinstall them if you disconnect the refrigerant line.
	Continued next page

Route and Install the Refrigerant Lines, Continued

Step	Action
7.	Refer to Figure 23 and Figure 24 below for the steps on the following page. **Figure 23. Parker CPI Ultra Seal compatible Coupling (standard coupling)**  **Figure 24. Cajon VCR Coupling (optional fitting)** 
	Continued next page

Route and Install the Refrigerant Lines, Continued

Step	Action
8.	Bend the refrigerant line so that the couplings are even when they get to the mating couplings on the refrigeration unit (For example, the feed and return lines should have the same bend radius.)
9.	Loosely fasten all couplings on the refrigerant line and check the line for stress or misalignment between couplings. Correct these problems before going to the next step.
10.	Tighten all of the couplings on the refrigerant line: **For Parker UltraSeal compatible couplings:** Go to Step 11. **For Cajon VCR couplings:** Go to Step 17.
Parker CPI UltraSeal compatible couplings (standard fitting)	
11.	Insert an O-ring into the male coupling's groove
12.	Place the gland against the O-ring and male coupling. Make certain the O-ring does not drop out of the groove
13.	Slide the nut forward and finger-tighten the coupling.
14.	While keeping the male coupling stationary with the 15/16-inch wrench, tighten the nut with the 1-inch wrench. Each wrench must have a length of at least 12 inches (300 mm).
15.	Tighten no less than ¼ turn until resistance increases sharply and no further tightening occurs.
16.	During the tightening procedure, the metal o-ring will be crushed into the o-ring groove. Tighten each coupling to 40-60 foot-pounds (54-80 Nm). **Note:** These fittings are coupled and sealed based on mechanical displacement of the threaded parts, which results in compression at the sealing surface. Torque values are provided for customers requiring a measurable value. Go to Step 20.
Cajon VCR couplings (optional fitting)	
17.	Place a gasket into the female nut.
18.	Assemble the components and finger-tighten the coupling.
19.	Use both wrenches to tighten each coupling no less than ¼ turn until resistance increases sharply and no further tightening occurs, approximately 40-60 foot-pounds (54-80 Nm). **Note:** These fittings are coupled and sealed based on mechanical displacement of the threaded parts, which results in compression at the sealing surface. Torque values are provided for customers requiring a measurable value.
20.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Check the Refrigerant Line and Cryosurface for Leaks

Note: Helium leak checking the refrigerant line and cryosurface is an acceptable alternative to the procedure specified below if helium leak check equipment and trained helium leak check operators are available.

Tools and materials:

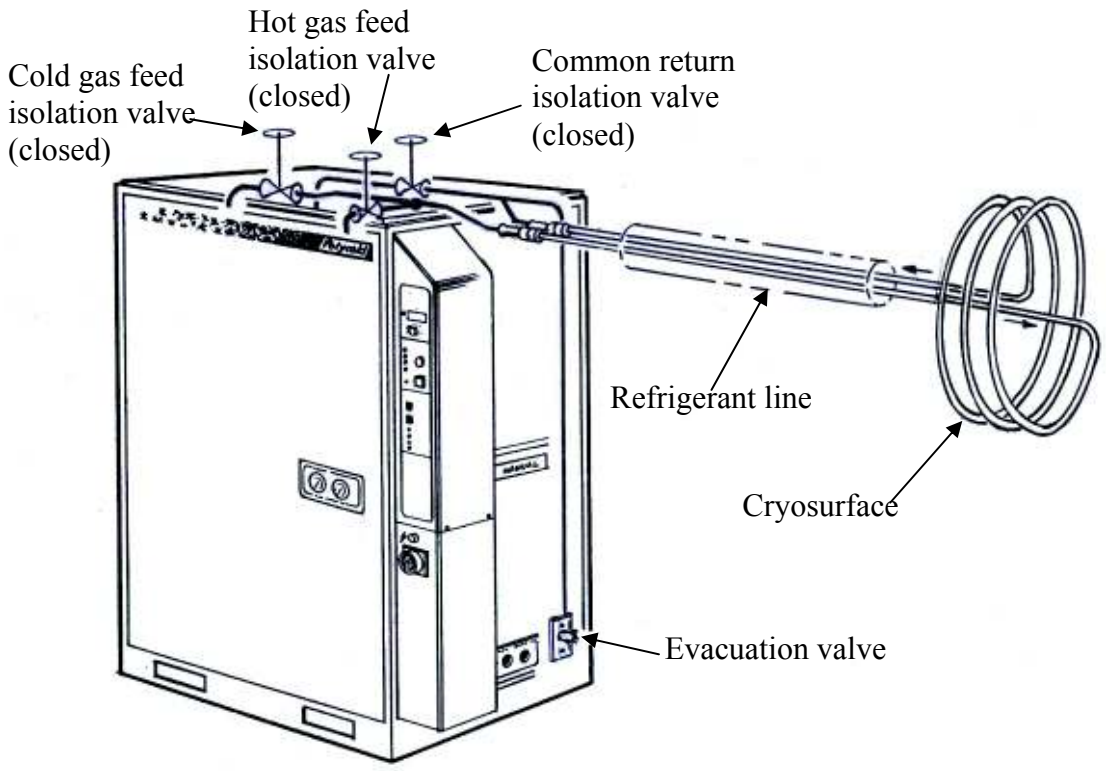
- Cylinder of refrigerant gas R-22 or R-134a

	**WARNING**
	If using R-22 refrigerant: Only personnel who meet all local requirements for handling R-22 refrigerant should perform this procedure. Use of R22 is not allowed in Europe.

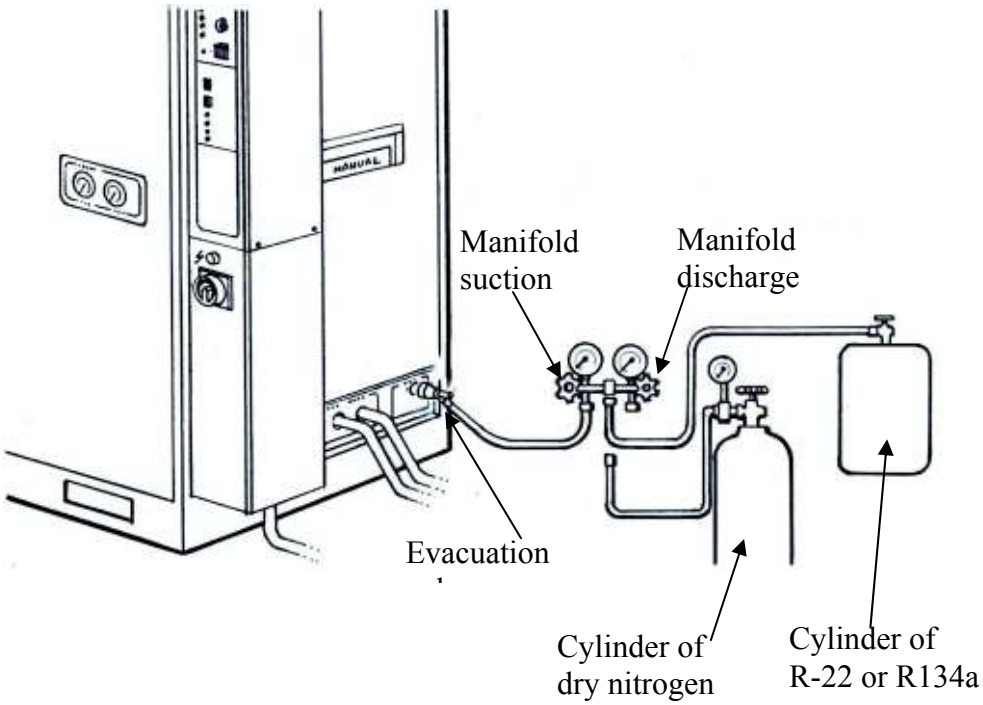
- Cylinder of dry nitrogen gas (very low dew point of –80 C) with a regulator
- Service manifold gauge set with three hoses (manifold)
- Electronic halogen leak detector with a leak sensitivity of at least 0.40 ounces (11 g) per year
- Leak detector soap
- Inspection mirror
- 5/8-inch open-end wrench
- 15/16-inch open-end wrench
- 1/4-inch ratchet valve wrench

Continued next page

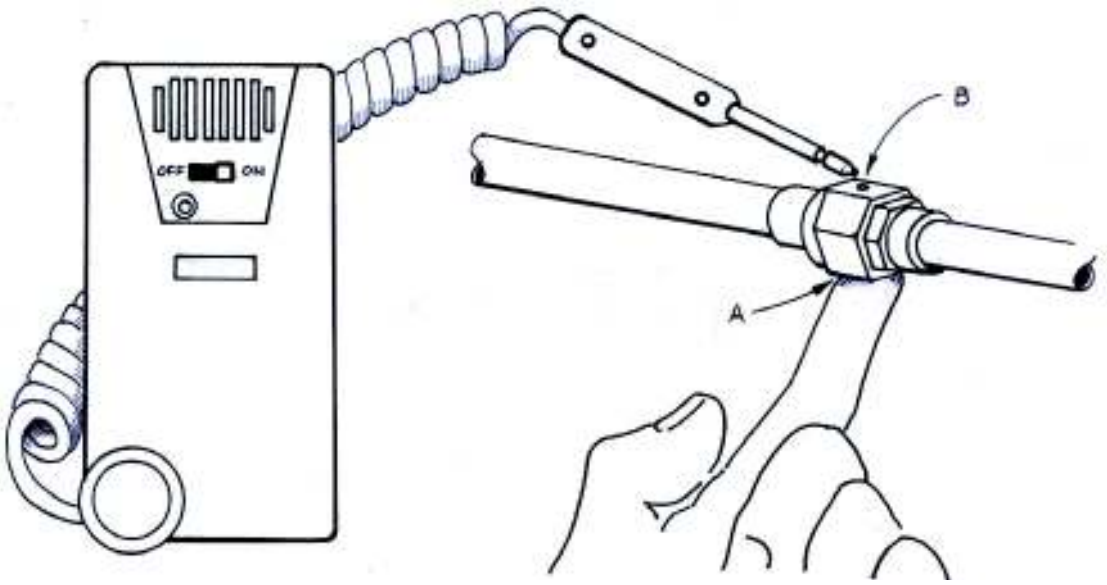
Check the Refrigerant Line and Cryosurface for Leaks, Continued

Step	Action
1.	Refer to Figure 25 and Figure 26 on page 61 for the following steps. **Figure 25. Refrigerant Line, Cryosurface, and Evacuation Valve** 
2.	Make certain the manifold's valves are closed. Connect the manifold's suction (low pressure) hose to the evacuation valve on the side of the refrigeration unit.
3.	Midseat the evacuation valve to open it. (Midseat the evacuation valve by turning the valve stem three complete rotations in the counter-clockwise direction.)
	Continued next page

Check the Refrigerant Line and Cryosurface for Leaks, Continued

Step	Action
4.	Connect the refrigerant cylinder to the manifold's center port. Open the manifold's suction valve. Pressurize the refrigerant line and cryosurface to 10-20 psig (70-140 kPa). Once pressurized, close the refrigerant valve and disconnect refrigerant cylinder.
	WARNING **If using R-22 refrigerant:** Only personnel who meet all local requirements for handling R-22 refrigerant should perform this procedure.
	CAUTION Do not pressurize the refrigerant line and cryosurface above 335 psig (2310 kPa). The pressure relief valve may leak if it is activated. Improper pressurization can result in damage to the line or equipment. Follow the previous step and following steps carefully.
5.	Connect the nitrogen cylinder to the manifold's center port. Increase the pressure in the refrigerant line and cryosurface to 150 psig (1030 kPa). See Figure 26 below. Close the valve on the nitrogen cylinder. **NOTE**: For a PFC/PFC, the last step will pressurize both refrigerant circuits.  **Figure 26. Leak Check Setup**
	Continued next page

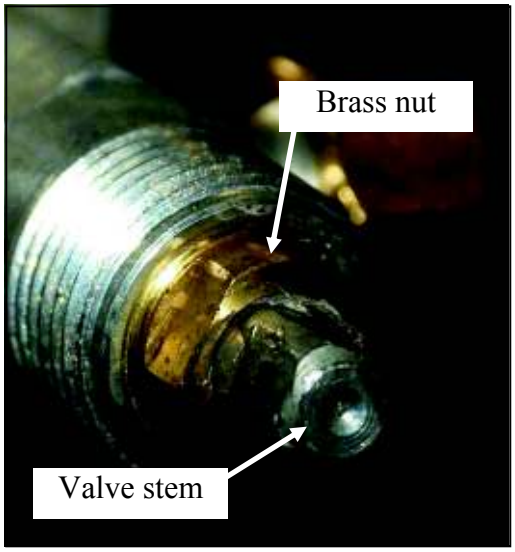
Check the Refrigerant Line and Cryosurface for Leaks, Continued

Step	Action
6.	With the halogen leak detector, carefully check each connection that was made. This includes the Parker CPI UltraSeal compatible or Cajon VCR couplings, the EVACUATION VALVE, and any brazed joints. The Parker and Cajon couplings have two small access holes on each nut to help find leaks. Cover the lower access hole with a finger and put the sensor at the higher hole (see Figure 27). **NOTE**: If there is a large leak and the source cannot be pinpointed without activating the leak detector, open the manifold's suction valve until the pressure drops to about 50 psig (345 kPa). This should allow detection of the source of the leak. **Figure 27. Leak-Checking Couplings** 
7.	If no leaks are found, check the pressure on the manifold to verify that it is still at 150 psig (1030 kPa).
8.	**If the pressure in the manifold is still 150 psig;** • Close the valves on the manifold. • Disconnect the equipment from the manifold, but leave the manifold connected to the evacuation valve on the refrigeration unit. • Go to the Installation Checklist on page 5 and date and initial this task, then go to the next task. **If the pressure in the manifold has decreased below 150 psig;** Go to Step 9 on the next page.
	Continued next page

Check the Refrigerant Line and Cryosurface for Leaks, Continued

Step	Action
	**WARNING** Never add refrigerant to a unit with a leak. Always pinpoint and repair any leaks prior to adding refrigerant or re-charging.
9.	Use leak detector soap to find leaks. A bubble that forms in approximately two minutes is equivalent to a leak of 1.5 ounces (43 grams) per year.
10.	**If a leak is found on a Parker CPI UltraSeal compatible or Cajon VCR coupling;** Go to Step 11. **If a leak is found on a brazed joint;** Go to Step 14. **If a leak is found on the evacuation valve on the refrigeration unit;** Go to Step 15.
Correct a leak in a Parker CPI UltraSeal compatible or Cajon VCR coupling	
11.	With a finger, cover the lower access hole and apply leak detector soap to the higher access hole. Observe the higher access hole for at least 2 minutes. If a bubble forms, verify that the coupling is tightened to within specification.
12.	Leak check the coupling again. **If the coupling still leaks, go to Step 13.** **If the coupling does not leak, go to Step 16.**
13.	If the coupling still leaks, it must be reassembled; a. Open the manifold's discharge valve to release the gas in the refrigerant line and cryosurface. b. Disassemble the coupling following the instructions in the section Disconnection, Storage, and Shipment in the PFC Service Manual. c. Make certain the coupling's sealing surfaces are not scratched or damaged. Re-assemble the coupling following the instructions in Route and Install the Refrigerant Lines on page 53. d. Leak check the coupling again. If it still leaks, call your Brooks Automation Service Representative.
Correct a leak on a brazed joint	
14.	a. Apply leak detector soap to the joint. Use an inspection mirror to view all sides of the joint to pinpoint the leak and verify that there is a leak on the brazed joint. b. Open the manifold's suction valve to release the gas in the refrigerant line and cryosurface. c. Repair the leak following the instructions in the Brazing Specification in the Appendix.
	Continued next page

Check the Refrigerant Line and Cryosurface for Leaks, Continued

Step	Action
Correct a leak on the evacuation valve	
15.	Tighten the brass nut on the valve stem of the evacuation valve (see Figure 28), and leak check the evacuation valve again. If the valve still leaks, call your local Brooks Automation Service Representative. **Figure 28. Evacuation Valve Close-up (shown in mid-seated position)** 
16.	• Close the valves on the manifold. • Disconnect the equipment from the manifold, but leave the manifold connected to the evacuation valve on the refrigeration unit. Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Evacuate the Refrigerant Line and Cryosurface

Tools and materials:

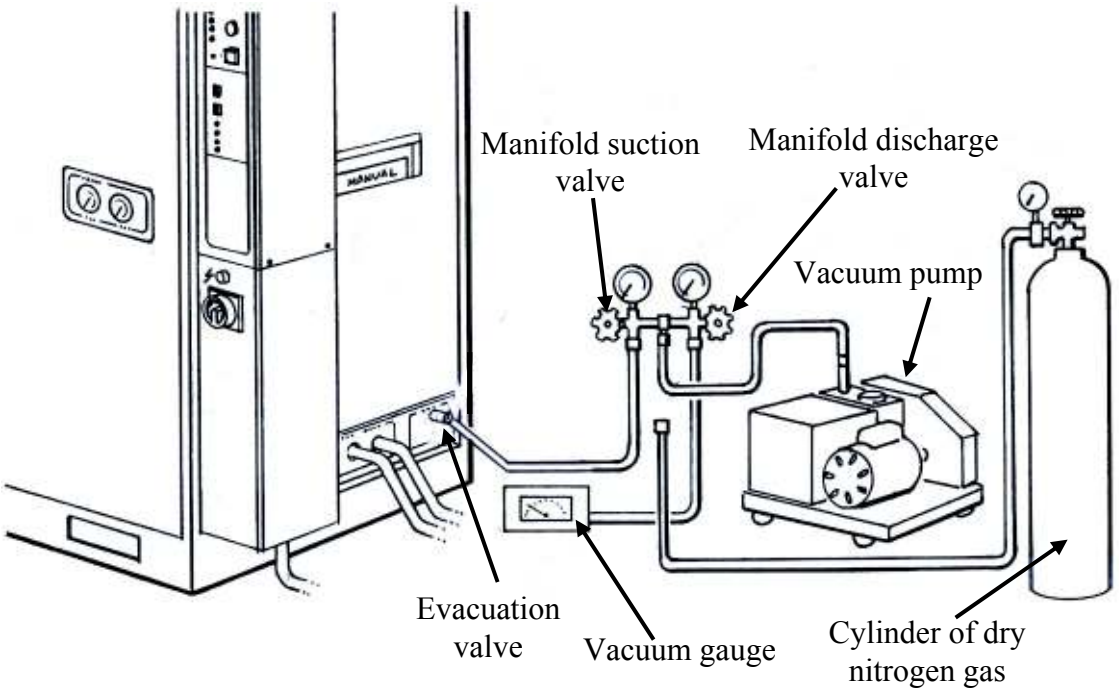
- Vacuum pump with a 1/4-inch SAE male flare connection that is capable of pumping down to at least 0.05 torr (6.5 Pa)
- Thermistor or thermocouple type vacuum gauge (Granville Phillips offers the Convectron and other products that work well for this purpose)
- Cylinder of dry nitrogen gas with a regulator
- Service manifold gauge set with hoses (manifold)
- 1/4 inch ratchet valve wrench
- 5/8 inch end wrench
- 15/16 inch end wrench

WARNING

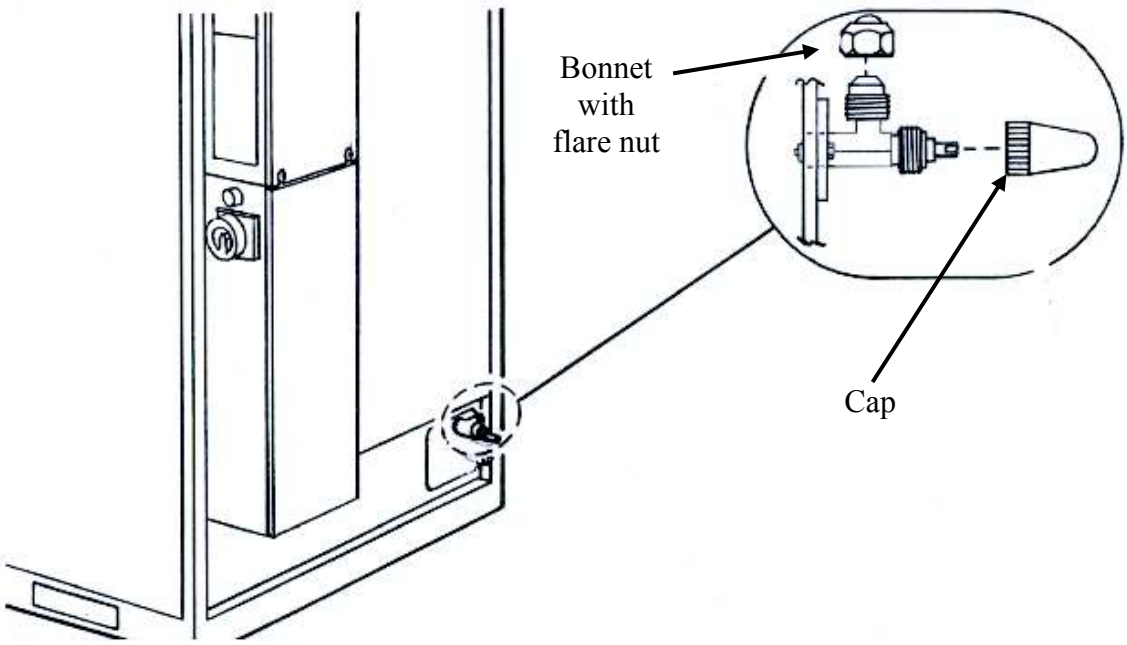
GENERAL HAZARD
Failure to have a qualified refrigeration technician do all refrigeration work could result in death or serious injury.
Do not attempt evacuation. Contact a qualified refrigeration technician.

Continued next page

Evacuate the Refrigerant Line and Cryosurface, Continued

Step	Action
1.	Refer to Figure 29 for the following steps. **Figure 29. Evacuation Setup for the Refrigerant Line and Cryosurface** 
2.	Connect the equipment and manifold as shown in Figure 29.
3.	Open both valves on the service manifold.
4.	Evacuate the refrigerant line and cryosurface to 0.1 torr (13 Pa).
5.	Allow the vacuum pump to continue pumping for at least 30 minutes.
6.	Close the manifold's suction valve and turn off the vacuum pump. Disconnect the vacuum pump from the manifold's center port. Note: The vacuum pump should evacuate the refrigerant line and cryosurface to 0.1 torr (13 Pa) within 30 minutes. If not, there may be a leak.
7.	Connect the nitrogen cylinder to the manifold's center hose. (See Figure 29) Pressurize the refrigerant line and cryosurface to 10 - 20 psig (70-140 kPa).
8.	Evacuate the refrigerant line and cryosurface to 0.1 torr (13 Pa). Allow the vacuum pump to continue pumping for at least 30 minutes. Close the unit's evacuation valve while the vacuum pump is still pumping. Turn off the vacuum pump. Slowly remove the hose from the evacuation valve.
	Continued next page

Evacuate the Refrigerant Line and Cryosurface, Continued

Step	Action
9.	Reinstall the protective cap and the flare nut with bonnet onto the evacuation valve (See Figure 30). **Figure 30. Evacuation Valve Closure** 
	CAUTION **It is very important to perform Step 9 in order to prevent refrigerant leaks.**
10.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Connect the Refrigerant Line Thermocouples

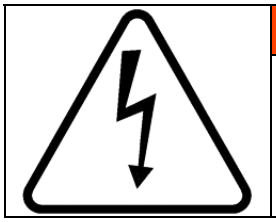
Tools and materials:

- Phillips screwdriver
- Small straight blade screwdriver
- Wire stripper, a thermal wire stripper is preferred

For PFC/PFC:

- Four small labels or tape
- Armaflex tape, about 1x2 inches (25x50 mm)

Note: If someone other than Polycold made the refrigerant line on this system, make sure that the thermocouples were properly installed. Refer to Optional: Fabricate the Refrigerant Lines on page 50 in this manual.

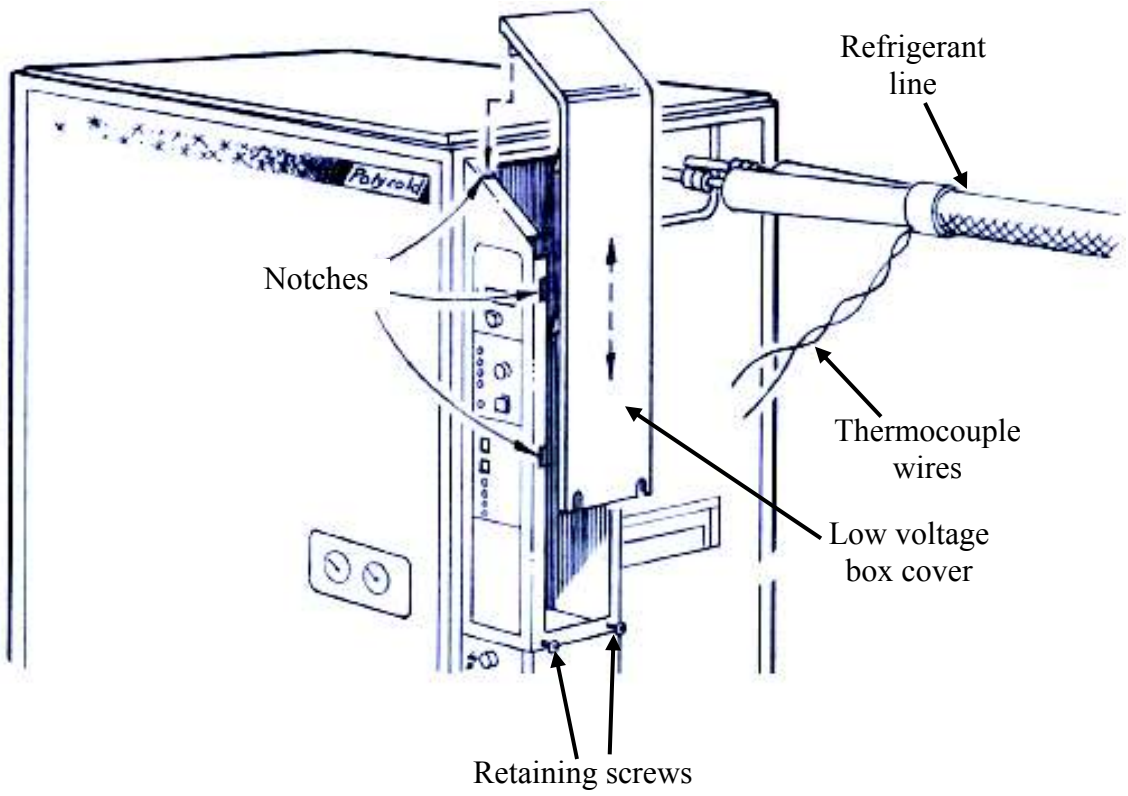


WARNING

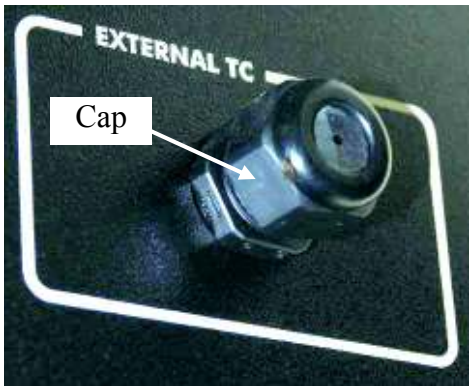
ELECTRICAL HAZARD
Contact could cause electric shock and result in death or serious injury.
Make certain the ON/OFF switch and the power disconnect switch are in the OFF position.

Continued next page

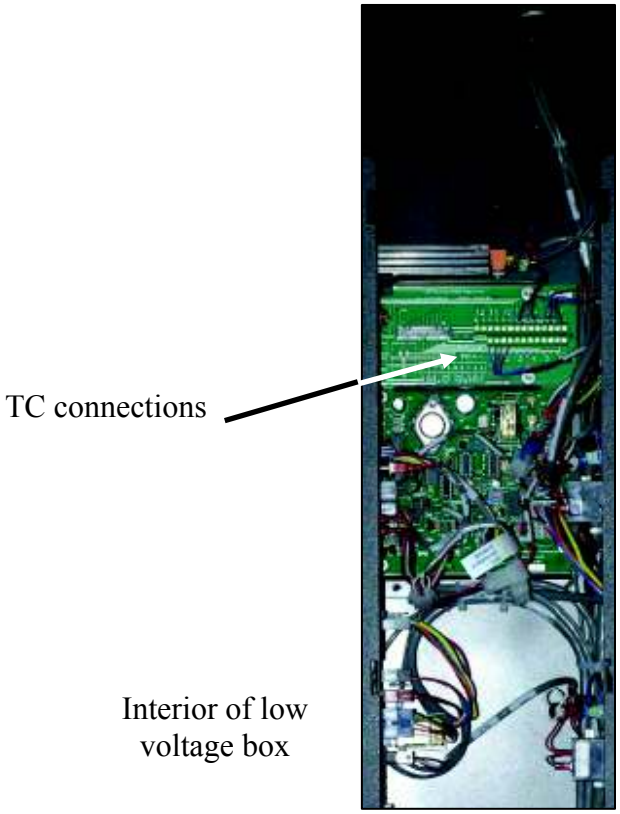
Connect the Refrigerant Line Thermocouples, Continued

Step	Action
1.	Locate the low voltage box on the refrigeration unit (see Figure 31 below). Remove the cover on the low voltage box as follows: a. Loosen the two lower retaining screws. b. Slide the cover upward, and then away from the low voltage box. **Figure 31. Low Voltage Box Details** 
	Continued next page

Connect the Refrigerant Line Thermocouples, Continued

Step	Action
2.	On the low voltage box right-side exterior, locate the EXTERNAL TC fitting (see Figure 32 below). Unscrew the cap on this fitting and remove the rubber seal from inside the fitting. **Figure 32. EXTERNAL TC Fitting on the Low Voltage Box** 
3.	Locate the thermocouple wires labeled COIL IN and COIL OUT on the refrigerant line (see Figure 31 on page 69).
4.	Slip the cap from the EXTERNAL TC fitting over these wires.
5.	**If you are working on a PFC refrigeration unit:** a. Push the thermocouple wires through the rubber seal from the fitting, then push the thermocouple wires through the EXTERNAL TC fitting and into the low voltage box b. Insert the rubber seal into the EXTERNAL TC fitting, and screw the cap back on. **If you are working on a PFC/PFC:** a. Fold a small piece of tape around each thermocouple wire next to its label. b. Label the tape "#1" on the COIL IN and COIL OUT thermocouple wires coming from the first refrigerant circuit. c. Label the tape "#2" on the COIL IN and COIL OUT thermocouple wires coming from the second refrigerant circuit. d. Wrap Armaflex tape around the thermocouple wires so that the wires fit tightly in the EXTERNAL TC fitting. e. Screw the cap back onto the EXTERNAL TC fitting.
	Continued next page

Connect the Refrigerant Line Thermocouples, Continued

Step	Action
6.	Strip about 1/4 inch (6 mm) of insulation from the end of each thermocouple wire.
	**WARNING** Do not to nick the conductor. The wire may break with future vibration and can result in damage to the equipment.
7.	Route the thermocouple wires to the TC connection board in the low voltage box (see Figure 33 below). **Figure 33. TC Connection Board in the Low Voltage Box** 
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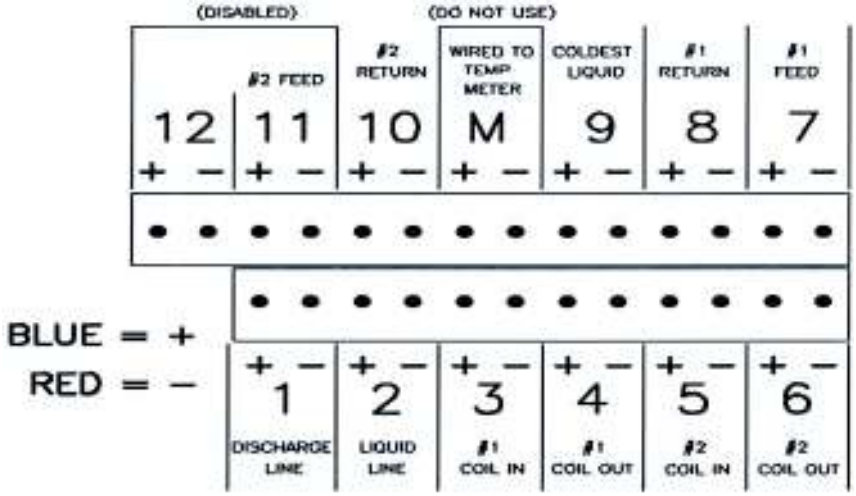
Connect the Refrigerant Line Thermocouples, Continued

Step	Action
8.	Attach the thermocouple wires to their designated locations. The blue-insulated copper wire must be attached to the positive (+) terminal. The red-insulated constantan wire must be attached to the negative (–) terminal (see Figure 34). **Figure 34. Thermocouple Connection Points**  **1** TC #1 = DISCHARGE LINE **2** TC #2 = LIQUID LINE **3** TC #3 = #1 COIL IN **4** TC #4 = #1 COIL OUT **5** TC #5 = #2 COIL IN **6** TC #6 = #2 COIL OUT **7** TC #7 = #1 FEED **8** TC #8 = #1 RETURN **9** TC #9 = COLDEST LIQUID **M** Wired to temperature meter—do not use. **10** TC #10 = #2 RETURN **11** #2 FEED—disabled **12** Disabled
	Continued next page

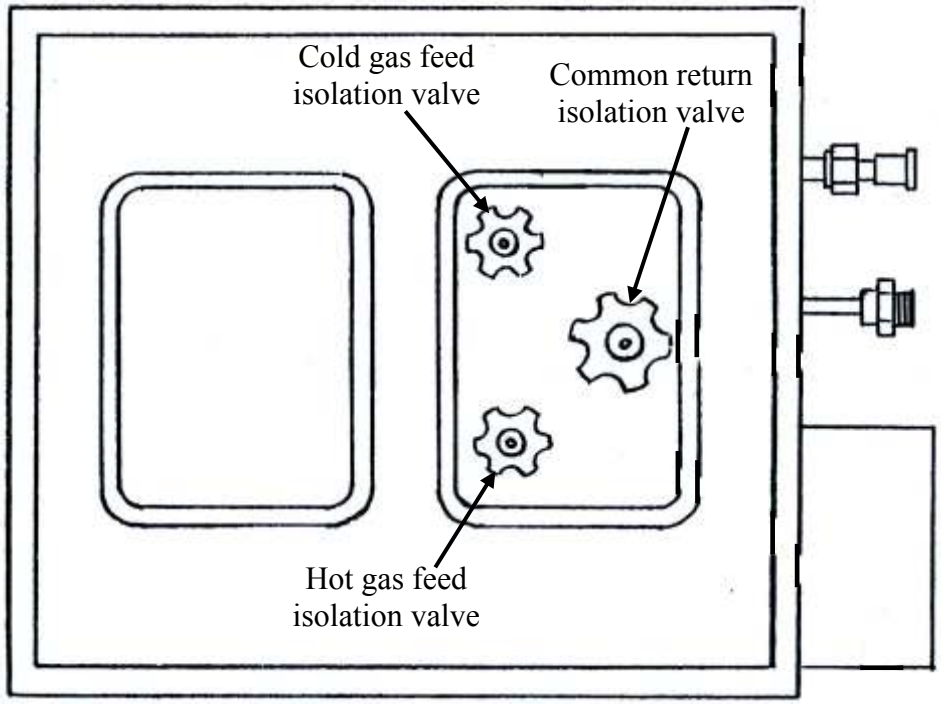
Connect the Refrigerant Line Thermocouples, Continued

Step	Action
9.	Refer to Figure 34 on the previous page for the following: **If you are working on a PFC, connect the TC wires as follows:** Position #3: COIL IN Position #4: COIL OUT **If you are working on a PFC/PFC, connect the TC wires as follows:** Position #3: #1 COIL IN Position #4: #1 COIL OUT Position #5: #2 COIL IN Position #6: #2 COIL OUT
10.	Slide the low voltage box cover down into its original position, ensuring that the tabs on the side of the cover go into the notches in the box. Then tighten the two retaining screws at the bottom of the box.
11.	**Note:** The temperature from a single thermocouple in Figure 34 on page 72 can be displayed at a remote location through the remote connector. To accomplish this see Install Remote Temperature Indication on page 92.
12.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Preliminary Check of the PFC

This task describes how to perform a preliminary check of the major functions of the PFC.

	**CAUTION** GENERAL HAZARD Do not open the isolation valves: doing so can result in damage to the equipment. Make sure you have performed the tasks Check the Refrigerant Line and Cryosurface for Leaks, and Evacuate the Refrigerant Line and Cryosurface, on the Installation Checklist on page 5, before opening the isolation valves on the refrigeration unit.

Step	Action
1.	Refer to Figure 35 for the following steps. **Figure 35. Location of Isolation Valves on Top of Refrigeration Unit** 
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Preliminary Check of the PFC, Continued

Step	Action
2.	Locate the red hand valves underneath the top panel of the refrigeration unit. They are labeled COLD GAS FEED, COMMON RETURN, and HOT GAS FEED.
3.	Turn all three hand valves completely counter-clockwise to fully open each valve.
4.	Turn each hand valve clockwise 1/4 turn from full open.
5.	Wait 10 minutes for the pressure to equalize in the system. The pressure may drop 5-10 psig (35-70 kPa) as the refrigerant mixture enters the refrigerant line and cryosurface.
6.	Locate the discharge pressure gauge on the front of the refrigeration unit (see Figure 36) **Figure 36. Compressor Pressure Gauges on Front of Refrigeration Unit** 
7.	Record the pressure of the discharge gauge in a maintenance log for future reference.
8.	Locate the valve box cover and inspect the inside of it to make sure the rubber seals are intact. Screw the valve box into place, covering the three hand valves. The gasket should form a seal to keep out water vapor.
9.	Start the cooling water.
	Continued next page

Preliminary Check of the PFC, Continued

Step	Action
10.	Locate the controls on the front of the utility panel on the refrigeration unit (see Figure 37). Power up the refrigeration unit: • Turn on the electrical power source for the refrigeration unit. • Switch on the power disconnect on the front of the unit (see Figure 37, **A**) • Switch on the 24 volt circuit (see Figure 37, **B**) • Switch the REMOTE/LOCAL switch to LOCAL (see Figure 37, **C**) • Switch the DEFROST/STANDBY/COOL switch to STANDBY (see Figure 37, **C**)
11.	Wait at least 30 minutes for the "Polycold stack" (heat exchangers and other components that are encased in insulating foam) to reach operating temperature.
12.	Evacuate the vacuum chamber where the cryosurface is installed to at least 0.01 torr (1.33 Pa).
13.	Select COOL (see Figure 37) and wait 5-10 minutes (10 minutes if the refrigerant line is longer than 20 feet (6 m)).
14.	Select DEFROST. The unit will automatically go into STANDBY when DEFROST is complete. Remain in STANDBY for 15 minutes.
15.	Repeat this COOL, DEFROST, and STANDBY cycle two or three times. **PFC/PFC**: Select LOCAL and STANDBY for both refrigerant circuits. Cycle both refrigerant circuits at the same time.
16.	For the second refrigerant circuit, select COOL and wait 10 minutes.
	Continued next page

A **B** **C**

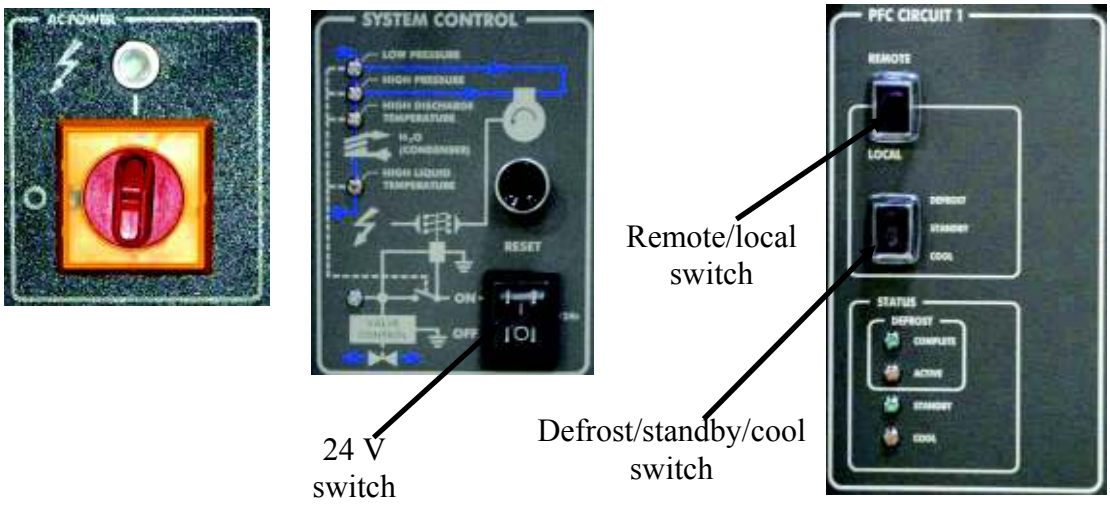


Figure 37. AC Power Switch on Front of Refrigeration Unit

Preliminary Check of the PFC, Continued

Step	Action
17.	Select STANDBY and wait 10 minutes.
	**CAUTION** EXTREME TEMPERATURES MAY EXIST Do touch the refrigerant lines when the unit is operating. Failure to allow the refrigerant lines to warm up with a Defrost cycle or by waiting for an adequate amount of time may result in minor or moderate injury.
18.	Turn off the refrigeration unit and dry the exposed tubes of the refrigerant line with a clean rag (see Figure 38). **Figure 38. Cleaning the Refrigerant Line** 
19.	With the halogen leak detector carefully check each connection that was made. This includes the Parker CPI UltraSeal compatible or Cajon VCR couplings, the evacuation valve, and any brazed joint that was made. **See** Check the Refrigerant Line and Cryosurface for Leaks on page 59 for help finding leaks. **Note:** If disassembly and reassembly of a coupling is needed (or to fix a brazed joint), the refrigerant mixture must first be drawn back into the refrigerant unit. See the section Disconnection, Storage, and Shipment in the PFC Service Manual. **Optional:** check the refrigeration unit's compressor compartment. Check the compressor's suction and discharge valves, and the valves on the tanks.
20.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Insulate Exposed Refrigerant Tubes and Couplings

Properly insulating the exposed tubes and couplings will keep them dry. Penetrating moisture will add heat load to the cryopump and can cause corrosion or leaks.

Tools and materials:

- Tubes of closed-cell pipe insulation †
- Sheet of closed-cell pipe insulation †
- Armaflex tape †
- Armstrong 520 adhesive † **See warning below**
- Large pair of scissors or knife

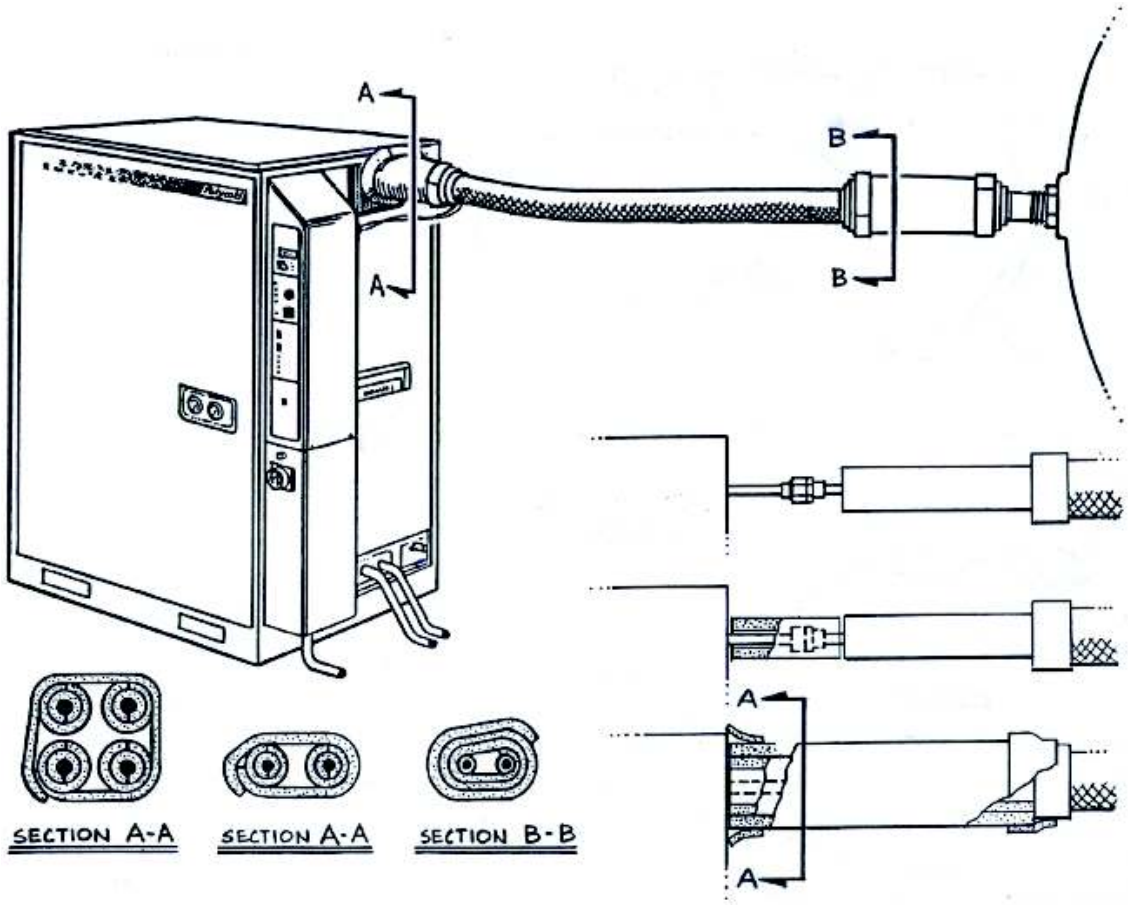
† Shipped with the unit if purchased with a refrigerant line.

WARNING

FLAMMABLE MATERIAL AND CHEMICAL HAZARD
Fumes from the adhesive Armstrong 520 are a source of ignition and suffocation. Make sure there is adequate ventilation and no ignition source when using the Armstrong 520 adhesive. Failure to do so could result in death or serious injury.
Read the label on the container.

Continued next page

Insulate Exposed Refrigerant Tubes and Couplings, Continued

Step	Action
1.	Refer to Figure 39 for the following steps. **Figure 39. Insulating Exposed Tubes and Couplings** 
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Insulate Exposed Refrigerant Tubes and Couplings, Continued

Step	Action
Insulate exposed tubes between the refrigeration unit and the refrigerant line insulation (see cross-section A-A in Figure 39 on page 79).	
2.	Cut the tubes of insulation so that they will fit snugly between the unit and the refrigerant line's insulation. Cut each tube of insulation lengthwise.
3.	Fit a smaller diameter tube of insulation around each exposed tube. Apply adhesive to the lengthwise slits in the insulation. Close the lengthwise slits to form an air-tight seal.
4.	Fit the larger diameter tubes of insulation around the smaller diameter tubes of insulation. Seal each lengthwise slit shut with adhesive. (It is best to stagger the lengthwise seams.)
5.	Cut the sheet of insulation the same length as the tubes of insulation. Wrap the sheet once around the tubes of insulation, allowing the sheet to overlap 2-3 inches (50-75 mm). Put adhesive on the last 1-1.5 inches (25-40 mm) of the overlapping sheet to secure it in place.
6.	Seal both ends of the sheet with tape. Secure the sheet to the refrigerant line's insulation and to the unit's panel. Flare the tape so that it connects the sheet to the panel.
Insulate exposed tubes between the refrigerant line insulation and the feed-through (see cross-section B-B in Figure 39 on page 79).	
	**CAUTION** GENERAL HAZARD Do not get Armaflex tape or Armstrong 520 adhesive in the threads of the feed-through. It is extremely difficult to remove, and makes the feed-through nut bind when unscrewed and may result in damage to the equipment.
7.	Fit the sheet of insulation between the pre-insulated refrigerant line and the feed-through. Wrap the insulation around the exposed tubes three times. Put adhesive on the last 1-1.5 inches (25-40 mm) of the overlapping sheet to secure it in place.
8.	Seal both ends of the sheet with tape. Secure the sheet to the refrigerant line's insulation and to the feed-through. Do not put the tape closer than 1-2 inches (25-50 mm) to the threads on the feed-through.
9.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Evaluate and Put the PFC Into Service

Unless you are installing remote control or remote temperature read-out, this is the last task for installing a PFC.

DANGER

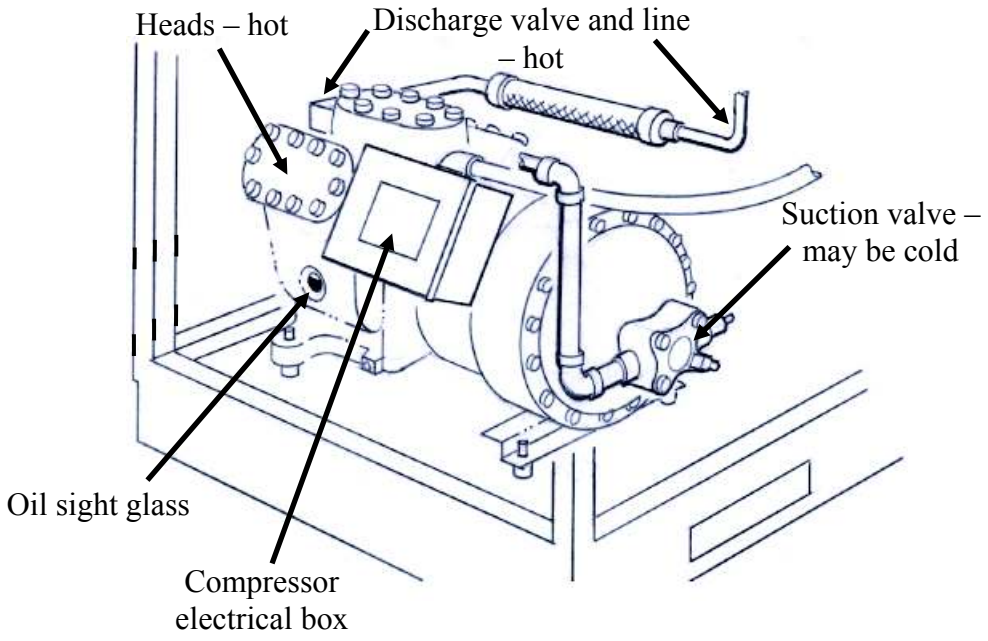
ELECTRICAL
Do not reach inside the compressor compartment when the unit is operating. The compressor electrical box contains hazardous voltages. Failure to have a qualified electrician do all electrical work could result in death or serious injury.
Do not reach inside the unit. A qualified electrician must do all electrical work.

CAUTION

EXTREME TEMPERATURES EXIST
Do not reach inside the compressor compartment when the unit is operating. The compressor's heads and discharge line may be hot; contact with the hot surface may result in minor or moderate injury.
Do not touch the compressor's heads or discharge line.

Step	Action
1.	For the following steps, refer to the figures on page 82.
2.	Start the cooling water. Make sure the minimum flow rate for the water's temperature is adequate; see Connect Cooling Water to the Refrigeration Unit on page 39.
3.	Select LOCAL and STANDBY.
4.	Turn on the unit and wait 30 minutes for the stack to cool down. For PFC/PFC: Select LOCAL and STANDBY for both refrigerant circuits.
5.	Listen to the compressor. It should run continuously without cycling or turning off.
6.	Remove the unit's left panel. Locate the oil sightglass on the compressor. **It should be 1/8 to 1/2 full (1/8 full is preferred) while the compressor is running for at least 60 minutes.**
7.	Record the compressor oil level while the compressor is running for at least 60 minutes:
	Continued next page

Evaluate and Put the PFC Into Service, Continued

Step	Action
8.	**Figure 40. Compressor Parts Location**  **Figure 41. Cooling Water Flow Direction Check** 
	Continued next page

Evaluate and Put the PFC Into Service, Continued

Step	Action
9.	Check the direction of the cooling water's flow. The drain line (OUT) should be warmer than the supply line (IN). If not, turn off the unit and connect the supply and drain lines to the proper ports.
10.	Record the pressures and temperatures shown in Table 19.

Table 19. Pressures and Temperatures in Standby

	Acceptable Range for		Your Measurements for	
	1101	**552 672 1102**	**1101**	**552 672 1102**
SUCTION Pressure	3-25 psig (.2-1.7 bar)	3-50 psig (.2-3.4 bar)	_____psig1 _____bar1	_____psig 1 _____bar 1
DISCHARGE Pressure	90-235 psig (6.2-16.2 bar)	100-400 psig (6.9-27.6 bar)	_____psig 1 _____bar 1	_____psig 1 _____bar1
DISCHARGE LINE (TC #1)	80-120°C	80-120°C	_____°C 1	_____°C1
LIQUID LINE (TC #2)	15-32°C	15-32°C	_____°C1	_____°C1

Step	Action
11.	Evacuate the vacuum chamber where the cryosurface is installed to at least 0.01 torr (1.33 Pa).
12.	Select COOL and wait 30 minutes. **NOTE:** For PFC/PFC: Select COOL for both refrigerant circuits.
13.	Check the outlet temperature of the cooling water. The drain line (OUT) should be 72-95°F (22-35°C). If not, adjust the water flow to attain a temperature in this range.
14.	If there is any ice or water on the refrigerant line, turn off the unit and remove the ice or water. Apply another layer of insulation according to Insulate Exposed Refrigerant Tubes and Couplings on page 78. Re-evaluate the cryopump starting at Step 1.
15.	Record the pressures and temperatures shown in Table 20 and Table 21.
	Continued next page

Evaluate and Put the PFC Into Service, Continued

Table 20. Pressures and Temperatures in Cool				
	Acceptable Range for		Your Measurements for	
	1101	552 672 1102	1101	552 672 1102
SUCTION Pressure	4-45 psig (0.3-2.6 bar)	3-65 psig (0.2-4.5 bar)	psig1 _____bar1	_____psig1 _____bar1
DISCHARGE Pressure	100-380 psig (6.9-26.2 bar)	100-400 psig (6.9-27.6 bar)	psig1 _____bar1	_____psig1 _____bar1
DISCHARGE LINE (TC #1)	80-125°C	80-125°C	_____°C1	_____°C1
LIQUID LINE (TC #2)	15-32°C	15-32°C	_____°C1	_____°C1
COIL IN (TC #3)	See 4. Appendix on page 107		_____°C1	_____°C1
COIL IN (TC #4)	See 4. Appendix on page 107		_____°C1	_____°C1

Table 21. PFC/PFC and PFC/P Temperatures		
#2 COIL IN (TC #5)	See 4. Appendix on page 107 and page **Error! Bookmark not defined.**.	_____°C1
#2 COIL OUT (TC #6)	See 4. Appendix on page 107 and page **Error! Bookmark not defined.**.	_____°C1

Continued next page

Evaluate and Put the PFC Into Service, Continued

Step	Action
16.	Select DEFROST. **Note**: For a PFC/PFC: Select DEFROST for both refrigerant circuits.
17.	Record the time it takes for the cryosurface to defrost. When DEFROST is complete, the DEFROST COMPLETE lamp will light and the unit will automatically switch to STANDBY. Actual Defrost Time: _____minutes
18.	Open the vacuum chamber. The cryosurface should be dry and at room temperature or warmer.
19.	Recheck all measurements to verify that the PFC is operating within specifications. Record all measurements taken in this task in a maintenance log for future use as a baseline.
20.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Install the Remote Control (Optional)

Each PFC ships with a kit that contains parts to fabricate a plug that mates with the remote control connector on the low voltage box. This section describes how to connect the PFC standard remote control to a controlling system. Refer to the PFC schematics in the Appendix when determining wiring between the refrigeration unit and a controlling system.

All circuits connected to the PFC remote connector are 24 VAC.

Before performing this task, determine if a unit ON/OFF switch or function indicator lamps are wanted at a remote location.

Note: A temperature from the TC SELECT switch can also be displayed at a remote location through the remote connector. To do this, see Install Remote Temperature Indication on page 92.

If the PFC being installed includes the DTS option, refer to addendum 825147-01. If viewing this manual on CD, the addendums can be found in the Addendums folder.

Tools and materials:

- Connector plug (shipped with the unit)
- Remote connector pins (shipped with the unit)
- Heat shrinkable insulating tubes (shipped with the unit)
- Multi-strand cable with minimum 18 AWG (0.75 mm^2 cross-sectional area) wires

  Note: Remote wires should be 40 feet (12.2 m) or less to prevent voltage drop which can result in unit damage. If Remote wires longer than 40 feet are required, check the voltage at the remote control panel.

  Do not use the remote function if the voltage at the remote panel is less than 22.2 volts. Contact the Brooks Automation Service Department.
- Wire stripper
- Lead-free rosin core solder
- Soldering iron
- Switches with a minimum capacity of 1A
- 24 V indicator lamps (optional[1])

[1]If function indicator lamps are wanted at a remote location

WARNING

ELECTRICAL HAZARD
Contact with energized components could cause electric shock and result in death or serious injury.
Make certain the ON/OFF switch and the power disconnect switch for the PFC and connecting systems are in the OFF position.

Continued next page

Install the Remote Control (Optional), Continued

Use the worksheet in Table 22 below for information on wiring the PFC remote cable.

Table 22. Remote Connector Wiring Worksheet (see Figure 42 on page 88)

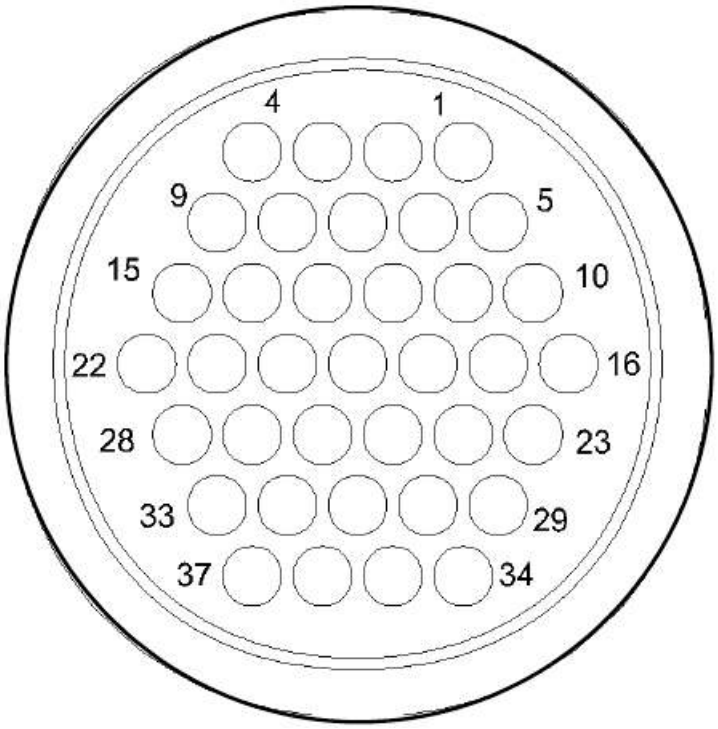
Group	Wire Function	Pin Number	Customer's Wire Color
System Control	Operate Unit	1	
		2	
	Indicate Unit OK	3	
	Indicate Power	4	
	Common	5	
	Ground	6	
Refrigerant Circuit 1 (PFC)	Indicate REMOTE	10	
	Operate COOL	11	
	Operate DEFROST	12	
	Indicate DEFROST COMPLETE	13	
	Indicate DEFROST ACTIVE	14	
Refrigerant Circuit 2 (PFC or P)	Indicate REMOTE	18	
	Operate COOL	19	
	Operate DEFROST (PFC only)	20	
	Indicate DEFROST COMPLETE (PFC only)	21	
	Indicate DEFROST ACTIVE (PFC only)	22	
Option	Indicate Setpoint Relay A	26	
		27	
Temperature Meter 1	Analog #1–Out	28	
	Analog #1–Return	29	
	Analog #1–Shield	30	
Option	Indicate Setpoint Relay B	31	
		32	
Option — Temperature Meter 2	Analog #1–Out	33	
	Analog #1–Return	34	
	Analog #1–Shield	35	

Continued next page

Install the Remote Control (Optional), Continued

Note: For functions of wire locations in Figure 42, see Table 22 on page 87.

Figure 42. Wire Side of the Remote Connector Plug.



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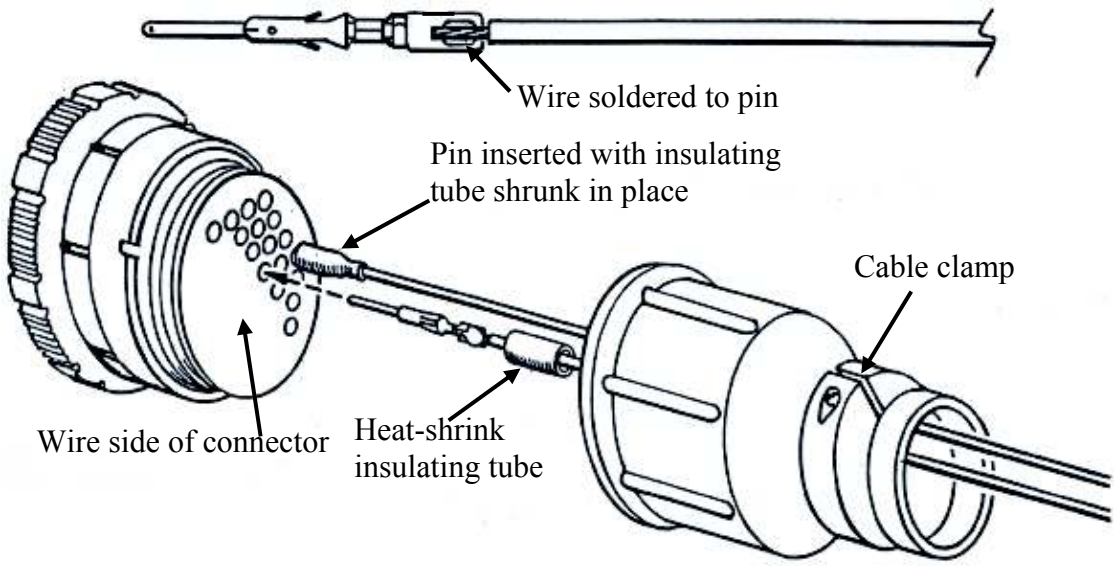
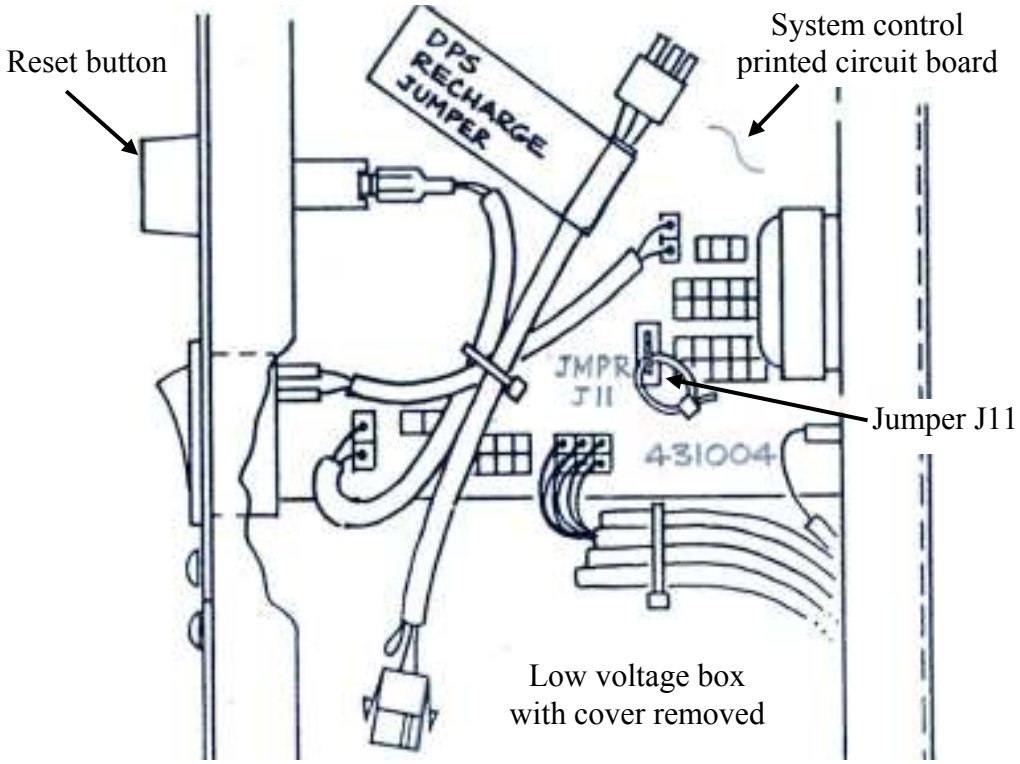
Install the Remote Control (Optional), Continued

Step	Action
1.	Refer to Figure 43 for the instructions that follow. **Figure 43. Assembling the Remote Connector** 
2.	Locate the parts kit that shipped with the PFC. This kit contains the parts for assembling a remote control plug.
3.	Remove no more than 1/2 inch (13 mm) of the cable jacket that covers the bundle of wires that make up the cable.
4.	Once the cable jacket has been removed, strip 5/32 inch (4 mm) of inner insulation from the 18 AWG wires.
5.	Pre-tin each wire and solder a pre-tinned wire to the back of each pin—do not insert the wire into the hole on the back of each pin.
6.	Cut the heat shrinkable insulating tubes into 1/2-inch (13 mm) lengths. Slide one of these tubes onto each wire. Slide the cable clamp over the jacket.
7.	Insert each pin into the back of the connector until it clicks into place.
8.	Slide the 1/2-inch long insulating tubes over the uninsulated wire and solder joint. Use a heat gun to shrink them in place.
9.	Firmly attach (thread, turn or screw) the cable clamp onto the connector. Tighten the cable clamp over the cable jacket.
	Continued next page

Install the Remote Control (Optional), Continued

Step	Action
10.	Carefully check the wiring of the remote control plug and cable to verify the connections and that there are no short- or open-circuits in the cable assembly.
	**CAUTION** GENERAL HAZARD Make sure the wiring configuration does not operate the unit in COOL and DEFROST at the same time; damage to the equipment can result. Polycold recommends the use of a three-position switch.
	**CAUTION** GENERAL HAZARD Make sure the wiring configuration does not start the unit in COOL or DEFROST; damage to the equipment can result. The three-position switch should be in the neutral position so that the unit will start in STANDBY. (When REMOTE is selected local functions will be disabled.)
11.	Has a remote ON/OFF switch been installed? If a remote ON/OFF switch has not been installed, go to Step 12. If a remote ON/OFF switch has been installed, go to Step 13.
12.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
	Continued next page

Install the Remote Control (Optional), Continued

Step	Action
13.	Remove the cover of the low voltage box as shown in Figure 31 on page 69.
14.	Refer to Figure 44 for the following steps. **Figure 44. Jumper J11 Location** 
15.	Locate JMPR J11 on the SYSTEM CONTROL printed circuit board in the low voltage box. Squeeze the jumper's latch to unplug it from the board.
16.	Replace the cover on the low voltage control box as shown in Figure 31 on page 69.
17.	Go to the Installation Checklist on page 5, initial and date this task, then go to the next task on the checklist.
End of Procedure	

Install Remote Temperature Indication (Optional)

Various temperatures associated with the PFC can be read remotely. This section gives information for installing this function.

Table 23. Thermocouples in the PFC

Thermocouple Name	Description
DISCHARGE LINE (TC #1)	This thermocouple is located in the refrigeration unit's compressor compartment. It is on the compressor discharge line near the compressor. It can be used to monitor compressor performance.
LIQUID LINE (TC #2)	This thermocouple is located in the refrigeration unit's compressor compartment. It is on the refrigerant circuit near the exit of the condenser. It can be used to monitor the effectiveness of the system's cooling water.
#1 COIL IN (TC #3)	This thermocouple is located on the feed line near the cryosurface. It can be used for troubleshooting if cryopumping is inadequate.
#1 COIL OUT (TC #4)	This thermocouple is located on the return line near the cryosurface. It can be used to monitor the warmest cryosurface temperature.
#1 FEED (TC #7)	This thermocouple is in the refrigeration unit's foamed compartment. It is on the refrigerant circuit near the feed line. It can be used for troubleshooting if cryopumping is inadequate.
#1 RETURN (TC #8)	This thermocouple is in the refrigeration unit's foamed compartment. It is on the refrigerant circuit near the return line. It can be used for troubleshooting if cryopumping is inadequate.
COLDEST LIQUID (TC #9)	This thermocouple is in the refrigeration unit's foamed compartment. It is on the final strainer in the "Polycold stack". It can be used to determine when to switch from STANDBY to COOL.
Additional Thermocouples for PFC/PFC Units	
#2 COIL IN (TC #5)	This thermocouple is located on the feed line near the cryosurface. It can be used for troubleshooting if cryopumping is inadequate.
#2 COIL OUT (TC #6)	This thermocouple is located on the return line near the cryosurface. It can be used to monitor the warmest cryosurface temperature.
#2 FEED (tied back) see #1 FEED	This thermocouple is in the refrigeration unit's foamed compartment. It is on the refrigerant circuit near the feed line. It can be used for troubleshooting if cryopumping is inadequate.
#2 RETURN (TC #10) see #1 RETURN	This thermocouple is in the refrigeration unit's foamed compartment. It is on the refrigerant circuit near the return line. It can be used for troubleshooting if cryopumping is inadequate.
Note: The COIL IN, COIL OUT, FEED and RETURN thermocouples only provide meaningful information when refrigerant is flowing through the cryosurface (i.e., in COOL or DEFROST).	

Continued next page

Install Remote Temperature Indication (Optional), Continued

About the temperature meter

The display range is –199.9 to +199.9°C and has an accuracy of ±3°C. The temperature meter accepts a type T (copper-constantan) thermocouple input and is powered by the unit's 24 VAC control transformer.

The temperature meter provides an analog output from –1.999 to +1.999 V(dc). The output is 0 VDC for 0°C. It provides positive voltage for positive temperatures and negative voltage for negative temperatures at a rate of 10 mV/°C.

Using the analog output

The output is taken directly from the analog stages immediately preceding the analog-to-digital conversion for the meter's display. This circuit is sensitive to currents introduced into the output from external noise sources and ground loop situations. Therefore, the following precautions must be observed.

- The connecting cable must be less than 100 feet (30.5 m).
- The connecting cable must be shielded with only one end of the shield connected to ground. This grounding is done at the refrigeration unit. Use the designated pins in the remote connector for cable shield connections.
- The shielded connecting cable must be separate from the remote cable bundle. However, it may be routed next to the remote cable bundle.

Do not ground either side of the analog output of the meter. The external device must have a differential input to isolate the connections.

End of Task

Isolated Interface Option

Introduction

The isolated interface is a device that maintains electrical isolation between the refrigeration unit's control voltage and a control system's voltage. This isolation prevents spurious electrical signals in either system from affecting the other system. It also allows the refrigeration unit to interface with an incoming voltage different than the 24 V(ac) used internally. Voltage option was specified when the isolated interface was ordered.

Isolation is provided by relays on a printed circuit board (I/O) board. A signal from the control system to the refrigeration unit activates the appropriate relay coil, closing the contact. This contact closure initiates the desired function within the refrigeration unit.

Status information from the refrigeration unit to the system activates a 24 V(ac) output relay, closing the contact. The control system must provide the appropriate detection circuit to interpret the contact closure.

NOTE: The analog output signal for remote temperature indication is not isolated.

Additional Instructions for Install the Cryosurface

1. Verify the voltage option

Loosen the two lower screws on the side of the low voltage box. Slide the low voltage box panel straight up to remove it.

Locate the isolated interface I/O board in the lower half of the low voltage box. Check the voltage specification printed on the housings of relays #1, #5, and #7. The voltage specified on the above relays should indicate the control supply voltage.

Note: For 12 V(ac) and 24 V(ac) options: Rectifiers are put before each relay, so the relay housings will indicate "DC" instead of "AC."

Note: For PFC/PFC: Also check the housings of relays #11 and #13.

Note: For PFC/P: Also check the housing of relay #11.

2. Verify that the control system meets the electrical requirements.

Table 24. Isolated Interface Option – Electrical Requirements			
	To Control the Refrigeration Unit		To Obtain Status Information
Specified Voltage Option	Acceptable Voltage Range (V)	Coil Resistance (Ω)	Acceptable Current Range† (mA)
6 V (ac)	4.8 - 6.6	18.8	100 - 5000
6 V (dc)	4.8 - 6.6	47.0	100 - 5000
12 V (ac or dc)	9.6 - 13.2	188.0	60 - 5000
24 V (ac or dc)	18.2 - 26.4	750.0	30 - 5000
† The voltage used to obtain status information must not exceed 24 V. † Minimum current required to keep relay contacts clean. † Maximum switching current for inductive or resistive loads.			

3. Connect the control system to the isolated I/O connector plug.

The isolated interface provides the same status information and control functions as the standard remote connector. Follow the instructions Install the Remote Control (Optional) with the following exceptions:

- The contacts inserted into the back of the isolated I/O connector plug are sockets instead of pins.

Additional Instructions for Operation are in Polycold Fast Cycle (PFC) Water Vapor Cryopump Operation Manual 825160-00.

The refrigeration unit cannot operate in COOL and DEFROST at the same time. If the control system attempts to do this, the refrigeration unit will operate in COOL.

A "remote verification" signal for each refrigerant circuit is provided when the following conditions are met.

- Electrical power is connected to the refrigeration unit and the power disconnect switch is in the ON position.
- The ON/OFF switch on the unit's SYSTEM CONTROL panel is in the ON position, and the refrigeration unit (compressor) is running.
- The refrigerant circuit is in REMOTE.

If the refrigeration unit is shut off by one of Polycold's protective devices, both the "remote verification" signal and the "unit OK" signal will turn OFF.

Check the operation of each relay every year if running at less than the minimum current. See Table 24. If it is necessary to replace the relay, refer to the following part numbers.

Table 25. Isolated Interface Option Parts List		
Relay Description	**IDECs (manufacturer) Part Number**	**Polycold Part Number**
6 V(ac)	RH1B-U AC 6V	Not released
6 V(dc)	RH1B-U DC 6V	Not released
12 V(dc)	RH1B-U DC 12V	Not released
24 V(dc)	RH1B-U DC 24V	333026-01
24 V(ac), 1-pole†	RH1B-U AC 24V	333019-01
24 V(ac), 2-pole†	RH2B-U AC 24V	333019-02
† For relays operated by the refrigeration unit's control voltage		

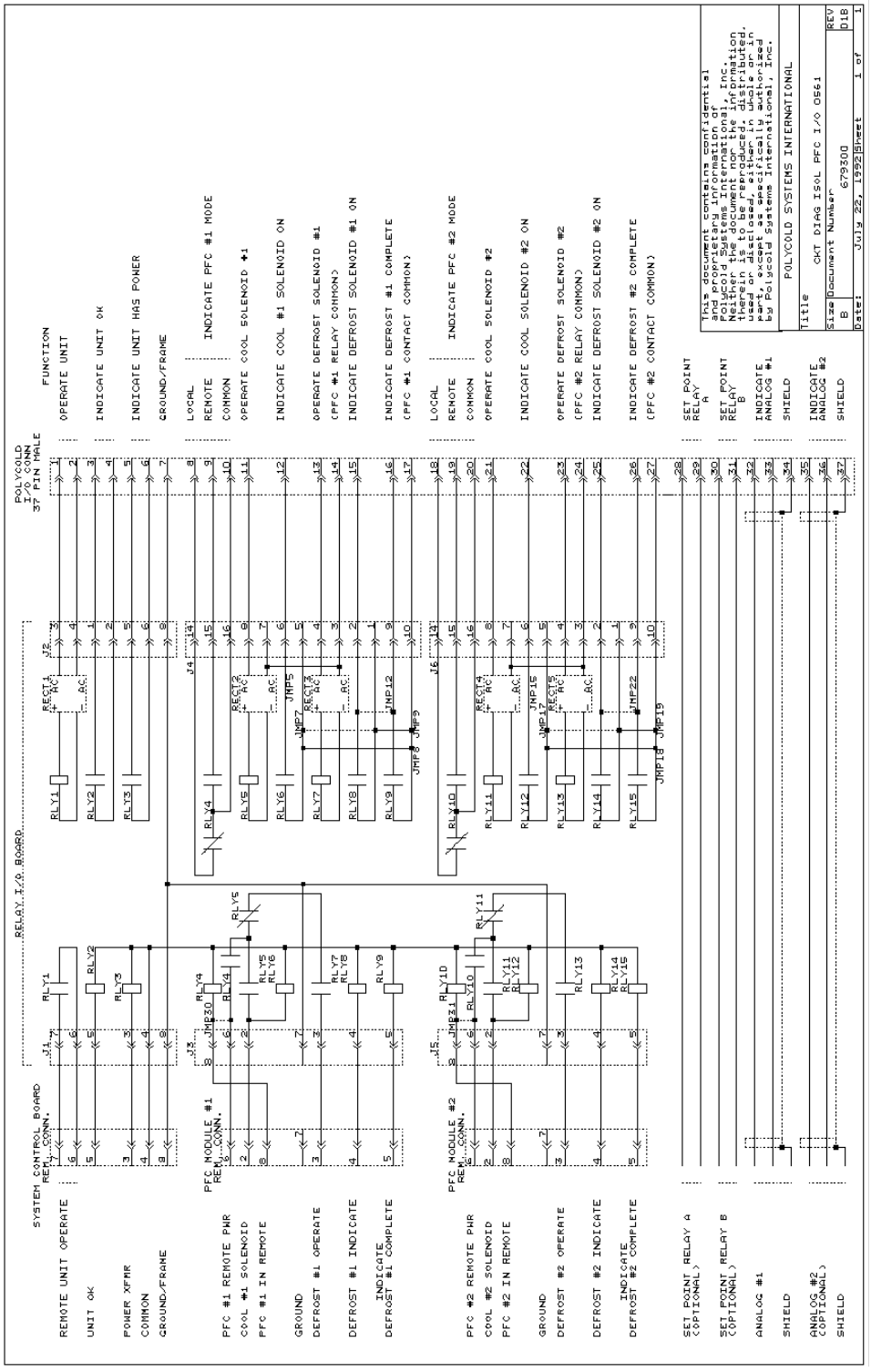


Figure 45. PFC and PFC/PFC isolated interface option—internal wiring

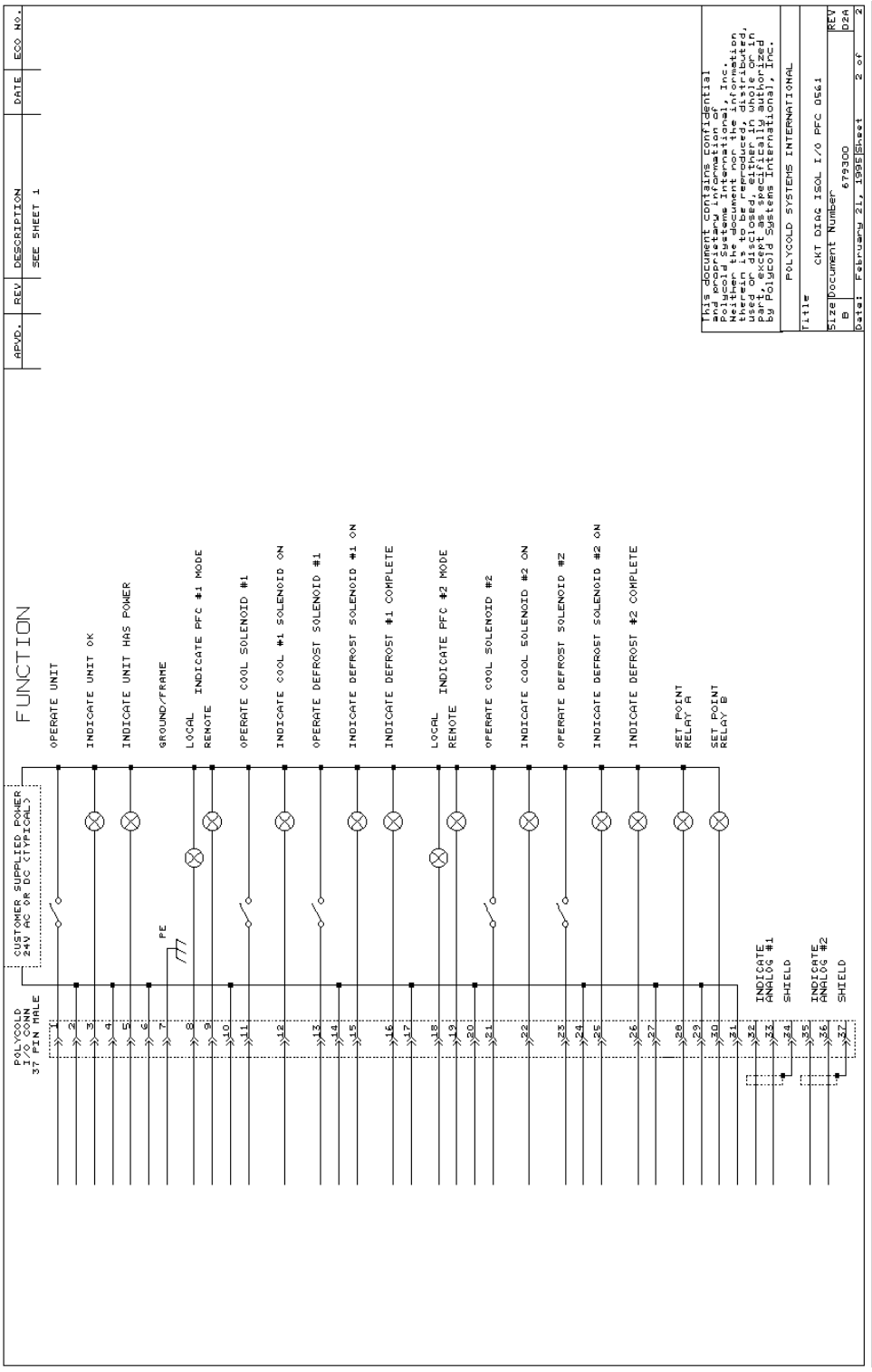


Figure 46. PFC and PFC/PFC isolated interface option suggested wiring for customer's control system

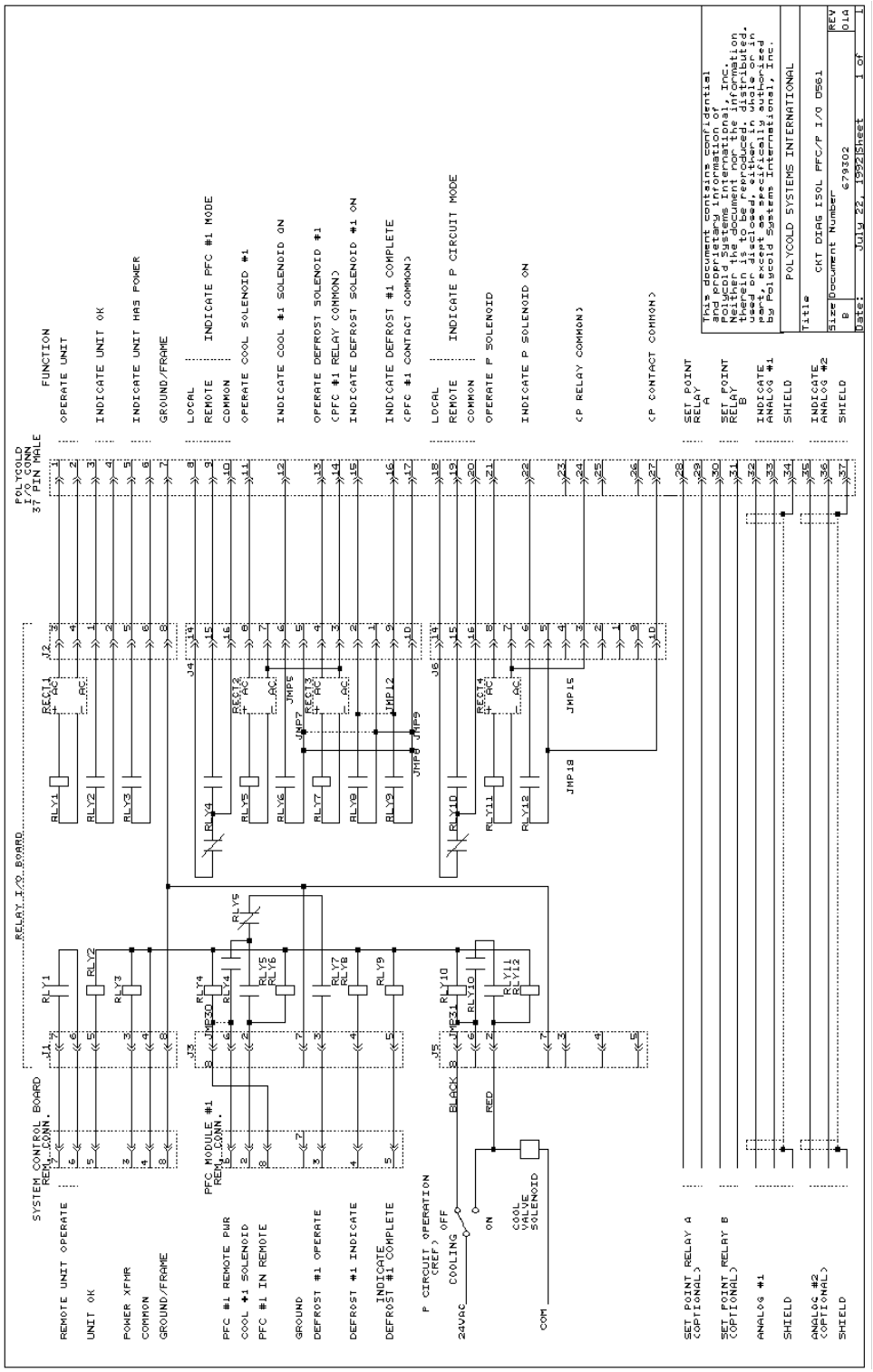


Figure 47. PFC/P isolated interface option—internal wiring

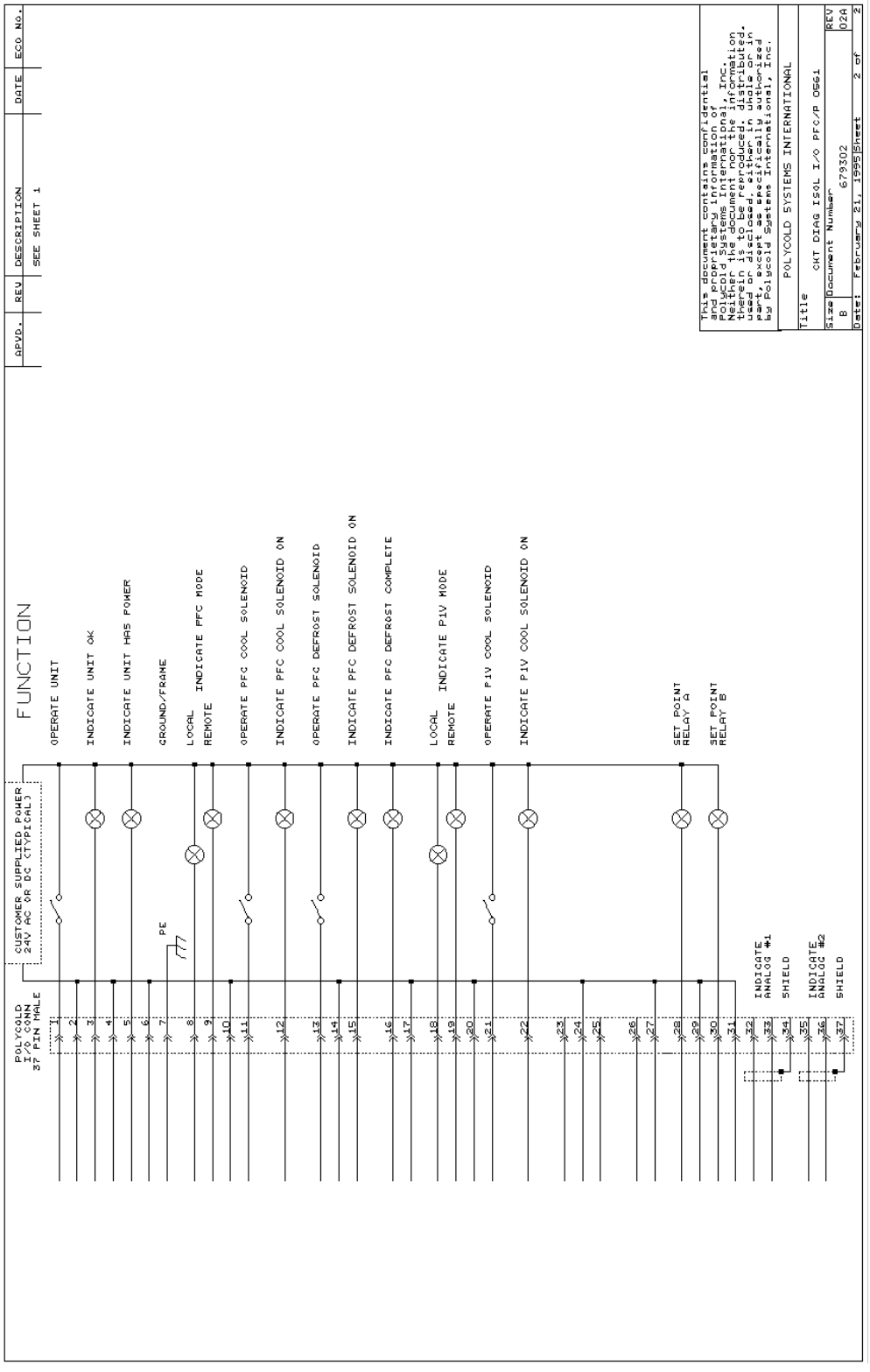


Figure 48. PFC/P isolated interface option—suggested wiring for customer's control system

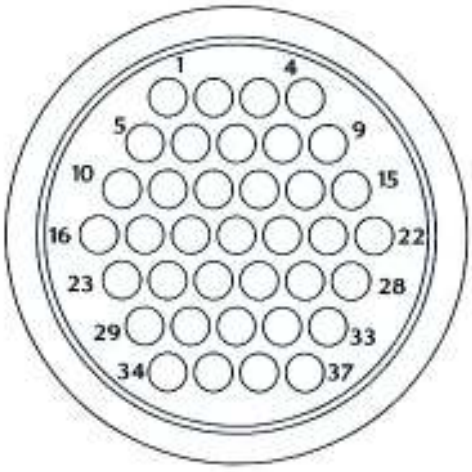


Figure 49. Isolated interface option—wire side of isolated I/O connector plug

Table 26. Isolated Interface Option—Isolated I/O Connector Wiring Worksheet			
Group	**Wire Function**	**Pin Number**	**Customer's Wire Color**
System Control	Operate Unit	1	
		2	
	Indicate Unit OK	3	
		4	
	Indicate Power	5	
		6	
	Ground	7	
Refrigerant Circuit 1 (PFC)	Indicate REMOTE- LOCAL	8	
	Indicate REMOTE – REMOTE	9	
	Indicate REMOTE – Common	10	
	Operate COOL	11	
	Indicate COOL	12	
	Operate DEFROST	13	
	Operate Common	14	
	Indicate DEFROST ACTIVE	15	
	Indicate DEFROST COMPLETE	16	

	Indicate Common	17
Refrigerant Circuit 2 (PFC or P)	Indicate REMOTE- LOCAL	18
	Indicate REMOTE – REMOTE	19
	Indicate REMOTE – Common	20
	Operate COOL	21
	Indicate COOL	22
	Operate DEFROST (PFC only)	23
	Operate Common	24
	Indicate DEFROST ACTIVE (PFC only)	25
	Indicate DEFROST COMPLETE (PFC only)	26
	Indicate Common	27
Option	Indicate Setpoint Relay A	28
		29
Option	Indicate Setpoint Relay B	30
		31
Temperature Meter 1	Analog #1 – Out	32
	Analog #1 – Return	33
	Analog #1 – Shield	34
Option— Temperature Meter 2	Analog #2 – Out	35
	Analog #2 – Return	36
	Analog #2 – Shield	37

Leybold Isolated Interface Option

The Leybold isolated interface option is the same as Polycold's standard isolated interface option with the following exceptions.

- The Leybold isolated interface option is only designed for models PFC and PFC/PFC.
- The Leybold isolated interface option is only designed for an incoming voltage of 24V.
- The isolated I/O connector plug has a different pin configuration.
- The Leybold isolated interface does not provide a "remote verification" signal.

Follow the instructions found in Isolated Interface Option with the following exceptions:

- Figure 50 - Leybold Isolated Interface Option- Schematic
- Figure 51 - Leybold isolated interface option – wiring side of isolated I/O connector plug
- Leybold Isolated Interface Option—Isolated I/O Connector Wiring Worksheet
- Disregard any information with respect to "remote verification" signal

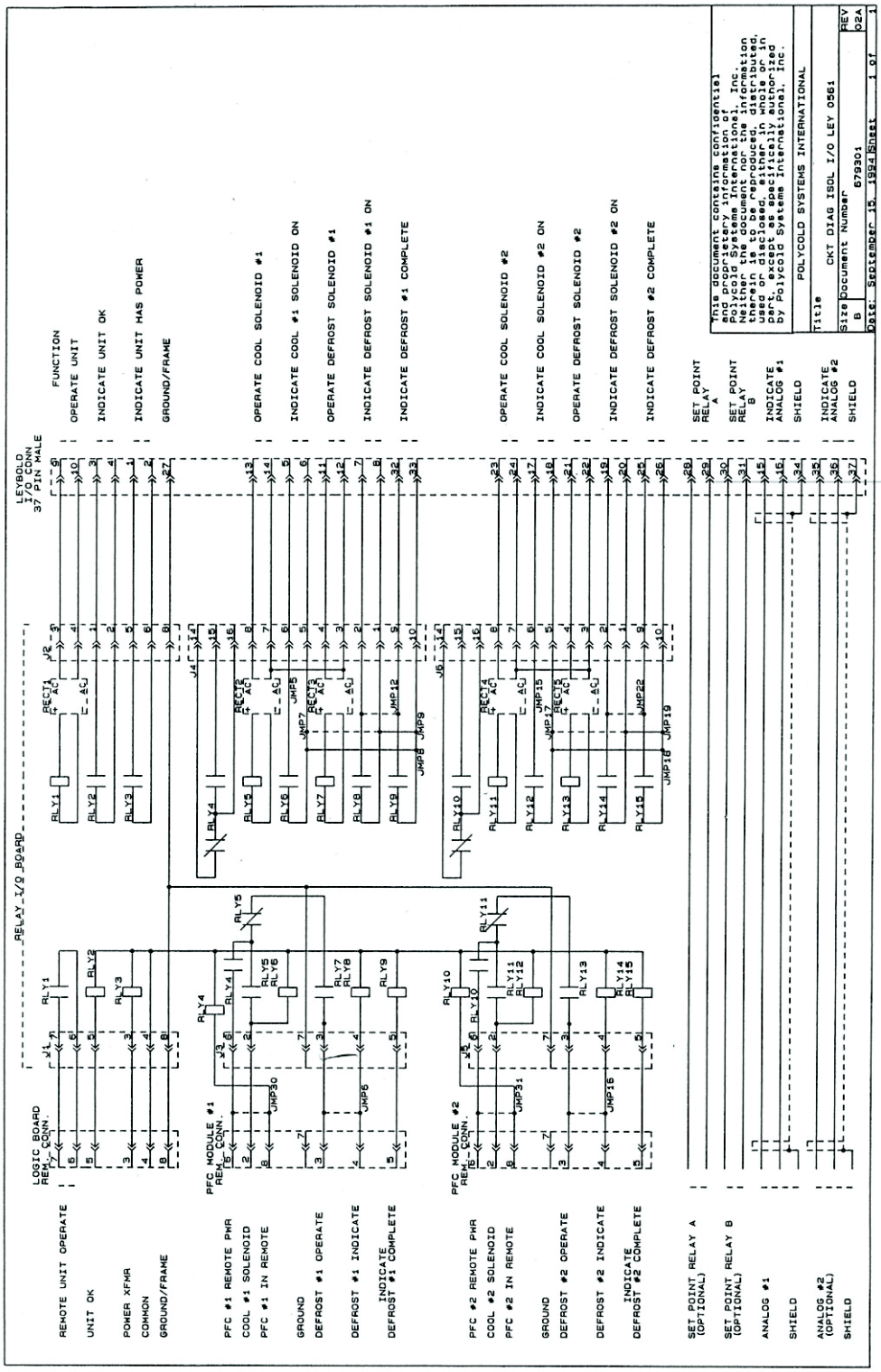


Figure 50. Leybold Isolated Interface Option- Schematic

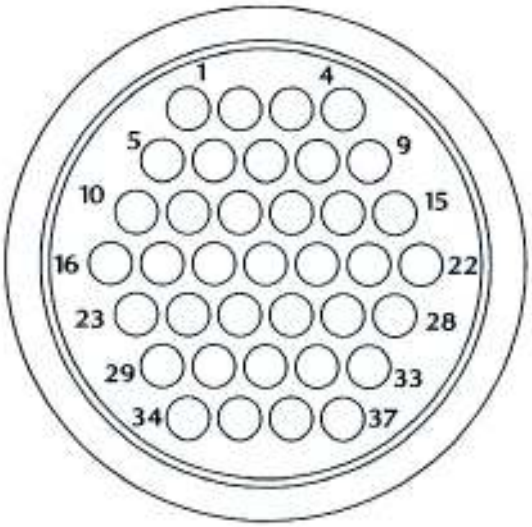


Figure 51. Leybold isolated interface option – wiring side of isolated I/O connector plug

Table 27. Leybold Isolated Interface Option-Isolated I/O Connector Wiring Worksheet			
Group	**Wire Function**	**Pin Number**	**Customer's Wire Color**
System Control	Indicate Power	1	
		2	
	Indicate Unit OK	3	
		4	
Refrigerant Circuit 1 (PFC)	Indicate COOL	5	
		6	
	Indicate DEFROST	7	
		8	
System Control	Operate Unit	9	
		10	
Refrigerant Circuit 1 (PFC)	Operate DEFROST	11	
		12	
	Operate COOL	13	
		14	
Temperature Meter 1	Analog #1 – Out	15	
	Analog #1 – Return	16	

Refrigerant Circuit 2 (PFC)	Indicate COOL	17
		18
	Indicate DEFROST	19
		20
	Operate DEFROST	21
		22
	Operate COOL	23
		24
	Indicate DEFROST COMPLETE	25
		26
System Control	Ground	27
Option	Indicate Setpoint Relay A	28
		29
Option	Indicate Setpoint Relay B	30
		31
Refrigerant Circuit 1 (PFC)	Indicate DEFROST COMPLETE	32
		33
Temperature Meter 1	Analog #1 – Shield	34
Option— Temperature Meter 2	Analog #2 – Out	35
	Analog #2 – Return	36
	Analog #2 – Shield	37

4. Appendix

Brazing Specification

Tools and materials:

- Sand paper or wire brush or steel wool
- Pressure or flow regulated dry nitrogen gas
- Oxy-acetylene torch or air-acetylene torch (propane is not hot enough)

For copper-to-copper joints:

- Harris Dynaflow or Handy & Harman Sil-Fos 6M or equivalent alloy

For copper-to-stainless steel or copper-to-brass joints:

- Harris Safety-Silv 56 or Handy & Harman Braze 560 or equivalent alloy
- Harris Stay-Silv black flux or Handy Flux Type B-1 or equivalent flux

Step	Action
1.	Thoroughly clean all mating surfaces to bare metal.
2.	Purge the tubes with dry nitrogen gas while brazing and until the tubes and joints have cooled to at least 374-392°F (190-200°C). This prevents internal scale formation or oxidation.
3.	Remove all excess flux from the brazed joints with a wet or damp rag while the brazed joint is still hot.
4.	Carefully inspect each joint for the proper flow of the brazing alloy. Both surfaces should be “wetted” by the alloy.
5.	Carefully check all joints for leaks.
End of Procedure	