



Trillium US Inc.
Cryo-Plex 16[®] Cryogenic High Vacuum Pump
User's Manual
Rev A / February 2016

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1 Revision History

Date	Revision	ECR #	Description of Change
October 2006	1.0.1		Conversion to new format
February 2016	A	2887	Rebranding and format changes
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2 Preface

2.1 About Trillium US Inc.

Trillium US Inc., an Oregon based company, specializes in the manufacture and repair of cryogenic vacuum pumps, cryocoolers (refrigerators) and helium compressors for semiconductor, optical coating, linear accelerators, medical equipment, and R&D applications.

You can find just what you need from our range of products and support services:

- New Equipment - cryopumps, such as the Cryo-Plex 16 cryopump described in this manual, compressors, cryocoolers, and cryopump controllers.
- Comprehensive range of accessories for the installation of whole systems and a complete range of spare parts to repair cryopumps and compressors.

2.2 Other Services from Trillium US Inc.

Trillium US Inc. offers comprehensive refurbishment services for its own equipment as well as for that of most of our competitors. Our products and services are available through our global network of agents and dealers.

- Repair and refurbishment services - We offer our own quality products, as well as most other manufactures models, often with off-the-shelf availability.
- Exchanges - We offer our own quality products, as well as most makes of cryopumps and helium compressors, which are refurbished and fully warranted.
- Technical Support - Our support engineers will help determine if your cryopump system is operating correctly so that you can get your system back to optimum efficiency as soon as possible.
 - To contact Trillium US Inc. Technical Support:
 - E-mail: support@trilliumus.com
 - Telephone: 1-512-441-9258 or Toll Free: 1-800-404-1055
- Installation - On-site installation services are available to guarantee performance and save you time.
- Training - We offer on-site training to help you and your staff to know more about your cryopump and compressor systems. Our training will give you confidence and the ability to maintain a highest possible uptime for your system.

2.3 About this Manual

The purpose of this manual is to provide our customers using the Cryo-Plex 16 Cryopumps with the information needed to safely and efficiently operate the compressor when operating as part of a cryogenic refrigeration system. Such a system is often comprised of the following equipment:

- Cryopump compressor unit such as the Model 600 compressor from Trillium US Inc.
- Coldhead(s) or cryopump(s)
- Connecting helium lines

This manual describes the design, operation and maintenance of the Cryo-Plex 16 cryopump unit.



2.4 Compatibility

The Cryo-Plex 16 cryopumps are designed for use with Trillium US Inc. Model 600 helium compressor (or equivalent).

3 Safety Warnings

3.1 Standards for the Use of Warnings and Cautions

Warnings are noted when there is a possibility of injury or death to persons operating the equipment or performing specific tasks or procedures noted in this manual. Cautions are noted when there is a possibility of damage to equipment if the caution is ignored.

3.2 Warnings Applicable to All Aspects of Cryo-Plex 16 Cryopump Operation



If the Cryo-Plex 16 cryopump has been used to pump any toxic or dangerous materials, this information and associated paperwork must be listed on all shipping containers and on associated paperwork before the equipment is returned to Trillium US Inc. for any repairs.



When pumping any toxic, corrosive, or flammable gases, a vent pipe must be connected to the cryopump relief valve and vented to a safe location.



Do not install a hot filament vacuum gauge on the cryopump side of the hi-vac gate valve as this could be a source of ignition.



Helium gas can cause rapid asphyxiation and death if released in a confined area.



Use a pressure reducing regulator when with-drawing Helium gases from a high pressure cylinder



Detaching the helium flex lines with the compressor load at low temperature can cause the pressure rise in the system beyond the permissible level therefore creating a safety hazard.

3.3 Operator Instructions

Follow standard Cryo-Plex 16 operating procedures as described in this manual. If after reading this manual, you still have questions regarding the safe operation of the CP16 cryopump, please contact Trillium US Inc. Technical Support using the contact information found in Section 2.

4 Introduction

4.1 General Information about the Cryo-Plex 16 Cryopump

Trillium US Inc. provides both custom and industry standard cryogenic solutions at highly competitive prices. Cryogenic vacuum pumps provide clean, oil-free high vacuum with high pumping speeds are the pump of choice for sputtering, electron beam evaporation, accelerator beam lines and many aerospace and coating applications.

Cryo-Plex 16 cryopumps are available in various standard inlet flange configurations - ISO and CVC, with temperature sensors either in diode or hydrogen-vapor-bulb (HVB) configurations.

4.1.1 Cryo-Plex 16 Cryopump Features

The Cryo-Plex 16 cryopumps, as seen in **Figure 1** and **Figure 2**, are typically used in the following applications:

- Sputtering tools
- Ion implanters
- R & D bell-jar systems
- Surface analysis
- Accelerators
- Beam lines
- General vacuum systems

4.2 Specifications

The Cryo-Plex 16 cryopump specifications are listed in **Table 4-1**. **Figure 1** and **Figure 2** shows the Cryo-Plex 16 cryopump dimensions.

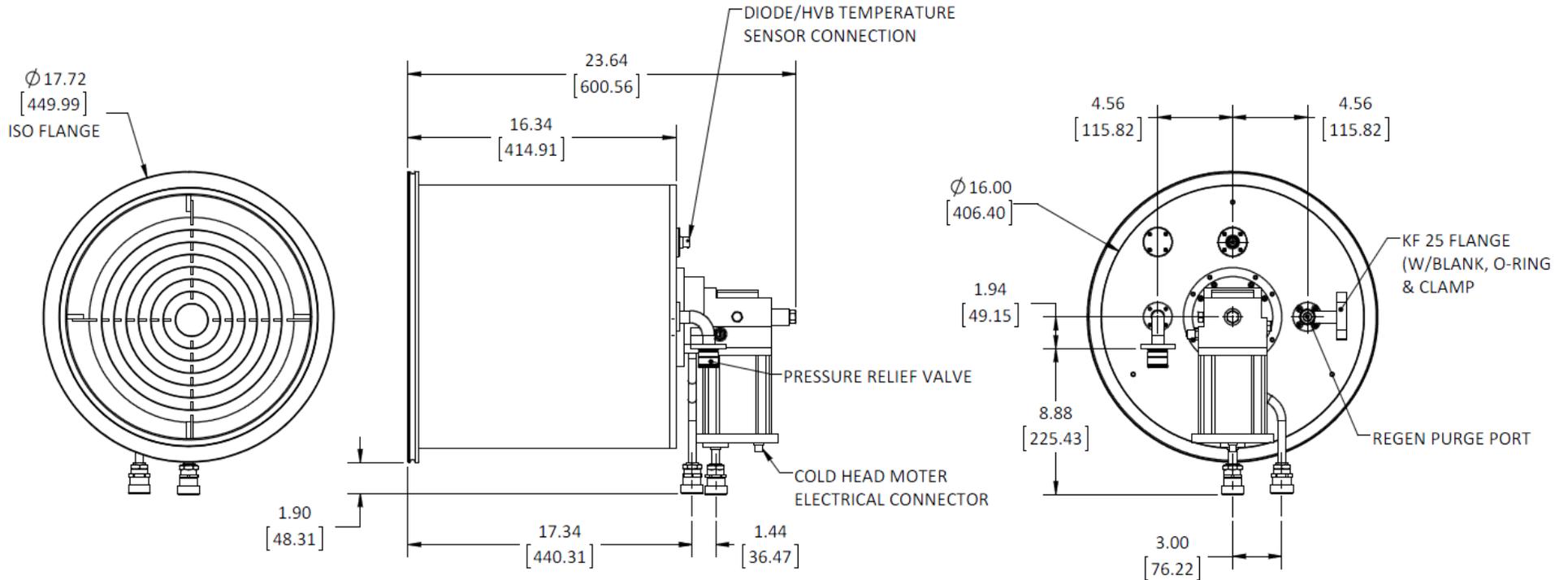
Table 4-1: Cryo-Plex 16 Characteristics

Characteristic	ISO Flange	CVC Flange
Height (inches)	23.6	23.7
Maximum Flange Diameter (inches)	17.7	18.0
Weight (lbs)	160	160

- Pumping Speeds (liter/sec.)
 - Air: 5000
 - Water: 16000
 - Hydrogen: 5000
 - Argon: 4200
- Argon Throughput
 - 500 scc/min.
- Capacity:
 - Argon: 2000 standard liters
 - Hydrogen: 15 standard liters @ 5x10e-6 torr
- Crossover: 300 torr-liters
- Cool Down Time (Room temperature to 20K):
 - 60 Hz: 2.5 hours
 - 50 Hz: 3.5 hours
- Inlet Flange (Size: Standard)
 - 16-inch: CVC
 - NW 400: ISO

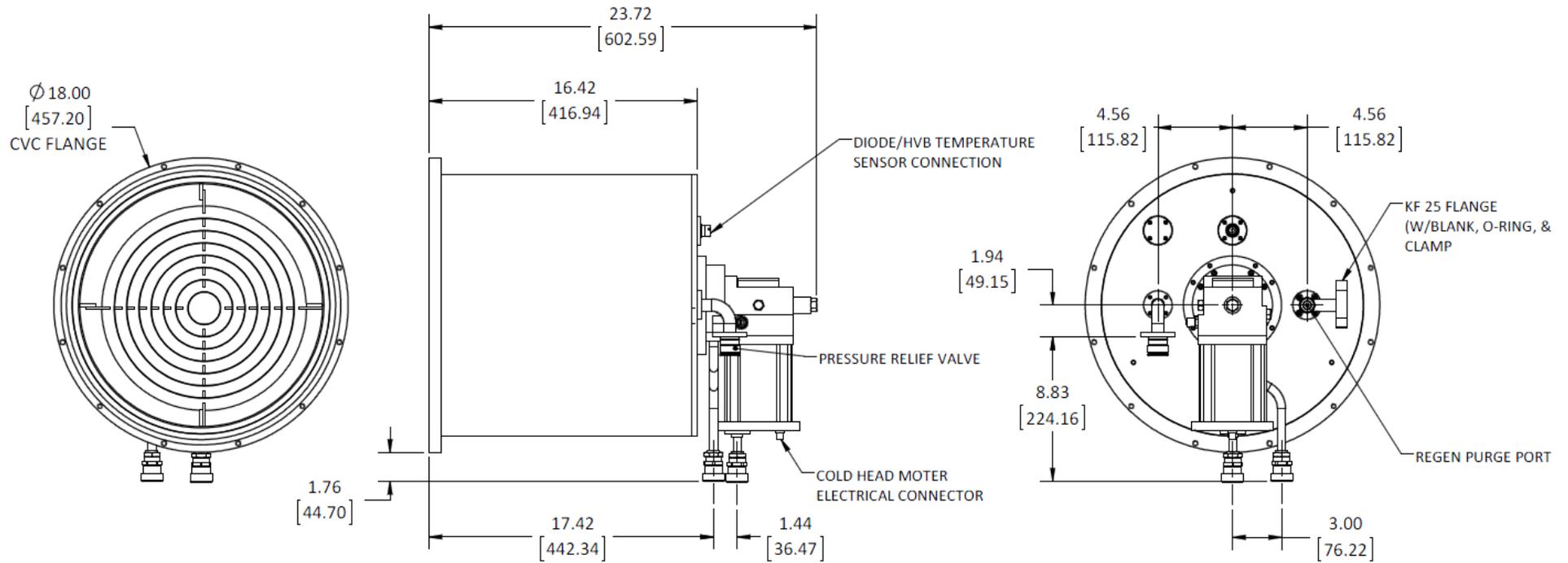
Note: Cryo-Plex 16 cryopumps can operate safely in any mounting orientation.

Figure 1 – Cryo-Plex 16 Cryopump with ISO Flange Dimensions



OVERALL DIMENSIONS in [mm]

Figure 2 – Cryo-Plex 16 Cryopump with CVC Flange Dimension



OVERALL DIMENSIONS in [mm]



4.3 Ordering Information

Table 4-2 contains the ordering information for the Cryo-Plex 16 Cryopumps. Customers can also order the optional accessories and replacement parts listed in **Table 4-3**.

Table 4-2: Cryo-Plex 16 Cryopump Ordering Information Cryopump Part Number

Cryopump	Part Number
Cryo-Plex 16 (CVC Flange, Diode)	10301
Cryo-Plex 16 (CVC Flange, HVB)	10302
Cryo-Plex 16 (ISO Flange, Diode)	10303
Cryo-Plex 16 (ISO Flange, HVB)	10304

Table 4-3: Optional Accessories and Replacement Parts

Accessories/Replacement Parts	Part Number
Blanket Heater	BH-16
Purge Gas Valve	10185
Purge Gas Valve Heater	10340
Rough Valve	10191
Burst Disc	BD-133
Relief Valve Cover	60210
Drive Unit Power Cable (10 ft.)*	10144-10
Diode Monitor	10132
Diode Cable for Diode Monitor (10 ft.)*	10133-10
Model 2200 Automatic Cryopump Controller w/ Remote (115V)	93-00016-910
Model 2200 Automatic Cryopump Controller w/ RS232 (220V)	93-00015-232
Single Pump Installation Kit	10251

*Custom length available.

5 Installation

5.1 Safety Warnings

Review the safety warnings in Section 3 before beginning any installation activities.

5.2 Inspect Equipment Before Installing

Remove the cryopump from the box and inspect for any damage during shipping. Notify Trillium US Inc. immediately if any damage was found.

5.3 Tool Needed for Installation

The Installation Kit for the Cryo-Plex 16 cryopump is offered as an optional accessory that can be ordered from Trillium US Inc. Refer to **Table 4-3** for the part number.

5.4 Installing the Cryo-Plex 16 Cryopump

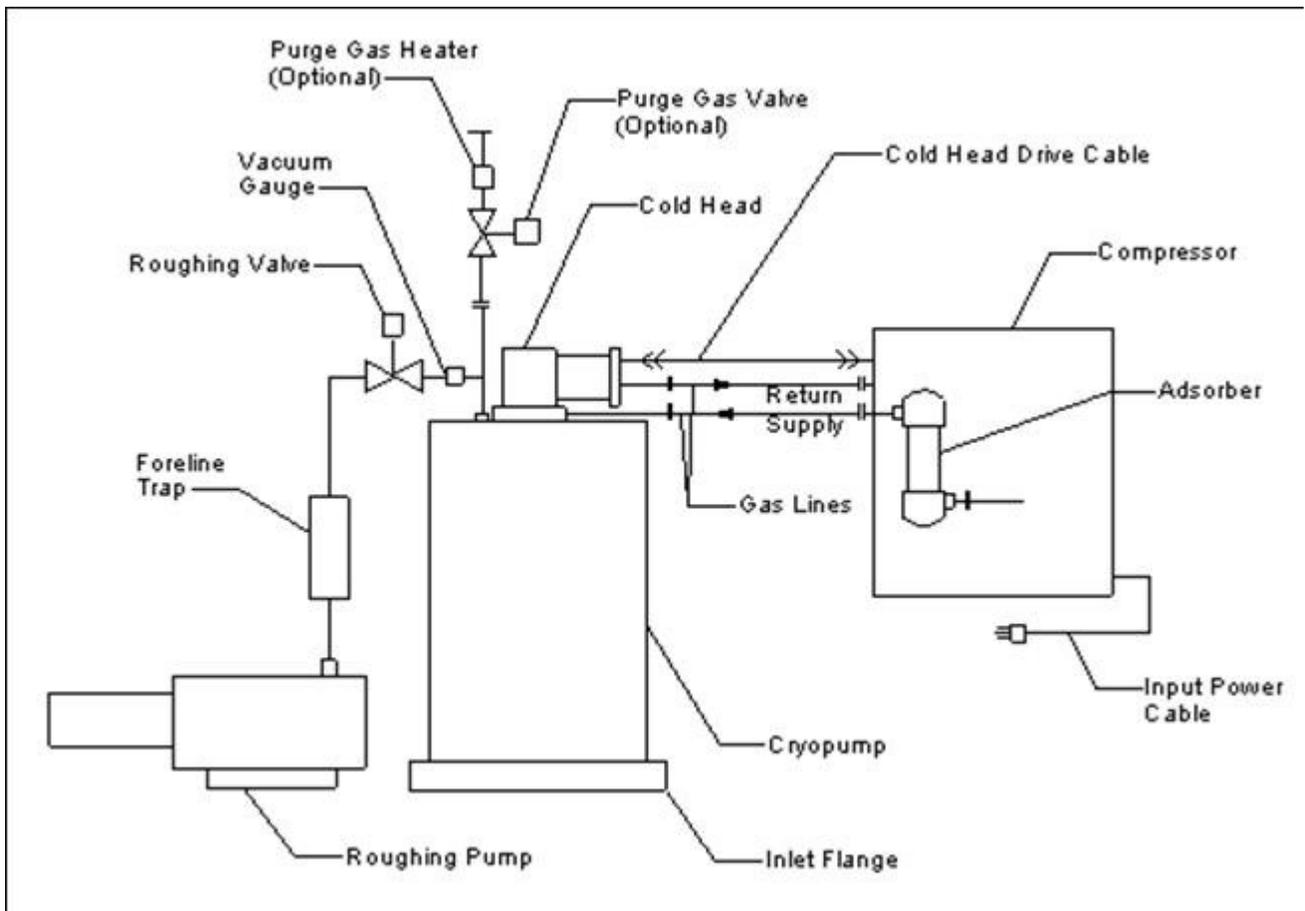
Figure 3 shows a typical installation diagram when making connections. Follow these steps to install the Cryo-Plex 16 cryopump:

1. Clean all sealing surfaces, apply a thin film of vacuum grease to inlet flange o-ring and install it.
2. Bolt cryopump to the chamber hi-vac gate valve:
3. Attach roughing valve to the KF 25 flange on the purge tube adaptor of the cryopump.



4. Remove dust plugs from any Aeroquip Self Sealing Couplings and inspect gasket seals.
5. Connect helium gas lines in the following order.
 - a. Use a helium flex line to connect the "Return" ports on both the Cryo-Plex 16 and the compressor.
 - b. Use a helium flex line to connect the "Supply" ports on both the Cryo-Plex 16 and the compressor.
6. Check gas pressure gauge per compressor specifications.
7. Connect cold-head drive cable from cryopump to compressor.
8. Connect diode cable to temperature monitor if applicable.
9. Connect main power cable per compressor specifications.

Figure 3 – Connection Diagram



5.5 Installing a Roughing Pump

To install a roughing pump follow these steps:

1. Connect the roughing pump system directly to the accessory port located on the cryopump.
2. A vacuum gauge and roughing valve should be installed as close as possible to the cryopump.
3. Install an oil back streaming device (fore line trap) in series to the roughing pump.



6 Operations and Controls

6.1 Cryopump Preparation

When a cryopump has been in storage for a period of time or when receiving a new one, the charcoal array of the cryopump may be loaded with moisture or other contaminants. A so-called "Extended Nitrogen Purge" process should be performed to get the cryopump to its desired condition before cool-down operation.

Follow these steps of the "Extended Nitrogen Purge" process:

1. Install the cryopump per procedures described in Section 5.4, leak check all mounting seals and valves to ensure the cryopump is leak-tight.
2. Make sure the cryopump is at room temperature.
3. Using a gas supply flex line with proper connections to connect a nitrogen gas (N₂) cylinder (with a pressure regulator) to the purge gas valve of the cryopump.
4. Open the purge gas valve and regulate the pressure of nitrogen gas to between 18 to 30 psi.
5. Turn on the purge gas heater.
6. Continue the purging process for at least 4 hours.
7. Turn off the purge gas heater and close the purge gas valve.
8. Clean and then remount the o-ring of the relief valve on the cryopump.

The cryopump unit is now ready for start-up operation.

6.2 Normal Operation

6.2.1 Cryopump Start-Up

1. Make sure the gate valve to the main chamber is closed.
2. Open the rough valve of the cryopump and rough to appropriate crossover pressure level.
3. Perform Rate of Rise test to verify proper regeneration and leak rate of the cryopump. Normally a 10 micron/minute rate of rise is considered acceptable. If the Rate of Rise test fails, leak check the cryopump and the gate valve first and fix any leak that is present. If the test still fails after that, repeat the "Extended Nitrogen Purge" process described in Section 6.1.
4. Rough pump the cryopump back to its appropriate crossover pressure level.
5. Close the rough valve and start the compressor that runs the cryopump.
6. When a cryopump is operating properly, it usually takes about 90~100 minutes to reach 20K.
7. Once the cryopump reaches its operating cryogenic temperature, observe the pressure in the main vacuum chamber before opening the gate valve and starting cryopumping the chamber.
8. The crossover of the main vacuum chamber from rough pump to cryopumping should be at 300 torr-liters.

Only open the gate valve when this condition is met.

6.2.2 Rough Pumping

Observe the following cautions when rough pumping the cryopump:

Caution: Do not begin to rough pump the cryopump without knowing the pre-determined roughing pressure.

Caution: Never rough pump the cryopump longer than necessary, it could result in back streaming of mechanical pump oil that will contaminate the cryopump.



6.2.3 Regeneration of the Cryopump

Since cryopumps are capture type pumps, they must be periodically warmed up and evacuated in order to remove the accumulated condensed and adsorbed gases. The process of warming up and evacuating gases from a cryopump is called regeneration.

6.2.3.1 Unassisted Regeneration

1. Close the high vacuum gate valve and turn off the compressor and cryopump.
2. The cryopump condensing arrays should be allowed to warm up to 80°F (26°C, 300K).
3. Begin roughing the cryopump to the crossover pressure, close the roughing valve and restart the compressor and cryopump.
4. Cryopump is now ready for cool-down.

6.2.3.2 Assisted Regeneration

1. Close the high vacuum gate valve and turn off the compressor and cryopump.
2. Using a heated dry gas (nitrogen/argon) to purge the cryopump through the purge gas valve. The purge gas should be injected at 1 to 2 cfm and a maximum temperature of 150°F (65°C, 338K). Trillium US Inc. offers a purge gas valve heater option that can limit the heated purge gas temperature to 150°F (65°C).
3. The exterior of the cryopump may be heated using a blanket heater available from Trillium US Inc. (P/N BH-16). Never let the surface exceed 150°F (65°C).
4. When the temperature sensor of the cryopump reaches 80°F (26°C, 300K), discontinue the regeneration process, and rough the cryopump to the initial starting pressure, close the roughing valve and restart compressor and cryopump.
5. Cryopump is now ready for cool-down procedures.

6.2.3.3 Automatic Regeneration

Automatic regeneration of the cryopump can be accomplished by the use of the Cryo-Plex 2200 Automatic Cryopump Controller, available from Trillium US Inc. Automatic regeneration occurs when predetermined pressure or temperature set points are exceeded.

7 Trouble Shooting Activities

7.1 Troubleshooting Activities

Table 7-1 describes some problems that users might encounter while operating the Cryo-Plex 16 Cryopump and provides solutions to those problems.

Table 7-1: Trouble Shooting Procedures

Problem	Possible Cause	Corrective Action
High base pressure of vacuum system and the cryopump temperature is below 20K.	<ol style="list-style-type: none"> 1. Vacuum leak in vacuum system or in cryopump. 2. High partial pressure of non-condensable (helium, hydrogen, or neon) within the cryopump because the charcoal array of the cryopump has reached full capacity 	<ol style="list-style-type: none"> 1. Check the following for leaks: <ol style="list-style-type: none"> a. Check the vacuum chamber and hi-vac/ gate valve for leaks b. Check cryopump relief valve for proper seating c. Check cryopump for leaks (after closing the gate valve) 2. Regenerate the cryopump per Section 6.2.3.



Problem	Possible Cause	Corrective Action
<p>High base pressure of vacuum system and the cryopump temperature is above 20K.</p>	<ol style="list-style-type: none"> 1. High partial pressure of non condensable (helium, hydrogen, or neon) within the cryopump because the 15K array has reached its full capacity. 2. Excessive thermal load. 3. Decrease in cryopump cold head performance 	<ol style="list-style-type: none"> 1. Regenerate the cryopump using the instructions in Section 6.2.3. Re-cool the cryopump, making note of: <ol style="list-style-type: none"> a. Cool down time to the operating temperature b. Time to achieve the desired operating vacuum level of the cryopump Compare these figures to those indicated in the operating log. If they are significantly different, then refer to Possible Cause 3 of this problem, "Decrease in cryopump cold head performance". 2. Reduce the thermal radiation load by: <ol style="list-style-type: none"> a. Shielding the cryopump b. Lowering the temperature of the radiating surface 3. If the helium pressure gauge reads below the normal-operating pressure, add helium gas according to procedure described in the compressor manual. Regenerate and re-cool the cryopump. 4. If the temperature remains above 20K, the problem may be within the cold head and contact Trillium US Inc. for assistance.
<p>Cryopump fails to cool down to the required operating temperature or takes too long to reach that temperature.</p>	<ol style="list-style-type: none"> 1. Low helium supply pressure. 2. Vacuum leak in vacuum system or cryopump. 3. High partial pressure of non condensable (helium, hydrogen, or neon) within the cryopump. 4. Compressor problem. 	<ol style="list-style-type: none"> 1. Add helium gas according to procedure described in the compressor manual. 2. Check vacuum system for leaks: <ol style="list-style-type: none"> a. Check cryopump relief valve for proper seating. b. Check cryopump for leaks. 3. Regenerate the cryopump as described in Section 6.2.3. 4. Refer to the "Troubleshooting" section of the compressor manual.
<p>Cryopump has intermittent ratcheting or thumping sound during operation.</p>	<ol style="list-style-type: none"> 1. Helium gas contamination 	<ol style="list-style-type: none"> 1. Refer to Section 8.3 for instructions on how to decontaminate the cryopump.



8 Maintenance

8.1 Maintenance Personnel Requirements

Only trained and qualified personnel should perform the maintenance procedures described in this chapter. Observe safety warnings as described in Section 3. All other maintenance work must be performed by Trillium US Inc. personnel in the factory. Please contact Trillium US Inc. to make arrangement for such work. See contact information in Section 2.

Caution: Always use two wrenches when connecting or disconnecting the Aeroquip self-sealing couplings.

8.2 Tools Needed to Service the Cryo-Plex 16 Cryopump

The following tools are needed to carry out the maintenance activities described in this Section. Refer to Section 4.3 for the correct part number:

- Maintenance manifold
- Two self-sealing coupling wrenches

8.3 Scheduled Preventative Maintenance Activity

8.3.1 Preparation before Decontamination

1. Cool down the cryopump for at least one (1) hour.
2. Shut down the compressor and cryopump. Then immediately disconnect the supply and return gas lines from the compressor.
3. Connect the supply and return helium gas lines to the maintenance manifold. Use the manifold to reduce the pressure in the coldhead to 45 psig.
4. Allow the second stage of the coldhead to warm to 80°F (26°C, 300K). Purging the pump with a warm dry gas (argon or nitrogen) will reduce the time required to warm up the pump.

8.3.2 Purging the Regulator and Charging Line

1. Prior to opening the gas cylinder valve, turn the regulator adjustment screw clockwise until it is open.
2. Open the gas cylinder valve. Close the regulator adjustment screw. This will purge air from the gas charging line and the regulator.
3. Connect the gas charging line to the flare fitting attached to the valve on the maintenance manifold. Do not tighten.
4. Follow Steps 1 and 2 in this subsection for at least 30 seconds allowing gas to flow from the flare fitting. With gas still flowing, tighten the flare fitting.

8.3.3 Pressurize and Vent the Cold Head

Follow these steps to vent the cold head:

1. Open the gas cylinder regulator and pressurize the cold head to the static pressure of the compressor. Open the maintenance manifold valve and close when pressure has been reached.
2. Slowly open the valve on the manifold. Release the pressure to no less than 30 psig.
3. Repeat Steps 1 and 2 in this subsection three more times.
4. Re-pressurize the coldhead to compressor static pressure. Turn on the drive motor for 1 to 2 minutes.
5. Repeat Steps 2 through 4 in this subsection three more time to complete a total of 12 flushes and 4 drive motor runs.
6. Make sure the helium gas pressure level of the coldhead is charged per compressor static pressure specification.



8.3.4 Reconnect Gas Lines to Complete Decontamination

Disconnect both gas lines from manifold and reconnect to supply and return fittings on the compressor. The cryopump is now ready for cool-down procedures.

8.4 Cleaning Equipment

Caution: Do not use solvents to clean connectors. The fittings should never be greased or oiled; otherwise the helium gas circuit of the system could become contaminated.

8.5 Returning Equipment

Before returning any equipment, contact Trillium US Inc. to receive special instructions and to obtain a return authorization number (RMA). See contact information in Section 2.

