CRYOMECH

Model PT415

Cryogenic Refrigerator

INSTALLATION, OPERATION and ROUTINE MAINTENANCE MANUAL

INCLUDES CP1010 COMPRESSOR PACKAGE

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Correspondence concerning this document should be forwarded to:

Customer Service Department
Cryomech, Inc.
113 Falso Drive
Syracuse, NY 13211 USA

Telephone (315) 455-2555
FAX: (315) 455-2544

cryoservice@cryomech.com

www.cryomech.com

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1 Section 1: Overview

This section provides an overview discussion of cryorefrigerators and of the PT415 in particular. It also provides an overview of this manual, including the organization, basic definitions of terms used and expansion of acronyms used in the manual.

1.1 Cryogenic refrigeration system

1.1.1 General description

The operation of a cryogenic refrigeration system is based on a closed-loop helium expansion cycle. A complete system consists of two major components: one is the compressor package, which compresses refrigerant and removes heat from the system; the other is the cold head, which takes refrigerant through one or more additional expansion cycles to cool it down to cryogenic temperatures. The refrigerant gas used in the Cryomech cryogenic systems is 99.999% pure helium. Flexible stainless steel lines called helium flex lines carry compressed helium from the compressor package to the cold head and carry low-pressure helium back.

The compressor package works as follows. An oil-lubricated compressor compresses the pure low-pressure helium that is returned from the cold head. The heat of compression is removed via a heat exchanger, and the oil from the compression process is removed in a series of oil separators and filters. The compressed helium is then fed to the cold head via the high-pressure helium flex line.

In the cold head, adiabatic expansion of the helium and further heat removal allows cooling to cryogenic temperatures. The low-pressure helium then returns to the compressor package via the low-pressure helium flex line.

1.1.2 Features and benefits of the Cryomech PT415

The Cryomech PT415 Cryorefrigerator features the CHPT415 Pulse Tube. It has been carefully designed and manufactured to provide years of trouble free service.

Primary features

The unique feature of pulse tubes such as the PT415 is that the expansion of the helium in the cold head is done with out a displacer or piston. This results in a cold head that has no moving parts at cryogenic temperatures, no seals and no motion of the regenerative materials

Primary benefits

- Very low vibration
- High reliability
- Long mean time between maintenance
- Reduced magnetic fluctuation from rare earth materials
- Lower costs of operation and maintenance

1.1.3 Features and benefits of the Cryomech CP1000 Series Compressors

Primary features

The CP1000 Series Compressor Package includes a microprocessor control with the following features:

- Fault sensing
- Automatic error logging
- Remote operation
- Remote indication of faults
- Phase error sensing

Primary benefits

- The CP1000 microprocessor control prevents reverse operation
- The CP1000 can be operated and monitored from a remote location

1.2 Cryomech PT415 Manual (CP1010)

This manual covers the PT415 Cryorefrigerator that consists of the CHPT415 Cold Head, the CP1010 Compressor Package, a cold head motor cord and a set of helium flex lines.

It is important that you review this manual carefully before beginning the installation process.

1.2.1 Organization of the manual

The main body of the manual provides a detailed discussion of everything you will need in order to install and operate the Cryomech PT415 Cryorefrigerator and to perform routine maintenance. It is divided into 8 sections. Illustrations accompany the discussion as needed for clarification. Additional information will be in the appendix.

Numbered lists labeled with 1), 2), etc and lettered lists labeled with a., b., etc. are used for sequential actions that must be performed in the order listed. Lists for which order is not important are bulleted, using solid or hollow bullets.

The manual contains essential information for the safe and effective operation of the Cryomech PT415. Sections 2 and 3 clearly lay out all safety precautions you should take and also explain the ways in which you might inadvertently void your warranty by doing something that would damage the system.

Sections 5 through 8 provide complete step-by-step instructions on the handling of your PT415, from inspection of the packing crate through routine maintenance. Each safety precaution is also shown in these sections in every place where observing the caution or warning is important.

- Section 1: Overview (including definitions and acronyms)
- Section 2: Warranty
- Section 3: Safety considerations
- Section 4: Specifications
- Section 5: Inspection and unpacking

- Section 6: Installation
- Section 7: Operation
- Section 8: Routine maintenance
- Appendix: CAD drawings of the cryorefrigerator and other information

1.2.2 Related documents

Technical manual

A separate detailed technical manual will be available by contacting Cryomech. This manual covers the theory behind cryorefrigerators, and supplies detailed information on optimizing instrumentation and insulation of cold heads for maximum performance.

1.3 Glossary

1.3.1 Definitions

The terms defined below are used with precision in the manual. For example, distinction is made between the (cryorefrigerator) system, the (compressor) package, and the (compressor) module.

The terms are in alphabetical order, and italicized terms within the definitions are terms that are also defined in this section.

Aeroquip® Couplings:

The term "Aeroquip® couplings" is used generically to describe the self-sealing fittings that connect components e.g. that connect *helium flex lines* to the *compressor package* and *helium flex lines* to the cold head.

Category II Installation:

Category II refers to the potential for transient over-voltage conditions in the mains power connection to the equipment. See IEC 664, Sub-clause 5.6 for further details.

Closed Loop System:

This refers to a cryogenic *system* that has no helium loss because the helium is cycled through a closed loop. The advantage of such a *system* is that there is no need to add helium.

Cold Head:

The cold head is an expansion device, which is capable of reaching *cryogenic temperatures*. In the PT415 system the cold head is a *Pulse Tube* (see Figure 5 in section 6.1.1).

Cold Head Motor Cord

The cold head motor cord is pre-wired and fitted with electrical connectors on each end that attach to the *cold head* and *compressor package*. The cold head motor cord provides electrical power from the *compressor package* to the *cold head* motor.

Compressor Module:

Located inside the *compressor package*, the compressor module is an oil-lubricated commercial compressor that compresses low-pressure helium to the necessary high pressure.

Compressor Package:

The compressor package houses the *compressor module* and all other components that compress and purify helium and that provide system safety control. The compressor package compresses the low-pressure helium returning from the *cold head* and provides clean high-pressure helium to the *cold head*.

Cryogenic Temperatures:

Temperatures lower than 120K or -153°C.

Cryorefrigerator (Cryocooler):

A cryorefrigerator is a cryogenic refrigeration *system* based upon a closed loop helium expansion cycle. It consists of a *compressor package*, *helium flex lines* and a *cold head* (expansion device).

Cold Head Heat Exchanger:

The first and second stage heat exchangers on the *cold head* provide cooling at cryogenic temperatures by transferring heat to the helium within the system. (See Figure 5 in section 6.1.1.)

Helium Flex Lines:

The helium flex lines are corrugated stainless steel hoses that transport helium between the *compressor package* and the *cold head*.

Pollution Degree 2:

Pollution degree 2 refers to the extent to which the local environmental conditions could affect the electrical safety of the system. See EN 61010 or UL 61010A for further details.

Pulse Tube Cryorefrigerator:

A pulse tube cryorefrigerator is a *cryorefrigerator* in which the *cold head* expands the helium using a pulse tube instead of a displacer or piston.

System:

The term "system" is used as a synonym for *cryorefrigerator*. It consists of a *compressor package*, *helium flex lines* and *cold head*.

1.3.2 Acronyms

The following acronyms are used in the text and provided here for convenient lookup.

FPT	Female Pipe Thread
GPM	Gallons per Minute
LPM	Liters per Minute
MPT	Male Pipe Thread
OFHC	Oxygen-Free High Conductivity (describes a form of Copper)
PSIG	Pounds per Square Inch Gauge

1.4 Cryomech Contact Information

Cryomech, Inc.
113 Falso Drive
Syracuse, NY 13211

Phone: (315) 455-2555
Fax: (315) 455-2544
Email: specs@cryomech.com
Website: www.cryomech.com

2 Section 2: Warranty

2.1 Statement of warranty

Provided that the customer installs, operates and maintains this cryorefrigerator according to the specifications and procedures set forth in this manual, Cryomech, Inc. extends a warranty on all parts and workmanship for a period of three (3) years or 12,000 operating hours, whichever comes first. This warranty covers all non-user serviceable components of the compressor package, the cold head and the helium flex lines. The warranty does not cover user-serviceable parts (such as fuses).

If found to be defective and in accordance with the terms of the limited warranty, Cryomech will provide warranty replacement parts at no cost to the customer. Customers are responsible for all shipping and handling charges associated with warranty repair.

The PT415 Cold Head is also warranted for the same three (3) years or period of 12,000 operating hours to deliver the specified temperatures and cooling capacities.-

2.2 Conditions that can void the warranty

- Do not apply heat directly to the cold head (e.g. soldering anything to the 2nd stage heat exchanger, see Figure 5) Doing so will destroy the cold head and void the warranty. The warranty will not cover heating of the cold head over 325K (125ºF, 52ºC). Section 6.1.2.
- The entire section on cold head installation should be reviewed before installing and operating the cold head. The entire section on compressor installation should be reviewed before installing and operating the compressor package. Failure to follow installation directions could result in loss of warranty rights. See sections 6.1 and 6.2.
- A voltage deviation of more than 10% above or below the voltage rating can cause compressor motor overheating and possible failure. Indications of operation outside that voltage range will void the compressor warranty. See section 7.1.1.
- Helium added to the system must be 99.999% pure. Contamination of the helium by other gases is a common cause of premature failure and, unless resulting from a system failure, is not covered by the warranty. See sections 6.2.6 and 8.2.2.
- Never wet either part of the system. Water getting into the system will void the warranty.
- Operating the cold head in a magnetic field of greater than 500 gauss will void the warranty. See sections 6.1 and 7.1.1.
- If water that does not meet the cooling water specifications in section 4 is introduced into the system, even for cleaning purposes, it will void the warranty. See section 6.2.2.
- There are no user-serviceable parts in the cold head. Cryomech requires that all service to the PT415 Cold Head be performed by Cryomech certified technicians. *Attempting to disassemble the cold head will void the warranty.* See section 8.4.
- Because the tubes in the cold head must have very thin walls for cryogenic performance, extreme care must be taken when handling the cold head. *The warranty will not cover dented or bent tubes.* See section 6.1 and 6.1.2.

- In some applications, heavy components must be mounted to the cold surfaces. With the cold head oriented vertically, the maximum allowable load is 22 lb or 10 kg on the 1st stage heat exchanger and 11 lb or 5 kg on the 2nd stage heat exchanger (see Figure 5, section 6.1.1). If your application requires a heavier load or an orientation other than vertical with a load, please contact Cryomech. *An excessive load on the cold head can damage the tubes. This type of damage is not covered under the warranty.*
- If the bolt pattern on either heat exchanger needs to be changed, you must consult Cryomech first to learn how to prevent damage to the cold head. *Holes drilled without prior approval from Cryomech will void the warranty.*
- *Operation of the cryorefrigerator in any situation that does not meet the specifications in section 4.2 will void the warranty.* If you plan to operate the system outside any of the specified conditions, contact Cryomech. See section 4.2.

3 Section 3: Safety

3.1 Safety and information symbols

3.1.1 Equipment symbols

The safety and information symbol stickers placed on Cryomech PT415 Cryorefrigerators are defined below.

Alternating current. The symbol signifies that alternating current is present.

Internal ground. This symbol represents an internal protective grounding terminal. Such a terminal must be connected to earth ground prior to making any other connections to the equipment.

Warning Icon. Refer to the documents that accompany the equipment.

The CE icon is placed on a product if the product has been tested for and meets the safety standards set by the European Community. CE stands for Communauté Européenne.

Power switch. This symbol designates an in/out or push/push switch.

Read the manual or handbook sign. When this symbol is found on a piece of equipment, the user should read the whole manual before starting installation or use. This symbol is found on the compressor package.

3.1.2 Icons in the manual

Definitions of Warning and Caution and Information icons in the manual

Warning Icon. A warning message is used when failure to observe instructions or precautions could result in injury or death to humans.

Electrical Warning Icon. An electrical warning message is used when failure to observe instructions or precautions could result in electrical shock or burns to humans

Caution Icon. A caution message is used when failure to observe instructions or precautions could result in significant damage to equipment and/or facilities.

Information Icon. The accompanying message contains information to aid the operator in obtaining the best performance from the equipment or other important information that does not involve danger to equipment or humans.

3.2 Warnings and cautions

Warnings and cautions for the PT415 Cryorefrigerator system are listed here by subsystem. The same warnings and cautions appear in the appropriate places in the unpacking, installation, operation and routine maintenance sections of this document.

3.2.1 Section 4. Technical specifications

Section 4.2 Technical specifications

IMPORTANT

Operation of the cryorefrigerator in any situation that does not meet the specifications in this section will void the warranty. If you plan to operate the system outside any of the specified conditions, contact Cryomech.

3.2.2 Section 5. Shipping

Section 5.1 Inspection of crate (receiving)

IMPORTANT

IF THERE IS ANY VISIBLE DAMAGE, DO NOT OPEN OR UNPACK THE CRATE BEFORE YOU CONTACT CRYOMECH.

Section 5.4 Returning a system to Cryomech

IMPORTANT

Use the original cold head box to minimize the likelihood of damage during shipping.

3.2.3 Section 6. Installation

Section 6.1 Cold head installation

IMPORTANT

Failure to follow these installation guidelines could result in voiding the warranty.

 **CAUTION**

Because the tubes in the cold head must have very thin walls for cryogenic performance, extreme care must be taken when handling the cold head. *The warranty will not cover dented or bent tubes.*

 **CAUTION**

Operating the cold head in a magnetic field of greater than 500 gauss will void the warranty.

Section 6.1.2 Initial preparation of the cold head

CAUTION

Because the tubes in the cold head must have very thin walls for cryogenic performance, extreme care must be taken when handling the cold head. Take special care to not bend the tube assemblies. *Bent tubes will violate the system's warranty*.

CAUTION

Do not apply heat directly to the cold head (e.g. soldering anything to the 2nd stage heat exchanger, see Figure 5) Doing so will destroy the cold head and void the warranty. *The warranty will not cover heating of the cold head over 325K (125ºF, 52ºC).*

Section 6.2 Compressor package installation

IMPORTANT

Failure to follow these installation guidelines could result in voiding the warranty.

Section 6.2.1 Step 1 -- Prepare the compressor package location

WARNING

The compressor package must be positioned to provide easy access to the front-panel mounted circuit breaker.

Section 6.2.2 Step 2 – Connect the water lines to the compressor

CAUTION

Cooling water must meet the requirements in section 4.2. If water that does not meet the cooling water specifications in section 4.2 is introduced into the system, even for cleaning purposes, it will void the warranty.

CAUTION

Do not apply heat to the cooling water inlet and outlet connectors located on the front panel of the compressor (see Figure 3).

Section 6.2.3 Step 3 Connect the helium flex lines to the cold head and compressor package

CAUTION

Follow the procedure carefully when connecting and disconnecting the helium flex lines. Failure to follow the procedure can cause accidental coupling disassembly, destruction of the sealing O-ring, and helium loss.

WARNING

Never remove the Aeroquip® couplings from the helium flex lines without first relieving the helium charge in the line to acceptable levels. The pressure in the hose can blow off the coupling with sufficient force to cause injury.

Section 6.2.5 Step 5 – Connect the compressor to main power

IMPORTANT

A voltage deviation of more than 10% above or below the voltage rating can cause compressor motor overheating and possible failure. *Indications of operation outside that voltage range will void the compressor warranty*.

IMPORTANT

Be sure to follow all local electrical codes and guidelines.

WARNING

One lead of the compressor package is grounded. Never bypass this ground or attach the compressor package to an ungrounded circuit. A dangerous electrical hazard will develop.

Section 6.2.6 Step 6 – Remove excess helium from the compressor package prior to running the system for the first time

IMPORTANT

The system is shipped from the factory with excess helium in order to allow for some loss when assembling system components. *Complete this step ONLY if the actual system pressure exceeds the pressure indicated in Item 1, below.*

IMPORTANT

Helium added to the system must be 99.999% pure. Contamination of the helium by other gases is a common cause of premature failure and, *unless resulting from a system failure, is not covered by the warranty.*

3.2.4 Section 7. Operation

Section 7.1.1 Checks before operating

CAUTION

A voltage deviation of more than 10% above or below the voltage rating can cause compressor motor overheating and possible failure. *Indications of voltage operation outside that range will void the compressor warranty*.

CAUTION

Operating the cold head in a magnetic field of greater than 500 gauss will void the warranty.

Section 7.3 Recommended routine procedures

INFORMATION

It is helpful to monitor the PT415 Cryorefrigerator daily in order to detect changes in performance early. These changes can signify degradation in performance that could result from the beginning of a problem that requires attention.

Section 7.5 Disassembling the system for transport or storage

IMPORTANT

Do not continue with the remaining steps until the cold head temperature has risen above 150K. If the cold head is disconnected from the system while below 150K, helium will expand within the cold head as it warms, escape through the pressure relief valve and require the user to recharge the system with helium before it would again operate properly.

WARNING

Do not touch the cold end of the cold head until it has warmed to room temperature. If there is frost on the cold head, it is too cold to touch.

3.2.5 Section 8. Routine maintenance

Section 8.2.1 Vent helium

CAUTION

Venting more than 5 PSIG (.34 bar) of helium per minute will lead to improper oil migration within the system. If this condition occurs, factory service will be required.

Section 8.2.2 Recharge helium

CAUTION

When adding helium, the helium must be 99.999% pure. Contamination by other gases will result in the freezing of the contaminant gases in the cold head because their freezing temperature is much higher than that of helium. Contaminants in the helium charge will severely degrade the cold head's function and it will require factory servicing.

Contamination of the helium by other gases is a common cause of premature failure and, unless resulting from a system failure, is not covered by the warranty.

CAUTION

No more than 5 PSIG (.34 bar) of gas should be added per minute to prevent internal oil contamination to the system. If such contamination occurs, factory service will be required.

Section 8.3.1 Replace the adsorber

CAUTION

At no time should the Aeroquip® couplings be removed from the adsorber when replacing the adsorber. Replacement can be completed without relieving system pressure since the adsorber is equipped with Aeroquip® couplings for sealed removal.

Section 8.4 Cold head

CAUTION

The cold head contains no user-serviceable parts. Attempting to disassemble the cold head will void the warranty.

CONTACT CRYOMECH IF THE COLD HEAD NEEDS TO BE RETURNED FOR SERVICING.

Section 8.5.1 Cleaning

CAUTION

Never remove an Aeroquip® coupling from the helium flex line.

Section 8.5.4 Cord replacement - power cord

WARNING

One lead of the compressor system is grounded. Never bypass this ground or attach the compressor to an ungrounded circuit. A dangerous electrical hazard will develop.

4 Section 4: Specifications

4.1 Intended use of equipment

The PT415 Cryorefrigerator system is used for cooling to cryogenic temperatures. Current clients include research laboratories and universities as well as manufacturers of MRI and NMR superconducting magnets as well as other types of equipment that require cryogenic temperatures.

4.2 Technical specifications

Following are the detailed technical specifications for the PT415 Pulse Tube and the CP1000 Series Compressor Package.

IMPORTANT

Operation of the cryorefrigerator in any situation that does not meet the specifications in this section will void the warranty. If you plan to operate the system outside any of the specified conditions, contact Cryomech.

4.2.1 Weights and dimensions

Parameter	Value	
Cold Head Weight	55 lb	25 kg
Cold Head Dimensions	See Figure 12	
Compressor Package Weight	470 lb	213 kg
Compressor Package Dimensions with castors (L x W x H)	24 x 23 x 36 in	61 x 58 x 91 cm

4.2.2 Cooling water specifications

Parameter	Value	
Cooling Water: minimum flow @ maximum temperature See Chart 1 for details.	3.0 GPM @ 80 F	11.5 LPM @ 27 C
Maximum Inlet Pressure	110 PSIG	7.6 bar
Alkalinity	5.8 < pH < 8.0	5.8 < pH < 8.0
Calcium Carbonate	Concentration < 80 PPM	Concentration < 80 PPM

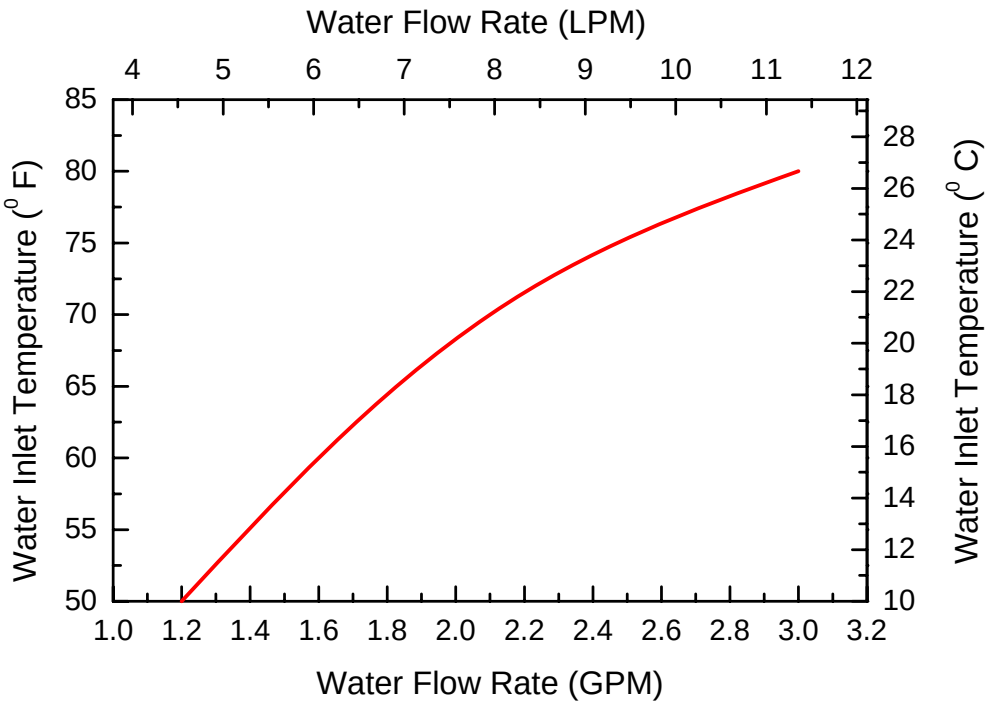

Figure 1: Cooling water requirement

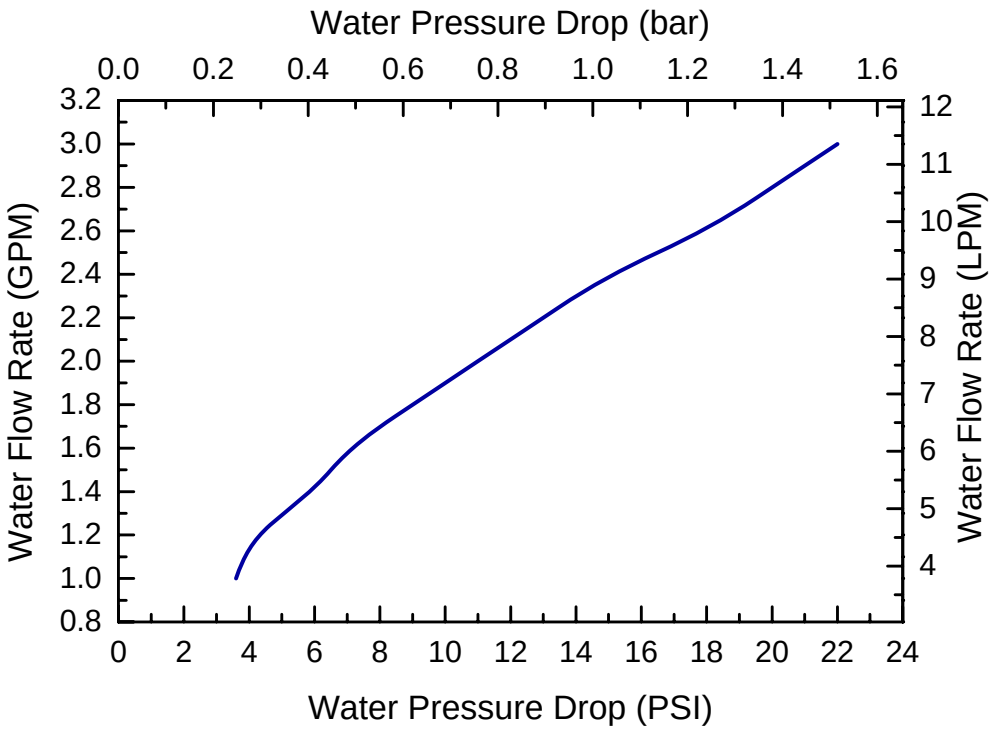

Figure 2: Cooling water pressure drop

4.2.3 Electrical specifications

Parameter	460 Volt 60 Hz Model	380/420 Volt 50 Hz Model
Nominal voltage	460 VAC	380/420 VAC
Operating voltage range	414 - 506 VAC	342 - 462 VAC
Frequency	60 Hz	50 Hz
Phase	3	3
Water Cooled *Input Power* Maximum: Steady state:	12.5 kW 11 kW	12 kW 10.5 kW
Current	19.5 A	22.5 A
Dedicated circuit breaker	40 A	40 A
Mains supply voltage fluctuations	Up to ± 10% of the nominal voltage	Up to ± 10% of the nominal voltage

4.2.4 Operating parameters

Parameter	Value	
Ambient temperature range	45 - 100°F	7 - 38°C
System helium pressure	200 ± 5 PSIG @ 60 Hz (13.8 ± .34 bar @ 60 Hz)	15.9 ± .34 bar @ 50 Hz (230 ± 5 PSIG @ 50 Hz)
Acceptable location	Indoors only	Indoors only
Maximum altitude for use	6560 Ft	2000 m
Environment	Pollution Degree 2	Pollution Degree 2
Installation	Category II	Category II
Maximum relative humidity	80% for T< 88°F Decreasing linearly to 50% at 104°F.	80% for T< 31°C Decreasing linearly to 50% at 40°C.
Maximum sound level	76 dBA at 1 meter	76 dBA at 1 meter
Cold head maximum load 1st stage heat exchanger: 2nd stage heat exchanger:	 22 lb 11 lb	 10 kg 5 kg

4.3 Description of compressor

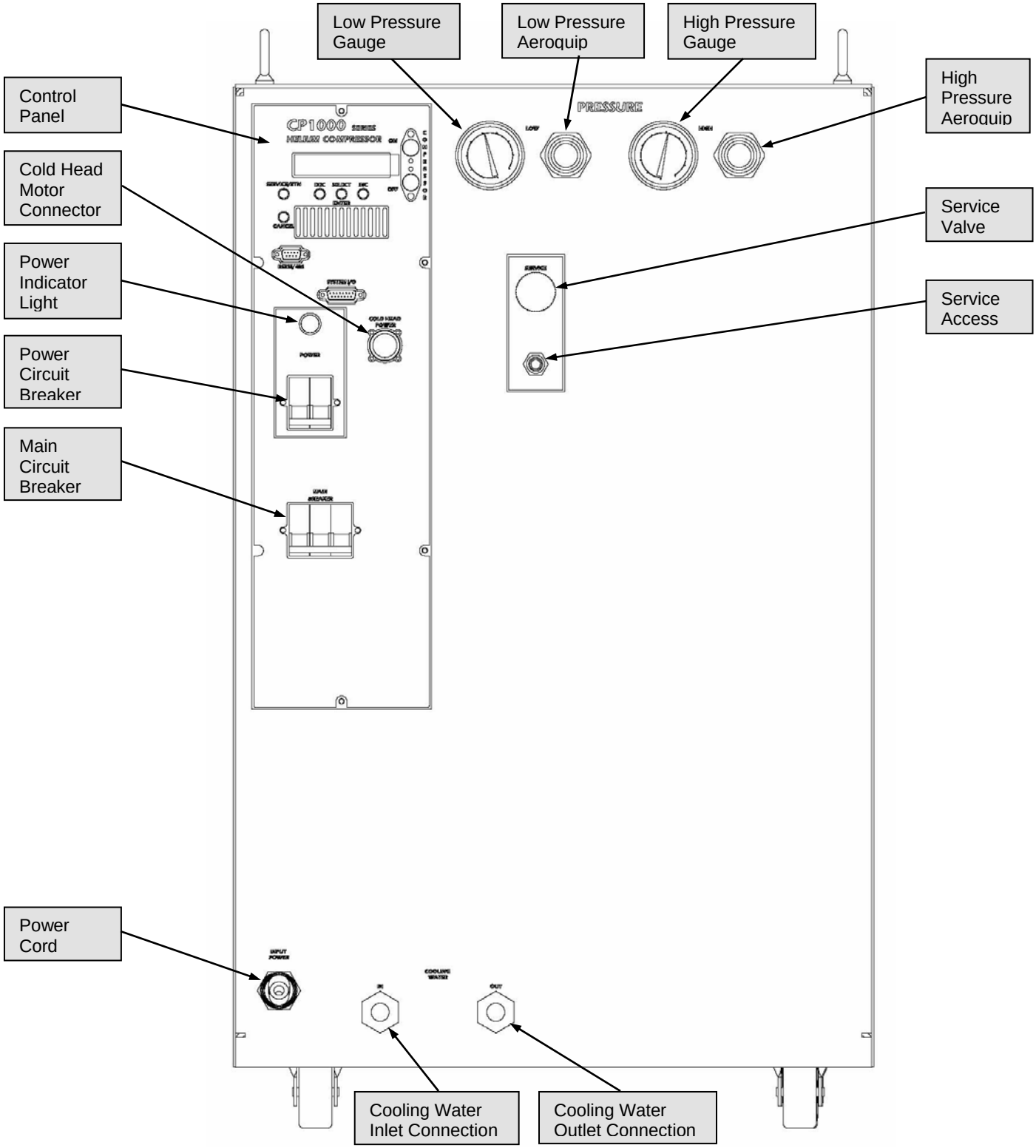

Figure 3: Front panel of the compressor package

4.3.1 Front panel interfaces

This section describes the function of all operator interfaces on the front panel of the CP1000 Series Compressor Package, including switches and valves. It also describes the functions of all connectors, electrical cords and gauges on the front panel.

Low-Pressure Aeroquip®

The low-pressure helium flex line (not shown) fastens to the low-pressure Aeroquip® that returns helium gas from the cold head to the compressor package.

Low-Pressure Gauge

The low pressure gauge displays the pressure of the helium gas that is being returned to the compressor package. When the compressor package is off and the complete system is at room temperature, the gauge should read 200 ± 5 PSIG (13.8 ± .34 bar) for 60 Hz operation or 230 ± 5 PSIG (15.9 ± .34 bar) for 50 Hz operation.

High-Pressure Aeroquip®

The high-pressure helium flex line (not shown) attaches to the high-pressure Aeroquip® that supplies compressed helium gas from the compressor package to the cold head.

High-Pressure Gauge

The high-pressure gauge displays the pressure of the compressed helium gas that is transported from the compressor package. When the compressor package is off and the complete system is at room temperature, the gauge should read 200 ± 5 PSIG (13.8 ± .34 bar) for 60 Hz operation or 230 ± 5 PSIG (15.9 ± .34 bar) for 50 Hz operation.

Control Panel

The control panel houses the compressor controls and display screen.

Cold Head Motor Connector

The cold head motor cord attaches to the cold head motor connector to provide power from the compressor package to the cold head motor.

Main Circuit Breaker

The main circuit breaker provides over-current protection for the cryorefrigerator and also functions as a main power disconnect.

Power Circuit Breaker

The power circuit breaker protects the control panel circuitry and also functions as a power disconnect for the control panel.

Power Indicator Light

The power indicator light illuminates when the power circuit breaker is switched to the on position.

Service Valve

The service valve is the valve used to regulate the amount of helium being added to or released from the system.

Service Access

The service access is used in conjunction with the service valve for adding helium to or releasing helium from the system.

Cooling Water Inlet Connection

The cooling water inlet connection provides water to the compressor package from your facility to cool the compressor package during operation. The connector thread size is 3/8 FPT (3/8” Female National Pipe Thread).

The water must meet the requirements outlined in section 4.2, Cooling Water Specifications.

Cooling Water Outlet Connection

The cooling water outlet connection carries heated water away from the compressor package after the water has been heated by cooling the compressor package during operation. The connector thread size is 3/8 FPT (3/8” Female National Pipe Thread).

Power Cord

The power cord supplies power from the wall to the entire system.

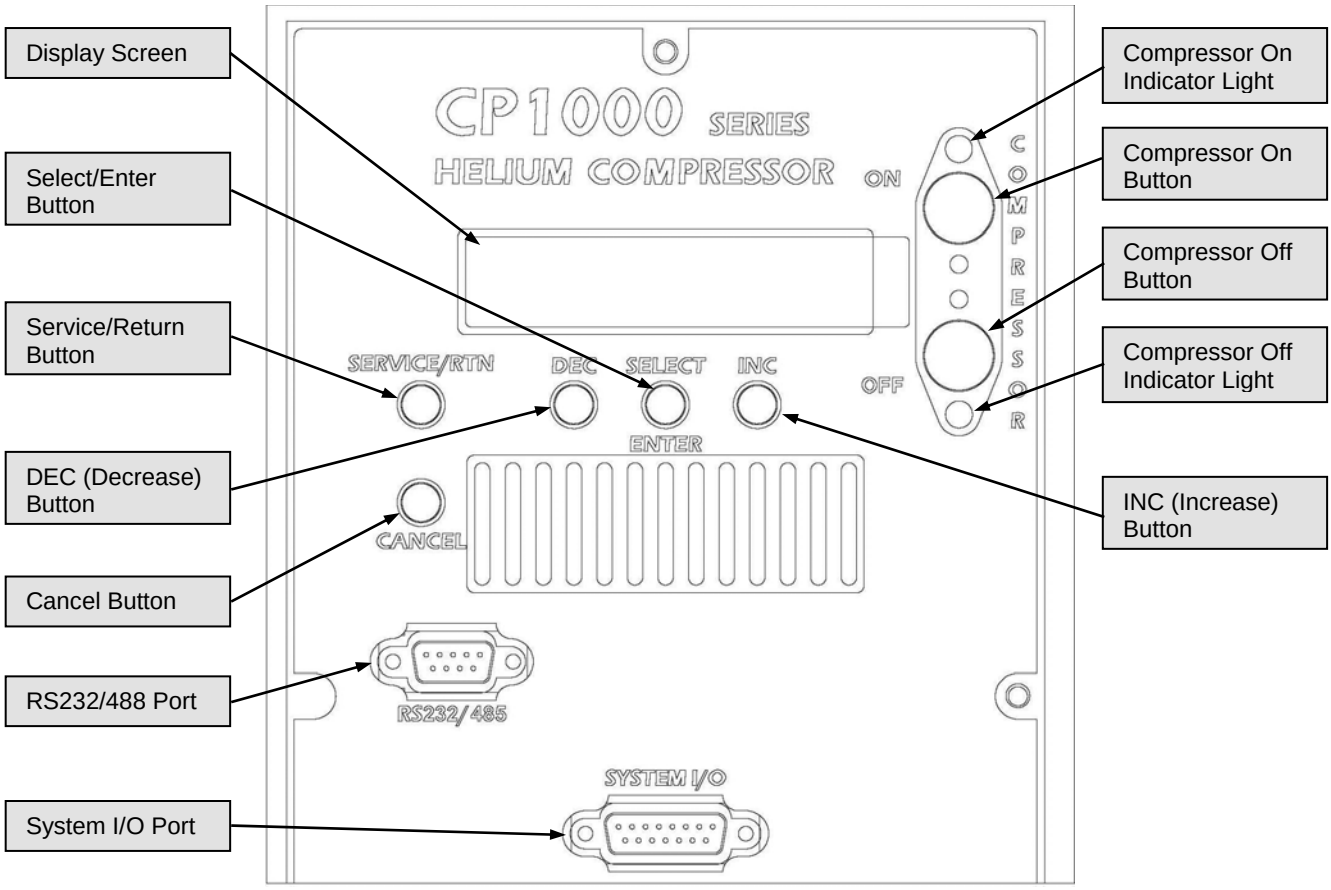

Figure 4: Control panel of the compressor package

Compressor On Button

The Compressor On button is used to start the compressor system.

Compressor On Indicator Light

The Compressor On indicator light is illuminated when the compressor is operating.

Compressor Off Button

The Compressor Off button is used to switch the compressor system off.

Compressor Off Indicator Light

The Compressor Off indicator light is illuminated when the compressor is switched off with the Compressor Off button or when one of the compressor's internal safety switches has tripped.

Display Screen

The Display Screen (also known as the run-time screen) displays system status, warnings, error messages, and the various menus available.

Select/Enter Button

The Select/Enter button is used to navigate down each menu, and to enter changes in values.

INC (Increase) Button

The INC button is used to navigate back and forth along the top level of the menu.

DEC (Decrease) Button

The DEC button is used to navigate back and forth along the top level of the menu.

Service/Return Button

The Service/Return button is used to switch from the run-time display to the top level of the menu (Monitor Sensors/Error Log/Event Log/User Settings/Service).

Cancel Button

The Cancel button is used to move back up the menu.

RS232/488 Port

The RS232/488 port can be used to remotely monitor and control the compressor system as well as access all stored data.

System I/O Port

The 15 pin digital I/O connector, with selected input controls and relay outputs, provides limited monitoring and control of the compressor system.

4.3.2 Safety devices

A number of safety switches and valves are located inside the compressor package and on the cold head. They operate automatically to protect the compressor package from developing extreme conditions that can damage it. Most of them are totally transparent to the user. The ones you need to know about are described below.

High-Pressure Atmospheric Relief Valve

The compressor package high-pressure atmospheric relief valve is set at 420 ± 5 PSIG (29 ± .34 bar). At pressures above 420 PSIG (29 bar) the relief valve will open automatically and relieve pressure to the atmosphere.

Internal Motor Overload Switch

An internal motor overload switch, located inside the compressor module, protects the system by sensing excessive current draw and temperature. This switch automatically resets itself after the compressor module cools to an acceptable level.

Cold Head High Pressure Relief Valve

The cold head high-pressure atmospheric relief valve is set at 425 ± 5 PSIG (29.3 ± .34 bar). At pressures above 425 PSIG (29.3 bar) the valve will open automatically and relieve pressure to the atmosphere.

5 Section 5: Inspection and Unpacking

5.1 Inspection of crate

IMPORTANT

IF THERE IS ANY VISIBLE DAMAGE, DO NOT OPEN OR UNPACK THE CRATE BEFORE YOU CONTACT CRYOMECH.

Be sure to note on the shipping documents any visible damage to the crate, including tip indicators that have been activated.

5.2 Unpacking

The system is packaged in a secure packing crate. The base of the packing crate is a pallet, to which the system is strapped. The walls of the crate are then placed around the system and attached to the pallet and each other with tension clips (Klimp® fasteners). After adding packing material as needed, the top is clipped onto the packing crate.

Directions for unpacking:

1) Remove the top of the packing crate by unfastening the Klimp® fasteners that fasten the top to the sides.
2) Check for tip indicators on the inside of the packing crate and notify Cryomech if interior tip indicators have been activated even though tip indicators on the outside were not.
3) Check for any visible signs of damage besides activated tip indicators.
4) Locate and remove the manual, and all other items that can easily be lifted out of the crate. The manual is packed in an envelope with the shipping documents.
5) Remove the sides of the packing crate by unfastening the Klimp® fasteners that fasten the sides to the pallet.
6) Remove packing material and any straps that anchor items to the pallet.
7) Remove the cold head box and set aside. See section 5.3 for unpacking and inspection instructions.
8) Make sure that a place is prepared for the compressor package to sit (see directions in Section 6 for installation).
9) Retain the packing crate and packing materials to use in the future if you need to ship the equipment to Cryomech.

Specific directions for moving when unpacking

1) Move the cold head separately from the compressor. The cold head is much more fragile than the compressor and needs to be treated with care.
2) The compressor package needs to be lifted off the base and onto the floor with a fork truck or a hoist. It weighs 470 lbs (213 kg). The compressor should not be tipped more than 5° at any time.

3) If the compressor package comes with castors installed, it can be rolled by hand after it is removed from the crate. Otherwise, it will need to be moved with a fork truck or a hoist.

5.3 Inspection of equipment

Packing list

There is a packing list included with your system. The first step is to check that all parts listed on the packing list are included in the crate.

Cold head motor cord

The cold head motor cord is completely pre-wired with connectors that attach to the cold head and compressor.

Inspect the cord for any signs of damage.

Helium flex lines

Inspect the two helium flex lines for any signs of damage.

Cold head

1) Inspect the box that contains the cold head for any signs of physical damage.
2) Remove the screws holding the cover to the box and lift the cover.
3) Carefully remove packing material to expose the cold head. Retain the packing material for future use.
4) Carefully remove the cold head from the box and place on a clean, secure work surface.
5) Inspect the cold head for any damage, in particular, small dents on the tubes and any scratches, especially on the mounting surface of the base plate – see Figure 5.
6) Retain the cold head box and packing material to use in the future if you need to store the cold head or ship it to Cryomech.

Compressor package

There should be a tag on the front of the compressor package that states the pressure of each gauge and the ambient temperature at the time the package was packed. Check the pressure readings on both pressure gauges. If either gauge reads 5 PSIG (.34 bar) lower than the recorded value, contact Cryomech.

Look for dents, scratches or any signs of oil leaks.

Tool kit

Your Cryomech Cryorefrigerator system is shipped with a box of tools. The label on the box lists the contents included inside.

5.4 Returning a system to Cryomech

Preparation of cold head, compressor, and helium flex lines

1) Contact Cryomech for an RMA number and for additional detailed instructions on how to properly return system components.
2) Repackage the system:

IMPORTANT
Use the original cold head box to minimize the likelihood of damage during shipping.

   - Using the original packing material, rewrap the cold head and place in the original cold head box. The original cold head box and packing materials were designed to protect the cold head during return shipment.
   - Place the compressor package on the pallet on top of sufficient vibration dampening material to prevent the wheels from touching the pallet.
   - Strap the compressor package to the pallet, making certain that there is sufficient insulating material between the compressor and the straps so the straps will not scrape any paint off the compressor package.
   - Using protective wrap, secure the original helium flex lines (included with compressor package) and place in container.
3) Be sure to include shipping labels on the box showing which side is up and making clear that the shipment is fragile.
4) Cryomech highly recommends using “tip and tell” indicators. These indicators are helpful in determining whether your package was handled properly or not. Replace used “tip and tell” indicators with new ones (total of three).
5) When the shipment is ready, please contact Cryomech for further instructions on shipping.

6 Section 6: Installation

6.1 Cold head installation

The entire section on the cold head installation should be reviewed before installing the cold head.

IMPORTANT

Failure to follow these installation guidelines could result in voiding the warranty.

CAUTION

Because the tubes in the cold head must have very thin walls for cryogenic performance, extreme care must be taken when handling the cold head. *The warranty will not cover dented or bent tubes.*

CAUTION

Operating the cold head in a magnetic field of greater than 500 gauss will void the warranty.

6.1.1 Inspect the cold head

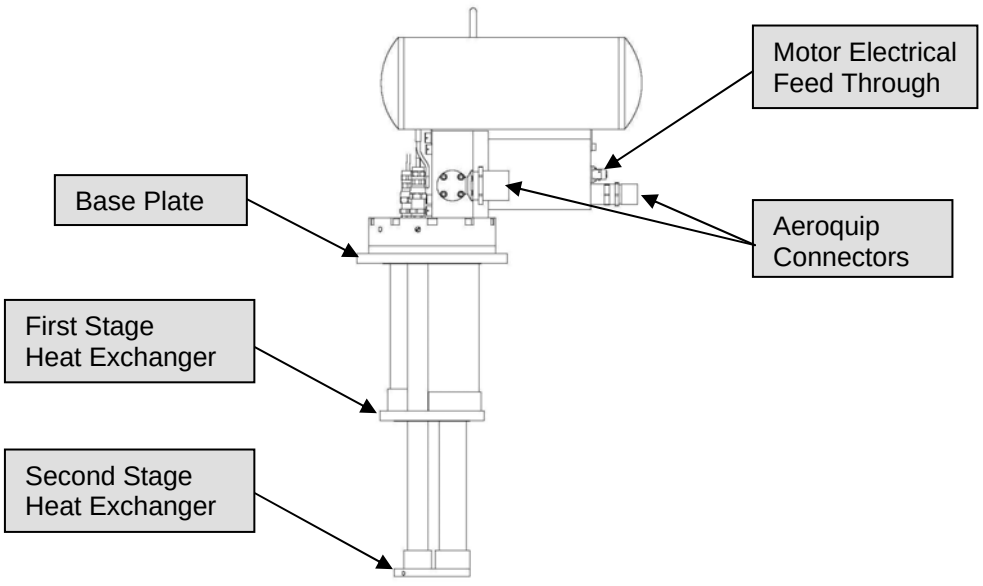

Figure 5: Schematic of the cold head

1) Inspect the mounting surface of the base plate for any scratches in the sealing area.

2) Make certain the flat gaskets are present and properly seated in the ends of the Aeroquip® connectors.

3) Inspect the first and second stage heat exchangers' interface surfaces for any scratches, dents or burrs.

6.1.2 Initial preparation of the cold head

1) Clean the mating surfaces of the base plate with isopropyl alcohol.

2) Apply a small amount of vacuum grease to the mating flange O-ring (not supplied) and insert in the O-ring groove. Cryomech recommends the use of a 2-256 Buna N O-ring for proper interface between flanges.

3) Join the mating flange of the vacuum chamber onto the cold head. Secure the flange to the base plate with screws by tightening evenly around the mating surface. Cryomech recommends eight 6 mm screws for securing to mating flange.

CAUTION

Because the tubes in the cold head must have very thin walls for cryogenic performance, extreme care must be taken when handling the cold head. Take special care to not bend the tube assemblies. *Bent tubes will violate the system's warranty*.

4) Prepare the desired cold mating surface(s) and, applying a small amount of Apiezon® N grease or pure Indium foil on all cold mating surfaces, secure to the heat exchanger(s) using brass screws.

CAUTION

Do not apply heat directly to the cold head (e.g. soldering anything to the 2nd stage heat exchanger, see Figure 5) Doing so will destroy the cold head and void the warranty. *The warranty will not cover heating of the cold head over 325K (125ºF, 52ºC).*

6.1.3 Optimal installation of temperature sensors (optional)

If the application requires the use of temperature sensors to monitor performance, there are three major areas that are critical to proper monitoring:

1) Proper mounting of the sensor(s) on the heat exchanger(s).

2) Proper joining of sensor lead wires and connecting wires.

3) Thermal anchoring of the lead wires to the heat exchanger(s).

Many reports of poor performance are traced back to problems in one of the three above areas.

Please refer to the Technical Manual if you need more specific details on installation of the sensors.

6.1.4 Installation of heaters (optional)

If the application requires the use of heaters to optimize performance, there are three major concerns that are critical to optimum performance:

1) Proper mounting of the heater(s) on the heat exchanger(s).
2) Proper joining of heater lead wires and connecting wires.
3) Thermal anchoring of the lead wires to the heat exchanger(s).

Many reports of poor performance are traced back to one of the three above areas.

Please refer to the Technical Manual if you need more specific details on installation of heaters.

6.1.5 Mounting the radiation shield (optional)

1) Clean the radiation shield with isopropyl alcohol.
2) Apply a small amount of Apiezon® N grease or pure Indium foil on the shield mating surface. Attach the radiation shield with six 5mm brass screws. Tighten it evenly to the first stage heat exchanger.

6.2 Compressor installation

The entire section on compressor installation should be reviewed before installing the compressor package.

IMPORTANT

Failure to follow these installation guidelines could result in voiding the warranty.

6.2.1 Step 1 -- Prepare the compressor package location

- Confirm that the physical space containing the compressor package has an ambient temperature in the range 45 - 100°F (7 - 38°C).
- Place the compressor package in a level position. For the compressor package to operate under optimal conditions, it must be oriented within 5° of being level.

WARNING

The compressor package must be positioned to provide easy access to the front-panel mounted circuit breaker.

- Position the compressor package so there is sufficient space around it for changing the adsorber. If the compressor package cannot be moved easily to an open area, leave approximately 2 additional feet (0.6 m) clearance above and to the left and right of it.

6.2.2 Step 2 – Connect the water lines to the compressor

CAUTION

Cooling water must meet the requirements in section 4.2. If water that does not meet the cooling water specifications in section 4.2 is introduced into the system, even for cleaning purposes, it will void the warranty.

CAUTION

Do not apply heat to the cooling water inlet and outlet connectors located on the front panel of the compressor (see Figure 3).

1) Make sure that the cooling water supply is turned OFF.
2) Apply Teflon tape or pipe sealant to the threads on the male 3/8 MPT (3/8" Male National Pipe Thread) fittings that you provide to connect to both the cooling water inlet connection and the cooling water outlet connection.
3) Attach the supply line from the water source to the cooling water inlet 3/8 FPT (3/8" Female National Pipe Thread) fitting. Turning the fitting clockwise, first hand-tighten the connection. Use a wrench to keep the cooling water inlet fitting from turning, and use another wrench to tighten the water source supply line fitting until snug.
4) Attach the return line from the water source to the cooling water outlet 3/8 FPT (3/8" Female National Pipe Thread) fitting. Turning the fitting clockwise, first hand-tighten connection. Use a wrench to keep the cooling water outlet fitting from turning, and use another wrench to tighten the water source supply line fitting until snug.
5) Turn the cooling water supply ON and check for leaks.
6) Make certain the cooling water flow rate and inlet temperature meets the requirements in section 4.2.

6.2.3 Step 3 – Connect the helium flex lines to the cold head and compressor package

CAUTION

Follow the procedure carefully when connecting and disconnecting the helium flex lines. Failure to follow the procedure can cause accidental coupling disassembly, destruction of the sealing O-ring, and helium loss.

1) Remove all dust caps and plugs from the helium flex lines, compressor package and cold head and place in tool kit. Save dust caps and plugs for future use.
2) Make certain the flat gaskets are present and properly seated in the compressor's and cold head's male Aeroquip® fittings.
3) With a dry, clean lint-free cloth remove any visible particles from the ends of all of the Aeroquip® couplings.

4) With the 1-5/8" and 1-3/8" wrenches supplied in the tool kit, connect the a helium flex line to the low-pressure port on the compressor package front panel. See Figure 6. The low-pressure port is marked "Low." Tighten the connector until a positive stop is felt. *When attaching the Aeroquip® to the mating connector, make sure the threads are in alignment before you tighten the connector.*

Figure 6: Connecting the flex lines to the compressor package

5) Connect the other end of the helium flex line to the low-pressure port on the cold head. The low-pressure port is marked "Low." Tighten the connector until a positive stop is felt.

6) With the same wrenches, connect the other helium flex line to the high-pressure port on the compressor package front panel. The high-pressure port is marked "HIGH". Tighten the connector until a positive stop is felt.

7) Connect the other end of the helium flex line to the high-pressure port on the cold head. The high-pressure port is marked "HIGH". Tighten the connector until a positive stop is felt.

WARNING

Never remove the Aeroquip® couplings from the helium flex lines without first relieving the helium charge in the line to acceptable levels. The pressure in the hose can blow off the coupling with sufficient force to cause injury.

6.2.4 Step 4 – Connect the cold head motor cord

1) Note that the female plugs attached to each end of the cold head motor cord are unique for both the compressor and the cold head.

2) Assure that the cold head motor cord is sufficiently long to reach the cold head. *If the cord length is not sufficient to reach the cold head, adjust the location of the compressor package or the cold head.*

3) To connect the cold head motor cord to the cold head, make sure that the alignment pins on the receptacle correspond to the alignment grooves on the plug. Turn the plug sleeve clockwise while pushing the plug into the receptacle. The plug is designed to "click and lock" when assembly is completed.

4) To connect the cold head motor cord to the compressor, align the pins on the plug with the grooves on the compressor's connector. Push the plug onto the connector and turn the locking ring clockwise until snug.

6.2.5 Step 5 – Connect the compressor package to the main power

IMPORTANT

A voltage deviation of more than 10% above or below the voltage rating can cause compressor motor overheating and possible failure. *Indications of operation outside that voltage range will void the compressor warranty*.

1) The system MUST be connected to a dedicated circuit breaker. The breaker must be mounted near the compressor package, within easy reach of the operator, and must be marked as the disconnecting device for the system. Specifications for circuit breakers vary according to the system's operating voltage. See the electrical specification tables in Section 4.2 for more information.

2) The compressor package comes with a main power cord attached. Assure that the length of the cord is sufficient to safely connect to the power source. If the cord is not sufficiently long, adjust the location of the compressor package.

IMPORTANT

Be sure to follow all local electrical codes and guidelines.

3) Make sure that the dedicated circuit breaker is turned OFF.

4) Identify which wire is the ground (or earth). Connect the ground wire in the power cord to the ground (or earth) connector in the breaker panel, making sure to tighten the connector securely. It is important not to disable this wire.

5) Connect the three hot wires in the power cord to the corresponding lugs on the breakers in the breaker panel, making sure to tighten the connector securely. The order of the wires is not important at this time – correct order will be determined in Step 7.

WARNING

One lead of the compressor package is grounded. Never bypass this ground or attach the compressor package to an ungrounded circuit. A dangerous electrical hazard will develop.

6.2.6 Step 6 – Remove excess helium from the system prior to running for the first time

IMPORTANT

The system is shipped from the factory with excess helium in order to allow for some loss when assembling system components. *Complete this step ONLY if the actual system pressure exceeds the pressure indicated in Item 1, below.*

1) Observe both the low and high pressure gauges located on the front panel and determine which gauge has the lower reading. If the system helium pressure shown

on the lowest reading gauge EXCEEDS 205 PSIG (14.1 bar) for 60 Hz models or 235 PSIG (16.2 bar) for 50 Hz models, follow the procedures in this step. Otherwise, skip this step and go to Step 7, below.

2) Assuming pressures exceed those indicated in Step 1, above, first make sure that the service valve (located on the front panel) is CLOSED (turned fully clockwise).

3) Attach the ¼" service Aeroquip® coupling to the service access.

4) Turning the service valve counter-clockwise, open the valve SLOWLY. Do not vent more than 5 PSIG (.34 bar) of gas per minute.

5) Observe the gauge with the lower reading. Once the gauge reaches the system helium pressure indicated in Step 1, close the service valve by turning clockwise and remove the service Aeroquip® from the service access.

6.2.7 Step 7 – Run the system for the first time

1) Recheck all water supply, helium flex line, and electrical connections to make sure they are correct and tight.

2) Energize the dedicated breaker.

3) Turn on the water flow to the specified level.

4) Switch on the compressor package power at the MAIN circuit breaker (see Figure 3).

5) Switch on the power to the compressor controls by switching on the POWER circuit breaker (see Figure 3). The green ON light above the circuit breaker and the yellow Compressor Off light will both illuminate. A series of beeps will be heard and the front panel display will initially show the compressor model number, date and time. After a few seconds the display will read Compressor Off and the number of hours on the system.

6) The compressor may be started by pushing the green “Compressor On” button, and stopped by pushing the black “Compressor Off” button (see Figure 3). The compressor controller does a power check for five seconds after the control power is switched on. During this check the compressor will not start if the Compressor On button is pushed. After the power check has been successfully completed, the compressor will start. There is also a 10 second time delay built in to allow pressure equalization in the event that the Compressor On button is pushed immediately after the Compressor Off button is pushed.

7) If the front panel display indicates “PWR PHASE ORDER BAD” after pushing the “Compressor On” button, perform the following steps to correct the phase error in the compressor package:

   a. Switch off the two circuit breakers on the front panel of the compressor package.

   b. Turn off the dedicated circuit breaker to disconnect the system from power at the source (to prevent electrical shock).

   c. Examine the power cord and wire colors at the panel circuit breaker. Swap two of the three hot wires – e.g. the red wire with the black wire.

   d. Energize the breakers and press the “Compressor On” button. The compressor package should now operate properly.

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Environment

The compressor package is designed to operate in an ambient temperature range from 45°F to 100°F (15-37°C). If the temperature is below 45°F, the increased viscosity of the oil could prevent start-up and/or cause poor lubrication. Operation above 100°F will cause overheating and subsequent problems. *If a unit must be subjected to either extreme, Cryomech must be consulted.*

To avoid electrical shock danger, make sure there is no direct contact with water.

7 Section 7: Operation

7.1 Starting the system

7.1.1 Checks before operating

1) Check the system pressure - the gauges should read 200 ± 5 PSIG (13.8 ± .34 bar) for 60Hz models or 230 ± 5 PSIG (15.9 ± .34 bar) for 50Hz models.
   - o If the pressure is too high, vent some of the helium following the instructions in section 8.2.
   - o If the pressure is too low, add helium following the instructions in section 8.2.
2) Make sure the cold head motor cord is connected.
3) Make sure all Aeroquip® couplings are securely fastened and the helium flex lines are connected correctly.
4) Make sure the input power meets the specifications on the identification label.

CAUTION

A voltage deviation of more than 10% above or below the voltage rating can cause compressor motor overheating and possible failure. *Indications of voltage operation outside that range will void the compressor warranty*.

5) Make sure the flow rate and temperature range of the cooling water meet the requirements shown in Figure 1.
6) Check that the dedicated circuit breaker is on.

CAUTION

Operating the cold head in a magnetic field of greater than 500 gauss will void the warranty.

7.1.2 Startup procedure

- Turn on the MAIN and POWER circuit breakers located on the front panel of the compressor package.
- Start the system by pressing the green “Compressor On” button.

7.2 Normal operation behavior

Normal pressures

On initial start up, with the entire system at room temperature, the compressor develops the greatest pressure differential. As the PT415 Cold Head cools down it draws more helium and the pressure differential decreases.

For 60 Hz systems, when the PT415 has reached a temperature of 4K, typical pressures are in the range of 80 – 95 PSIG (5.5 – 6.5 bar) on the low pressure gauge and 285 – 270 PSIG (19.7 – 18.6 bar) on the high pressure gauge.

Normal sounds

When operating properly, the cryorefrigerator will emit a rhythmic squeak or chirp approximately 80 times per minute. This noise is an indication of the proper flow of helium gas within the system.

Cool down time

An unloaded PT415 Cryorefrigerator with no additional mass on the heat exchangers will cool down to 4K in approximately 60 minutes. When additional mass is attached to either stage, the cool down time will increase.

Normal temperatures

In general a minimum no-load 1st stage temperature of approximately 32K and a 2nd stage temperature of 2.8K should be attained.

These temperatures will vary depending on the quality of the vacuum, the quality of the super-insulation, and the heat load brought in by the instrumentation leads.

Use of the display panel

Status and error messages will be shown on the display screen. The status messages, error messages, and setpoints at which error conditions will occur are listed in Section 7.6.4.

The screen normally shown on the display is referred to as the run-time screen. The messages described in section 7.6.4 are displayed on the top line of the run-time screen. The bottom line displays the compressor hours in place of the hour meter used on previous Cryomech products.

The Service/Return button is used to switch from the run-time display to the top level of the menu (Monitor Sensors/Error Log/Event Log/User Settings/Service).

The Service/Return button can also be used to return to the run-time screen from any part of the menu.

The INC and DEC buttons are used to navigate back and forth along the top level of the menu. The Select button is used to navigate down each menu, and the Cancel button is used to move back up.

See Figure 10 - CMAS Menu System - for the detailed depiction of the menu system.

7.3 Recommended routine procedures

INFORMATION

It is helpful to monitor the PT415 Cryorefrigerator daily in order to detect changes in performance early. These changes can signify degradation in performance that could result from the beginning of a problem that requires attention.

Cryomech recommends keeping regular logs of key measurements at intervals that make sense for the way you use your system.

7.3.1 High and low pressure

Changes in the high and low pressure are used for diagnosing several different types of problems. It is important to know whether changes are sudden or gradual and to know how the high and low pressures are changing relative to each other.

The high and low pressures should be monitored daily.

Cryomech recommends that you maintain a regular record, at intervals that make sense for the way you use your system, of the pressure of the high pressure gauge and of the low pressure gauge on the front panel of the compressor package.

7.3.2 Cold head temperature

Temperature changes are the other key diagnostic.

If a temperature sensor is attached to either or both of the cold head's heat exchangers, Cryomech strongly recommends that you monitor the temperature(s) daily.

Cryomech also recommends that you keep a regular record of the temperature at intervals that make sense for the way you use your system.

7.3.3 Cooling water input and output

If possible, Cryomech recommends keeping a regular record of the input and output cooling water temperatures and of the cooling water flow rate.

7.4 Shutdown procedure

Press the black "Compressor Off" button on the front panel of the compressor package (see Figure 3). This will switch off the compressor system. Switch off both front panel mounted circuit breakers to shut down the entire system.

7.5 Disassembling the system for transport or storage

Use the following steps to prepare a Cryomech cryorefrigerator for eventual transport or storage.

1) Make sure that the display on the front panel indicates that the compressor system is OFF.
2) Disconnect the power to the system by switching the front panel breakers to the OFF position.

3) Disconnect the main power to the system by switching the dedicated breaker to the OFF position.

4) Turn off the water supply at the source.

5) Disconnect the power cord from the external breaker panel. Coil up the power cord in preparation for transport or storage.

6) Disconnect the cold head motor cord from the cold head and from the compressor. Coil the cold head motor cord in preparation for transport or storage.

7) Using two wrenches disconnect the supply and return water lines from the inlet and outlet fittings by turning the fittings counter-clockwise until they are released from the fittings. Store the connectors for transport or storage.

8) Drain the water from the compressor package. Blow remaining water out with compressed air.

IMPORTANT

Do not continue with the remaining steps until the cold head temperature has risen above 150K. If the cold head is disconnected from the system while below 150K, helium will expand within the cold head as it warms, escape through the pressure relief valve and require the user to recharge the system with helium before it would again operate properly.

9) Verify that the cold head temperature is 150K or above. Then, using the wrenches supplied in the tool kit, disconnect the high and low pressure flex lines from the compressor package by turning the Aeroquips® counter-clockwise with one wrench while holding the other wrench to prevent the flex line from twisting. See Figure 7.

Figure 7: Disconnecting the flex lines from the compressor package

10) Disconnect the Aeroquip® on the high and low pressure fittings on the cold head by turning the flexible line's Aeroquip® counter-clockwise with one wrench while holding the cold head's Aeroquip® with the other wrench. See Figure 8.

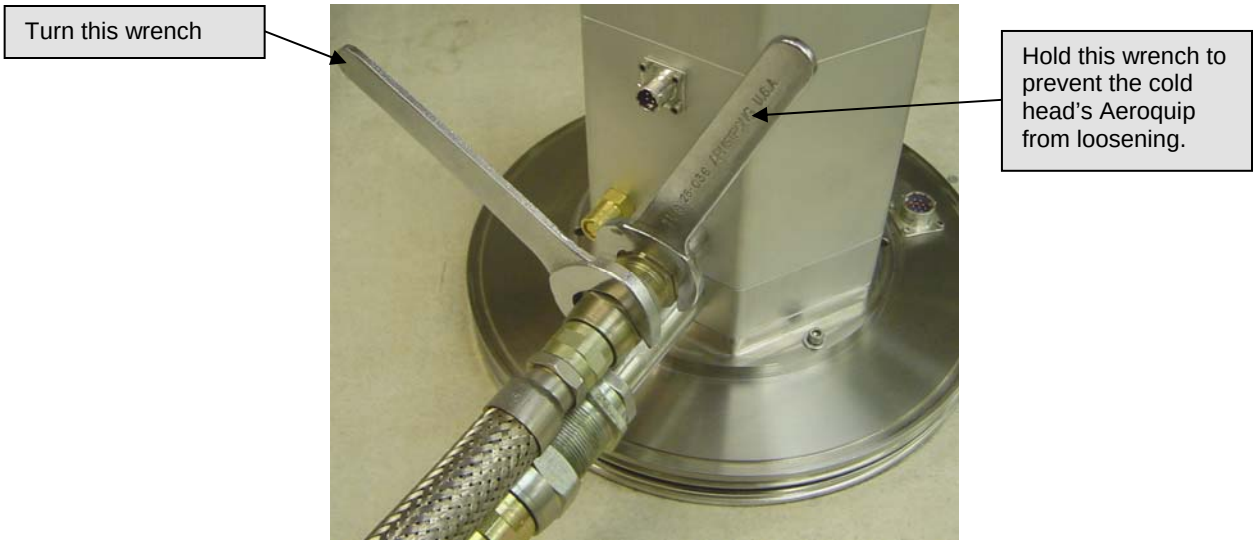

Figure 8: Disconnecting the flex lines from the cold head

11) Install the dust plugs (that originally came with the system and are stored in the tool kit) on the helium flex line fittings and install the dust caps on both the compressor package and the cold head.

12) If necessary, disconnect the cold head from its mounting surface, taking care not to damage any components. Once disconnected, place the cold head in the original packaging container.

WARNING

Do not touch the cold end of the cold head until it has warmed to room temperature. If there is frost on the cold head, it is too cold to touch.

13) Recoil the helium flex lines and prepare for transport or storage.

14) Assure that all components are stored in appropriate containers and location.

7.6 Troubleshooting

7.6.1 System will not start

SYMPTOM	System will not start
CAUSE	1) No power supplied to the compressor package. 2) Circuit breakers off 3) "Compressor Error" message displayed on display screen.
REMEDY	1) Check the power supply to the system and verify that it meets the requirements outlined in section 4.2.

	2) Make certain both circuit breakers, located on the front panel of the compressor package, are on. 3) Refer to Section 7.6.4 for error message diagnostics.

7.6.2 System starts, no pressure fluctuation

SYMPTOM	System starts, no bounce in the pressure gauges, no refrigeration.
CAUSE	1) Cold head motor cord not connected to the cold head and/or to the compressor package. 2) Aeroquip® connector(s) not completely tightened. 3) High and low pressure helium flex lines reversed.
REMEDY	1) Turn off the compressor and connect the cold head motor cord to the cold head and/or to the compressor package. 2) Tighten all Aeroquip® connectors. 3) Verify that one of the helium flex lines connects the high pressure port on the compressor package to the high pressure port on the cold head and that the other helium flex line connects the low pressure ports.

7.6.3 System has shut itself down.

SYMPTOM	System has shut itself down.
CAUSE	1) Circuit breaker tripped. 2) Interruption of the power supply to the compressor package. 3) “Compressor Error” message displayed on front panel screen.
REMEDY	1) Reset the circuit breaker on the front panel of the compressor package. 2) Check the power supply to the system and verify that it meets the requirements outlined in section 4.2. 3) Refer to Section 7.6.4 for error message diagnostics.

7.6.4 Run time display screen description

Run time messages are displayed on the top line of the display screen. The number of hours the system has operated is displayed on the bottom line.

Top line message on the display screen	Message description
“COMPRESSOR OFF”	Front panel or remote interface turned off compressor. All is well.
“COMPRESSOR ON”	Compressor is running. All is well.
“STARTING…WAIT X”	Compressor On request received, and compressor will start within 10 seconds unless an

(X is a number, counting down. When X is zero compressor will start)	error occurs or a stop request is received. This message will show when the compressor has not been off for more than 10 seconds and a start request is received. This state allows the pressure to balance.
"WAITING FOR POWER"	Compressor is waiting for good power. Will be displayed for a short time while the power tracking state machine is checking the line power, which takes 5 seconds minimum. In this state, WHEN POWER COMES BACK, THE COMPRESSOR WILL START.
"COMPRESSOR ERROR"	An error has occurred. The error will be displayed on the second line. If more than one error is lodged, the highest priority error will be displayed on screen. See below for error display and description.

7.6.5 Error diagnostics on display screen

Errors will cause the compressor system to stop. Errors are displayed on the bottom line of the display screen. If more than one of the errors below is present, only the highest priority one will be displayed.

Error Description	Explanation
"PWR PHASE ORDER BAD"	The order of the phase power is wrong. Re-wire the input to the compressor by switching any 2 of the 3 input power wires.
"REMOTE INTERLOCK 1"	Occurs when the "remote interlock" parameter is enabled (default) and the digital remote interlock line is TRUE.
"REMOTE INTERLOCK 2"	General purpose user interlock, can only be set via the computer interface.
"HIGH He PRESSURE"	This occurs when high side pressure is too high.
"LOW WATER FLOW"	This occurs when the output water temperature exceeds a threshold.
"HIGH He GAS TEMP"	This occurs when the helium gas temperature exceeds a threshold.
"LOW He PRES"	This occurs when the helium gas pressure is below the threshold.
"COMP MOTOR CURRENT"	This occurs when the compressor motor current is below threshold while the motor is requested running. Can be caused by an overheated compressor.
"HIGH OIL TEMP"	This occurs when the compressor oil temperature exceeds a threshold.

7.6.6 Warning diagnostics on display screen

Warnings do not cause the compressor to stop and do not prevent the compressor from starting. Warnings are displayed on the bottom line of the display screen. If more than one of the warnings below is present, only the highest priority one will be displayed.

Warning Description	Explanation
"*WARN: SENSOR FAILURE"	This occurs when one of the sensors (pressure or temperature) has published a reading that is out of the range of the sensor. Indicates a bad sensor, or shorted wiring.
"*WARN: IN WTR TEMP HI"	This occurs when the input water temperature exceeds a threshold.
"*WARN: HIGH DP"	This occurs when pressure differential is too high.

7.6.7 Error and warning set points

Error Description	Trip	Clear
HIGH He PRESSURE	High side PSI > 399 PSIG (27.5 bar)	High side PSI <= 399 PSIG (27.5 bar)
LOW WATER FLOW	115°F (46°C)	100°F (38°C)
HIGH He GAS TEMP	190°F (88°C)	180°F (82°C)
LOW He PRES	< 35 PSIG (2.4 bar)	>= 35 PSIG (2.4 bar)
COMP MOTOR CURRENT	< 5A	None
HIGH OIL TEMP	120°F (49°C)	100°F (38°C)

Warning Description	Trip	Clear
SENSOR FAILURE	Any bad temperature or pressure sensor	All temperature and pressure sensors OK
INPUT WATER TEMP	85°F (29°C)	80°F (27°C)
HIGH DP	> 265 PSI (18.3 bar)	<= 265 PSI (18.3 bar)

7.7 Contact Cryomech with Questions

It is hoped that the Operations Section of this manual has helped you to obtain satisfactory results in the use of your Cryomech PT415 Cryorefrigerator. While the information offered should facilitate set up and operation, you may have a special situation that requires further considerations. If after reading the Operations Section, you still have questions, contact Cryomech for further information.

7.7.1 Contact Information

Cryomech, Inc.

113 Falso Drive
Syracuse, NY 13211

Phone: (315) 455-2555
Fax: (315) 455-2544

Email: specs@cryomech.com
Website: www.cryomech.com

8 Section 8: Routine Maintenance

8.1 Introduction

This section contains basic, essential maintenance information. For more detailed information, consult the technical manual, which can be obtained by contacting Cryomech.

8.2 Cryorefrigerator system

8.2.1 Adjust helium pressure - vent excess helium

This procedure should only be used to vent small quantities of helium from an overcharged system.

1) Make sure the service valve is closed
2) Attach the small service Aeroquip® coupling to the service access port.
3) Open the service valve slowly. Do not vent more than 5 PSIG (.34 bar) of helium per minute.
4) After venting the helium, close the service valve and remove the service Aeroquip® from the service access port.

CAUTION

Venting more than 5 PSIG (.34 bar) of helium per minute will lead to improper oil migration within the system. If this condition occurs, factory service will be required.

8.2.2 Adjust helium pressure - recharge helium

CAUTION

When adding helium, the helium must be 99.999% pure. Contamination by other gases will result in the freezing of the contaminant gases in the cold head because their freezing temperature is much higher than that of helium. Contaminants in the helium charge will severely degrade the cold head's function and it will require factory servicing.

Contamination of the helium by other gases is a common cause of premature failure and, unless resulting from a system failure, is not covered by the warranty.

This procedure should be performed with the compressor package shut down. Adding helium is possible whether or not the cold head is attached to the compressor package. Both the service access and service valve are connected to the low-pressure manifold of the compressor.

1) Turn the system off.

2) Allow the entire system, both the compressor package and the cold head, to come to room temperature.

3) Use only high purity helium. The helium must be 99.999% pure.

4) Check that the helium source and regulator are capable of pressurizing to the desired low-pressure.

5) Make sure the service valve is closed.

6) Attach the service Aeroquip® coupling to the service access port.

7) Attach a charging line from the service Aeroquip® to a vacuum/charging pumping station as shown in Figure 9 below.

Figure 9: Pumping station

8) Evacuate to 50 microns.

9) Isolate the vacuum pump and add 50 PSIG (3.4 bar) of helium.

10) Vent the helium and repeat steps 8 to 10.

11) Final evacuation should be to 25 microns.

12) Pressurize the line to the service access with the desired amount of low pressure.

13) Slowly open the service valve to add helium to the system. Final helium charge, with the system at room temperature, should be 200 ± 5 PSIG (13.8 ± .34 bar) for 60 Hz systems or 230 ± 5 PSIG (15.9 ± .34 bar) for 50 Hz systems.

CAUTION

No more than 5 PSIG (.34 bar) of gas should be added per minute to prevent internal oil contamination to the system. If such contamination occurs, factory service will be required.

14) After adding the helium, close the service valve and remove the service Aeroquip® from the service access.

8.3 Compressor package

8.3.1 Replace the adsorber

> **CAUTION**
>
> At no time should the Aeroquip® couplings be removed from the adsorber when replacing the adsorber. Replacement can be completed without relieving system pressure since the adsorber is equipped with Aeroquip® couplings for sealed removal.

The adsorber should be replaced at 20,000-hour intervals as part of routine maintenance.

1) Remove the side panel from the right hand side of the compressor package.
   a. Remove the 6 quarter-turn screws that hold the side panel on and retain them.
   b. Pull the panel away from the compressor package.

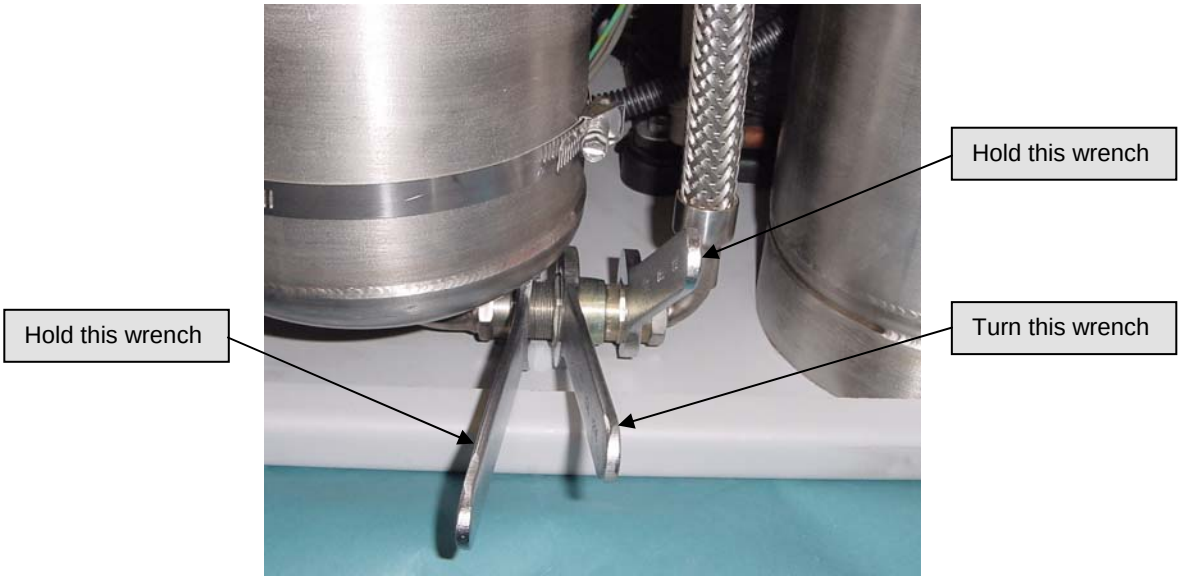

Figure 10: Disconnecting the adsorber.

2) Disconnect both helium flex lines from the compressor.
3) Using three wrenches disconnect the Aeroquip® coupling between the adsorber and the oil separator as shown in Figure 10.
4) Remove the nut holding the high-pressure Aeroquip® coupling to the front panel.
5) Loosen and disconnect the hose clamp that attaches the adsorber to the front panel.
6) Remove the adsorber from the compressor package.
7) Check the Aeroquip® couplings for oil residue. If oil is present, contact Cryomech for further assistance.
8) To install the new adsorber, reverse steps 3 through 6.

8.4 Cold head

CAUTION

The cold head contains no user-serviceable parts. *Attempting to disassemble the cold head will void the warranty.*

CONTACT CRYOMECH IF THE COLD HEAD NEEDS TO BE RETURNED FOR SERVICING.

8.5 Other maintenance items

8.5.1 Cleaning

Compressor package and cold head

The compressor package and cold head require no cleaning other than wiping the outside of each if it becomes dusty or dirty.

CAUTION

Never wet either part of the system. Water getting into the system will void the warranty.

Aeroquip® couplings

CAUTION

Never remove an Aeroquip® coupling from the helium flex line.

If operated in a clean environment, the only parts of the cryorefrigerator system that are likely to require cleaning are the Aeroquip® couplings. The mating surfaces of the Aeroquip® couplings can get particles on them when the helium flex lines are detached from the compressor package and/or the cold head.

If an Aeroquip® coupling needs cleaning:

- Wipe the mating surfaces of the coupling with a dry, lint-free cloth.
- After wiping, blow off the coupling with clean, dry compressed air.
- Solvents should never be used.
- If any grease gets on the Aeroquip® coupling, contact Cryomech.

8.5.2 Manufacturer only parts

The following parts are available only from Cryomech:

Helium flex lines

The helium flex lines must be handled with care. If they become damaged and need to be replaced, new ones must be obtained from Cryomech and installed using the directions in the installation section of this manual.

Adsorber

The adsorber needs to be replaced after every 20,000 hours of use. See section 8.3 for instructions on replacing the adsorber.

Cold head

The cold head contains no user-serviceable parts and must be serviced by Cryomech authorized technicians. *Attempting to disassemble the cold head will void the warranty.* See section 8.3.

Cold head motor cord

If the cold head motor cord becomes damaged, a replacement must be obtained from Cryomech.

8.6 Service

8.6.1 Cryomech contact information

Cryomech, Inc.
113 Falso Drive
Syracuse, NY 13211

Phone: (315) 455-2555
Fax: (315) 455-2544

Email: specs@cryomech.com
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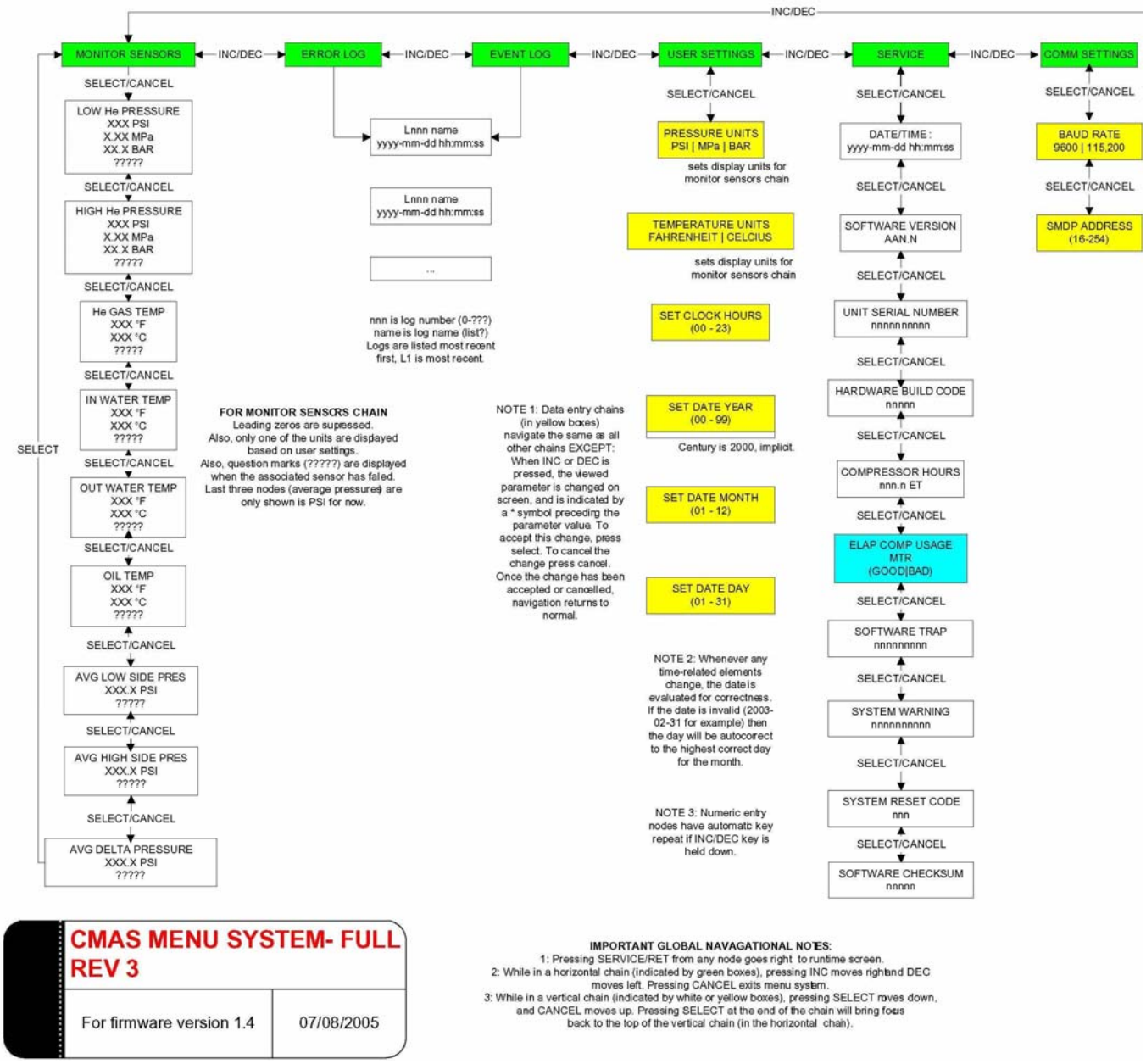

Figure 11: CMAS menu system

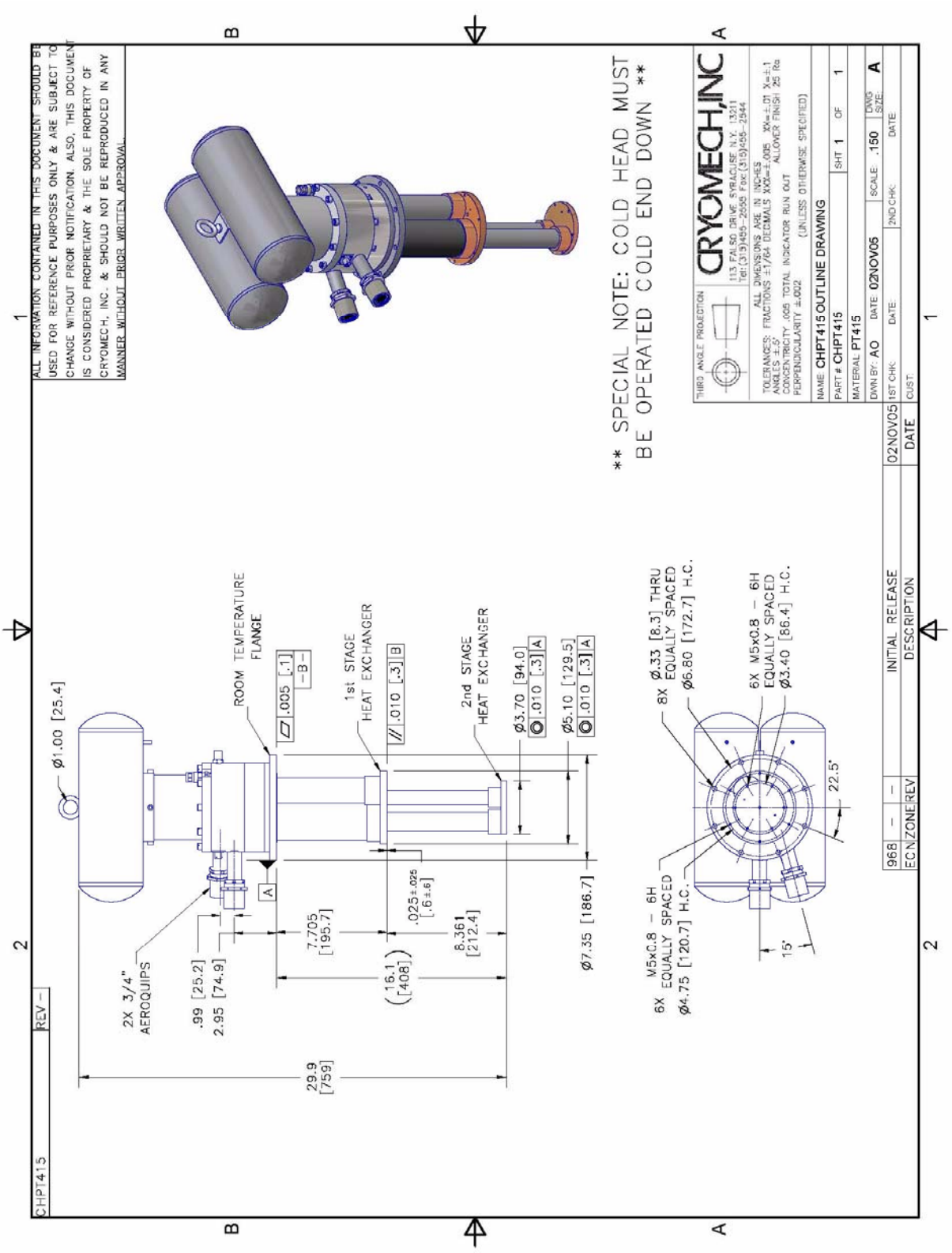

Figure 12: CHPT415 line drawing