9700A Compressor Installation, Operation, and Maintenance Instructions

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1 Introduction

This manual provides the information required to install, operate, and maintain the CTI-CRYOGENICS 9700A Compressor.

NOTE: *All personnel with installation, operation, and maintenance responsibilities should become familiar with the contents of both the 9700A Compressor Installation, Operation, Maintenance, and appropriate cryopump manuals to ensure safe, high quality, and reliable system performance.*

CAUTION

Refer to Appendix A to contact the local Customer Support Center for information on connecting 9700A Compressors to a manifold with other CTI-CRYOGENICS compressors.

Compressor Configurations

The 9700A Compressor supports either On-Board or Cryo-Torr Cryopumps. For multiple cryopump installations, an On-Board Splitter Box or Cryo-Torr Interface can be used for cold head power distribution that reduces total cable requirements as shown in Figure 1-6 and Figure 1-7.

System Documentation

The *system* manuals cover the cryopump and the Compressor. A manual is shipped with each component to install and operate that component. A loose-leaf binder is also provided to enable you to compile a set of tabulated manuals.

CTI-CRYOGENICS Helium Refrigeration System

The operation of CTI-CRYOGENICS' cryopumps is based on a closed loop helium expansion cycle. The *system* is made up of the cryopump, which contains the cold head, and the helium Compressor which compresses the helium gas.

Refrigeration is produced in the cryopump cold head through periodic expansion of high pressure helium in a regenerative process. The high pressure helium is provided by the Compressor. Low pressure helium returning from the cold head is compressed to the necessary high pressure to be returned to the cold head. The energy required to compress the helium is rejected as heat through the cooling water.

High pressure room temperature helium is transferred to the cold head through the supply lines. After expansion, low pressure helium is returned to the Compressor (at or near room temperature) to repeat the cycle in a closed loop fashion. Large separation distances can be accommodated between the Compressor and the cryopump.

In the Compressor, helium is compressed using a highly reliable, oil-lubricated commercial Compressor. Helium purification takes place via several stages of oil removal. The final stage of purification is performed with a replaceable adsorber cartridge. To maintain peak efficiency, the adsorber must be replaced every three years. The 9700A Compressor is shown in Figure 1-1.

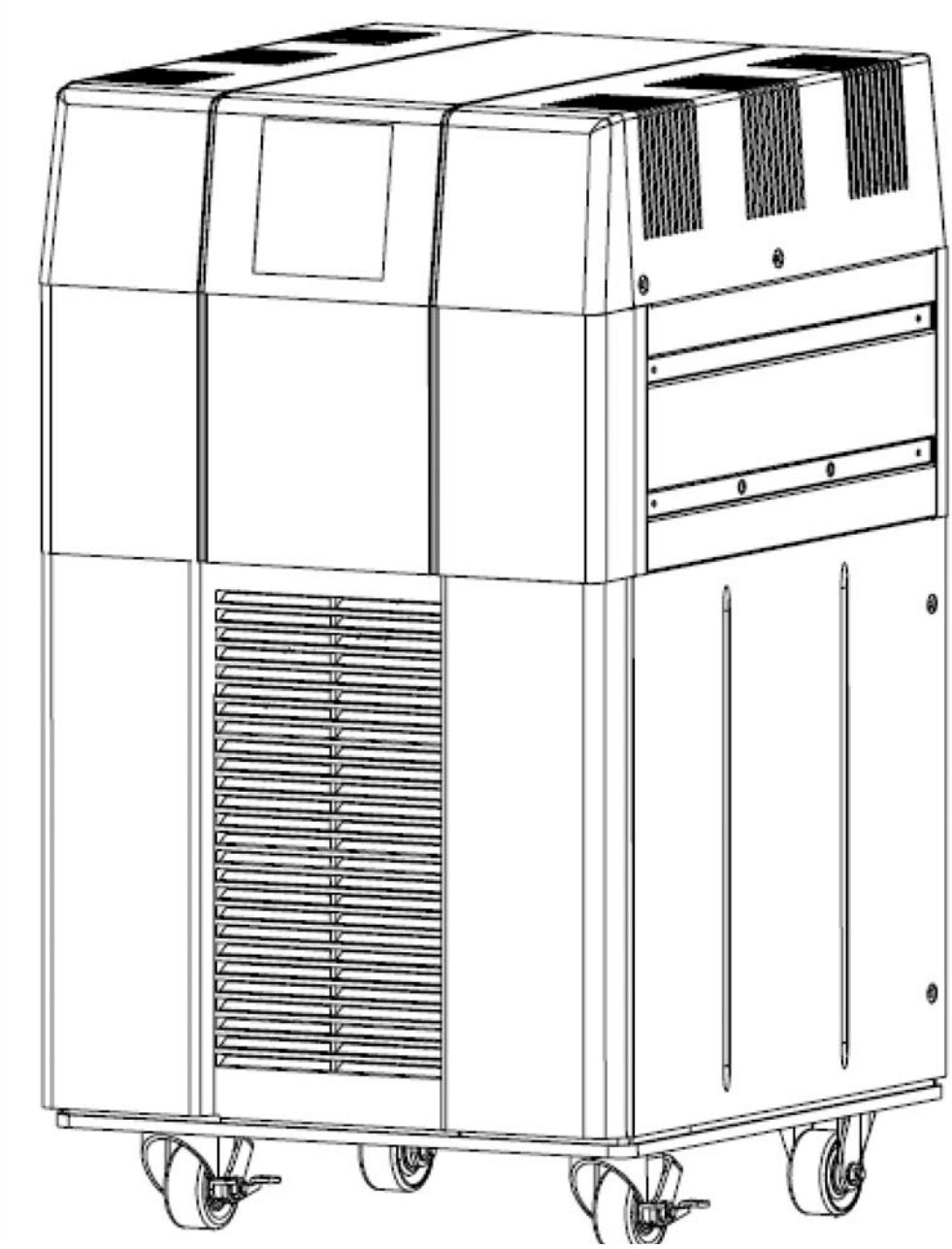


Figure 1-1: 9700A Compressor

Specifications

Dimensions

The dimensions of the 9700A Compressor are shown in Figure 1-2.

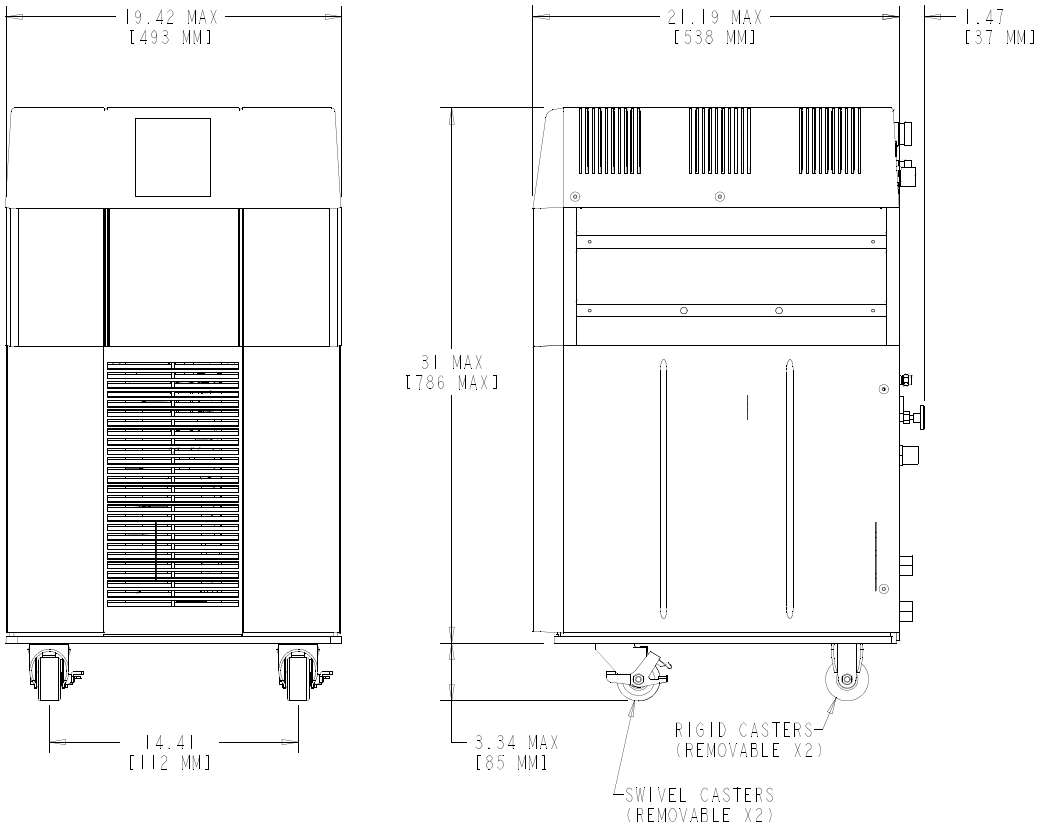


Figure 1-2: 9700A Compressor Dimensions

CAUTION

Do not place a weight greater than 75 lbs. (34Kg) on top of the Compressor.

Weight

The weight of the Compressor is listed in Table 1-1.

Table 1-1: Compressor Weight

Weight lbs./kg
350/159

Electrical

The electrical specifications of the Compressor are listed in Table 1-2.

Table 1-2: Electrical Input Specifications

Parameter	60 Hz	50 Hz
Operating Voltage Range	190 - 253 VAC	180 - 253 VAC
Phase	3	3
Nominal Input Power	5.8 KW	5.3 KW
Nominal Power Factor	0.85	0.85
Rated FL/LR[1] Current	23/85	22/80
Minimum Electrical Service	30 Amps	30 Amps

1. Full Load/Locked Rotor

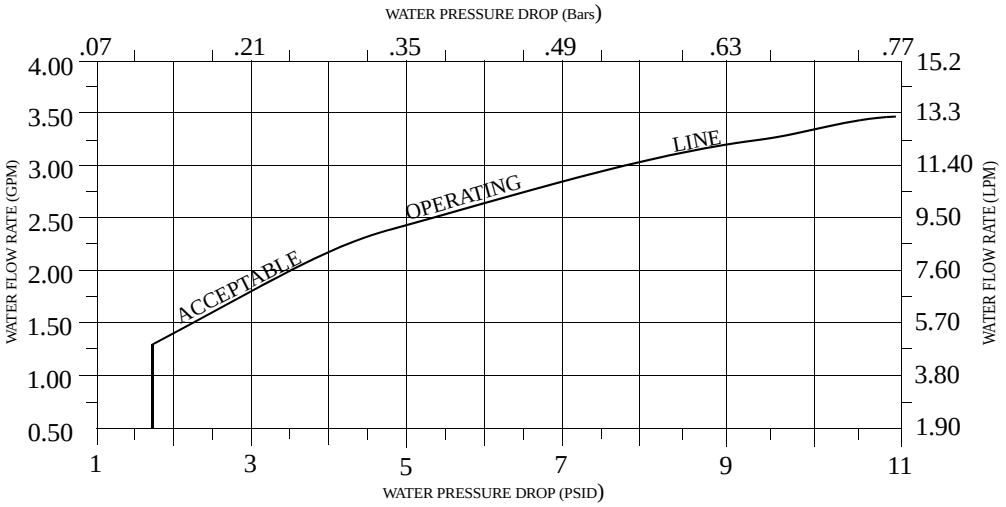
Cooling Water

The water used to cool the Compressor must meet the specifications shown in Table 1-3 for proper system operation.

Table 1-3: Cooling Water Specifications

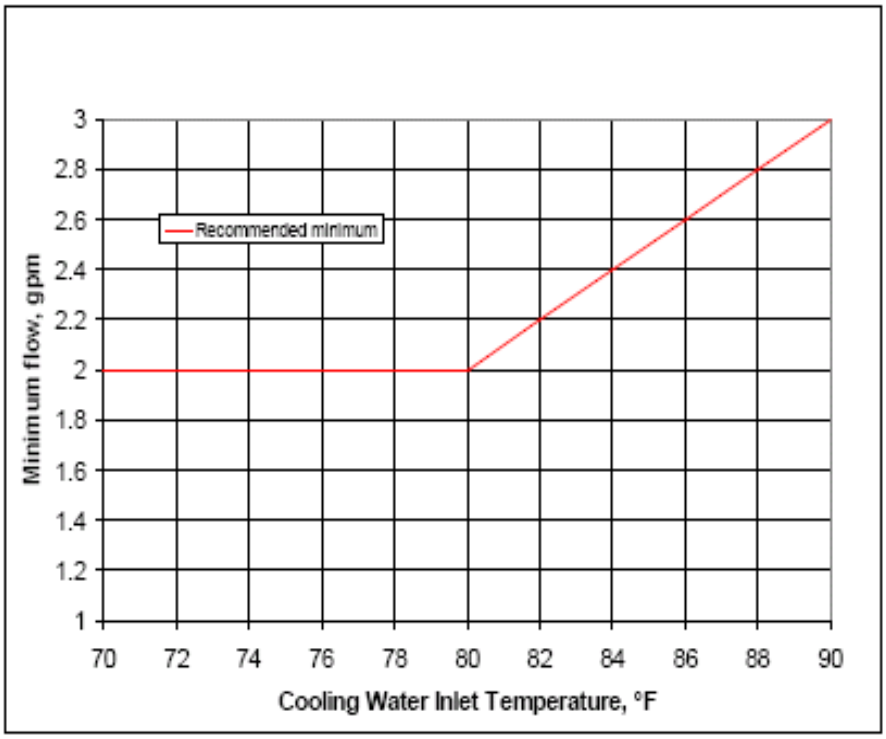
Parameter	Value
Maximum Inlet Temperature[1]	90°F (32°C)
Minimum Inlet Temperature	50°F (10°C)
Flow Rate	3.0 ±1.0 gpm (11.4 ± 3.8 lpm)
Pressure Drop (inlet-to-outlet)	See Figure 1-3
Maximum Inlet Pressure	100 psi (6.9 bars)
Alkalinity	6.0 - 8.0 pH
Calcium Carbonate	< 75 ppm

1. See Figure 1-4 for minimum recommended water flow above 80º F inlet temperature. Water conditioning may be required for applications not meeting these requirements.



NOTE: *Figure 1-3 defines the water flow rate through the Compressor as a function of the pressure drop from water inlet to water outlet. You must provide the correct pressure drop in your water supply system to ensure that the water flow condition meets the requirements specified in Table 1-3.*

Figure 1-3: Water Flow Rate versus Pressure Drop



NOTE: *Figure 1-4 shows that cooling water flow rate must be increased if the inlet temperature of the cooling water is above 80° F.*

Figure 1-4: 9700A Cooling Water Flow Rate versus Inlet Temperature

General

Table 1-4 provides general Compressor operating specifications.

Table 1-4: General Compressor Operating Specifications

Specification	Description
Part Number 8135924G001 8135924G002 8135924G003 8135924G004	 2-phase output with PSI gauge 2-phase output with kPa gauge and GFI 3-phase output with PSI gauge 3-phase output with kPa gauge and GFI
Input Power Cable (Customer Supplied)	600 VAC 10 Gauge, 3 conductor wire with ground Must conform to local electrical codes
Nominal Helium Pressure	Refer to Table 5-1.
Ambient Operating Temperature Range	50 - 100º F (10 - 38º C)
Interface	Cryopump Power Receptacle mates with the CTI-CRYOGENICS supplied cryopump power cable for single pump use. Mates with remote junction box power cable for multiple cryopump use.
Gas Supply Connector	1/2 in. Aeroquip self-sealing coupling
Gas Return Connector	1/2 in. Aeroquip self-sealing coupling
Remote Control Receptacle	24VAC, 2.7A inductive mates with P5 connector P/N MS3106A[1]
Adsorber Service Schedule	3 years

1. Supplied by CTI-CRYOGENICS

NOTE: *The 9700A Compressor is designed for continuous operation and should remain ON when the cryopumps are in a regeneration cycle.*

Component Description

The components of the 9700A Compressor that are accessible from the rear panel are shown in Figure 1-5 and described in the following paragraphs.

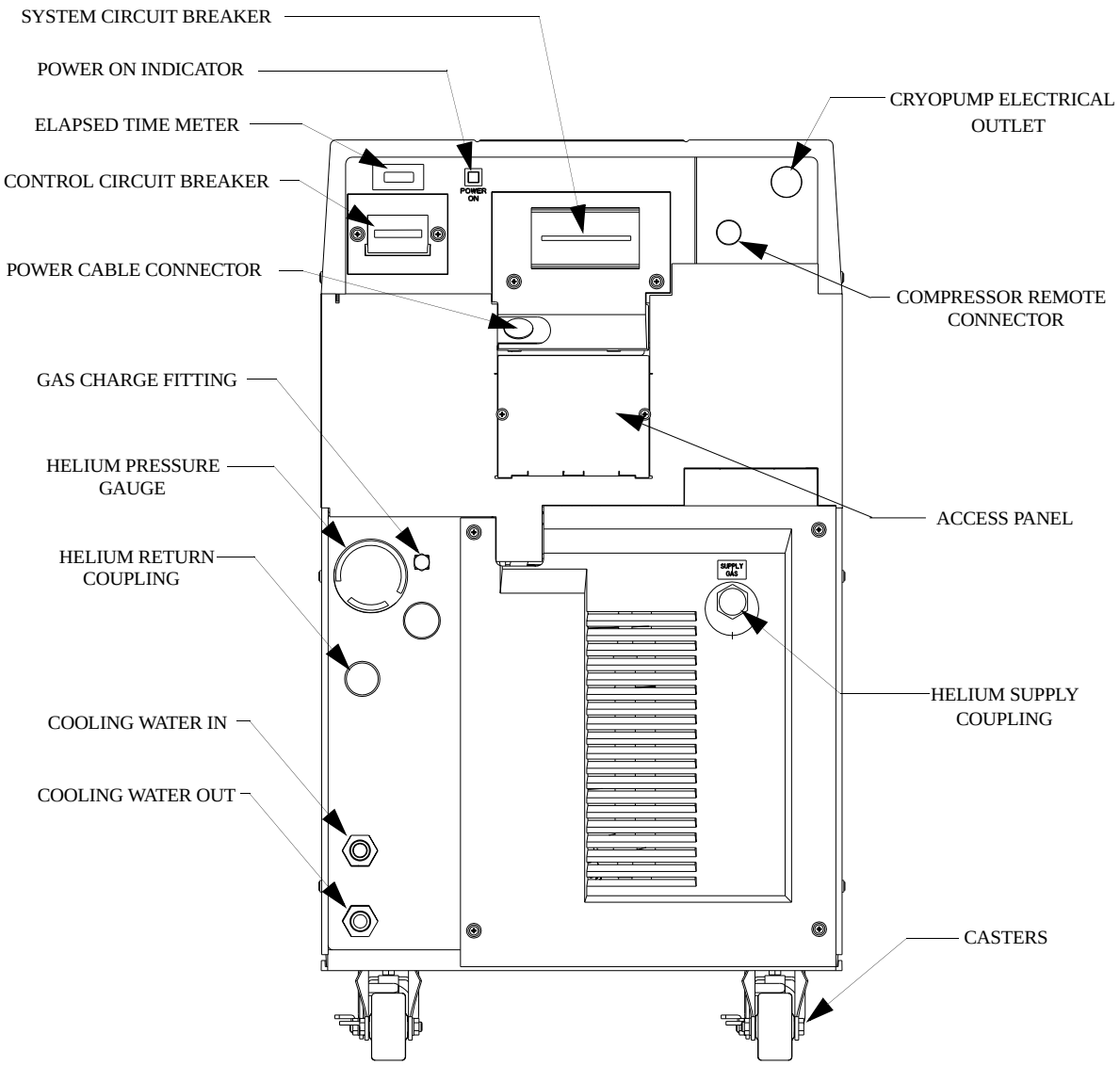


Figure 1-5: 9700A Compressor Rear View Component Locations

System Circuit Breaker

The System Circuit Breaker protects main input power to the Compressor pump and module. The circuit breaker positions are labeled ON (1), which is in the UP position, and OFF (0), which is in the DOWN position.

The phase monitor within the Compressor will cause the system circuit breaker to open when input power phases are incorrect.

Power ON Indicator

The Power On Indicator illuminates when the system circuit breaker is placed in the ON position. The Compressor pump is energized when the power indicator is illuminated, and the elapsed time meter records system operation time.

Elapsed Time Meter

The Elapsed Time Meter records the number of Compressor operating hours. Since the meter is digital, it is not illuminated unless the system circuit breaker is in the ON position, and power is connected to the Compressor. The Elapsed Time Meter maintains the correct accumulated operating hours while system power is turned OFF.

NOTE: *The meter cannot be reset.*

Control Circuit Breaker

The Control Circuit Breaker provides current overload protection for all internal components of the Compressor except the Compressor motor. The Compressor motor is protected by a separate overload protector. The Control Circuit Breaker opens automatically and must be reset manually.

Power Cable Connector

The Power Cable Connector connects the power cable to the Compressor. Refer to Chapter 3 for information on power cable installation.

Gas Charge Fitting

The Gas Charge Fitting is used to connect a 99.999% pure helium supply to the Compressor when helium charging is required. The fitting has a 45^{o} flare and 7/16 in. x 20 threads/inch.

Refer to for information on adding helium to the Compressor.

Helium Pressure Gauge

The Helium Pressure Gauge indicates system static helium charge pressure when the Compressor and cryopumps are OFF and Compressor suction or inlet pressure when the Compressor is ON. Refer to Table 5-1 for the appropriate static helium charge pressure.

Helium Return Coupling

The Return Gas Coupling returns the helium, which has been cycled through the cryopump, back to the Compressor. Refer to **CTI-CRYOGENICS Helium Refrigeration System** in this chapter for more information.

Cooling Water IN

The Cooling Water IN connector provides water to the Compressor from your facility to cool the Compressor during operation. The connector thread size is a 1/2 in. female pipe thread. The water must meet the specifications outlined in Table 1-3. Refer to Chapter 3 - Installation for more information on cooling water connections.

Cooling Water OUT

The Cooling Water OUT connector returns the water that has been used to cool the Compressor to your facility. The connector thread size is a 1/2 in. female pipe thread. Refer to Chapter 3 - Installation for more information on cooling water connections.

Casters

The Casters allow the 9700A Compressor to moved.

CAUTION

The Casters a should be in the locked position after the 9700A Compressor has been installed to prevent compressor movement.

Helium Supply Coupling

The Supply Gas Coupling provides a connection for high pressure compressed helium to the cryopump cold head. Refer to **CTI-CRYOGENICS Helium Refrigeration System** in this chapter for more information.

Access Panel

The Access Panel protects the Compressor Power Cable connections.

WARNING

The Access Panel should not be removed from the 9700A Compressor until the power source has been turned OFF.

Compressor Remote Connector

The Compressor Remote Connector is a two-pin connector that can be used in conjunction with the On-Board setpoint relays, relays in the Cryo-Torr Interface, or a signal from the vacuum system to turn the Compressor ON or OFF. Refer to Table 1-5 for connector pin identification. Switching contacts must be rated at 24VDC, 2.7A inductive.

NOTE: *The Compressor is shipped with a mating plug, which must remain installed in the Compressor Remote Connector to ensure Compressor operation when the Compressor remote feature is not being used.*

Table 1-5: Compressor Remote Connector Pin Assignments

Identifier	Function
A and B	Compressor Remote Control - Make = ON, Break = OFF

Cryopump Electrical Outlet

The Cryopump Electrical Outlet provides power to a single On-Board or Cryo-Torr Cryopump, an On-Board Splitter Box, or a Cryo-Torr Interface. The Compressor requires the use of an On-Board Splitter Box or Cryo-Torr Interface for multiple cryopump system connections. Refer to Table 1-6 for connector pin identification.

Refer to **Multiple On-Board Cryopump Connections** or **Multiple Cryo-Torr Cryopump Connections** in this chapter for more information.

Table 1-6: Cryopump Power Connector Pin Assignments

Identifier	Function
A and B	Heater Power - 208 VAC nominal
C	Center tap for D and E
D and E	24 VCT @ 4.6 Amps
F-G and G-H	Cold Head Voltage Output 130-160 VAC @ 4.5 Amps
J	Chassis Ground
K	Not Used

Multiple On-Board Cryopump Connections

The On-Board Splitter Box permits the connection of multiple On-Board Cryopumps or Waterpumps to one 9700A Compressor as shown in Figure 1-6. The actual number of On-Board Pumps that can be connected to the 9700A Compressor depends upon the process application and the type of On-Board pumps required.

NOTE: *Refer to Appendix A Customer Support Information to consult with your local CTI-CRYOGENICS Customer Support Center for information on specific compressor/pump applications.*

Refer to Chapter 3 Installation for more information on connecting single or multiple On-Board Cryopumps or Waterpumps to the 9700A Compressor.

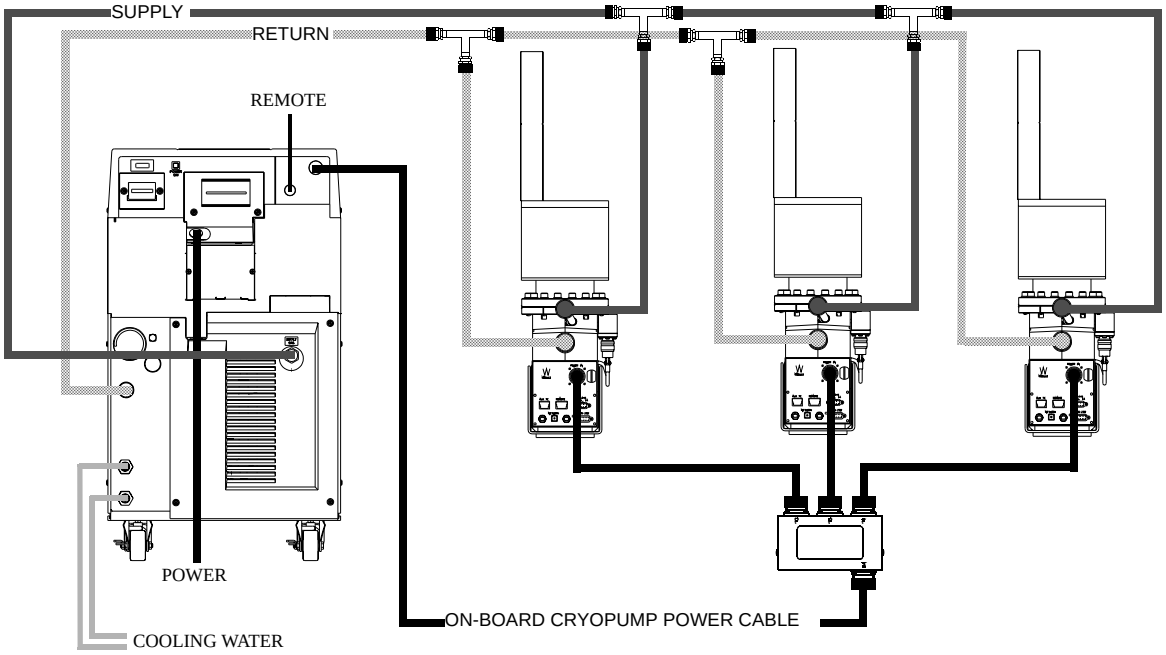


Figure 1-6: 9700A Compressor Connected to Multiple On-Board Waterpumps

Multiple Cryo-Torr Cryopump Connections

The Cryo-Torr Interface permits the connection of multiple Cryo-Torr Cryopumps to one 9700A Compressor as shown in Figure 1-7. The actual number of Cryo-Torr Pumps that can be connected to the 9700A Compressor depends upon the process application and the type of Cryo-Torr pumps required.

NOTE: *Refer to Appendix A to consult with your local CTI-CRYOGENICS Customer Support Center for information on specific compressor/cryopump applications.*

Refer to Chapter 3 Installation for more information on connecting single or multiple Cryo-Torr Cryopumps to the 9700A Compressor.

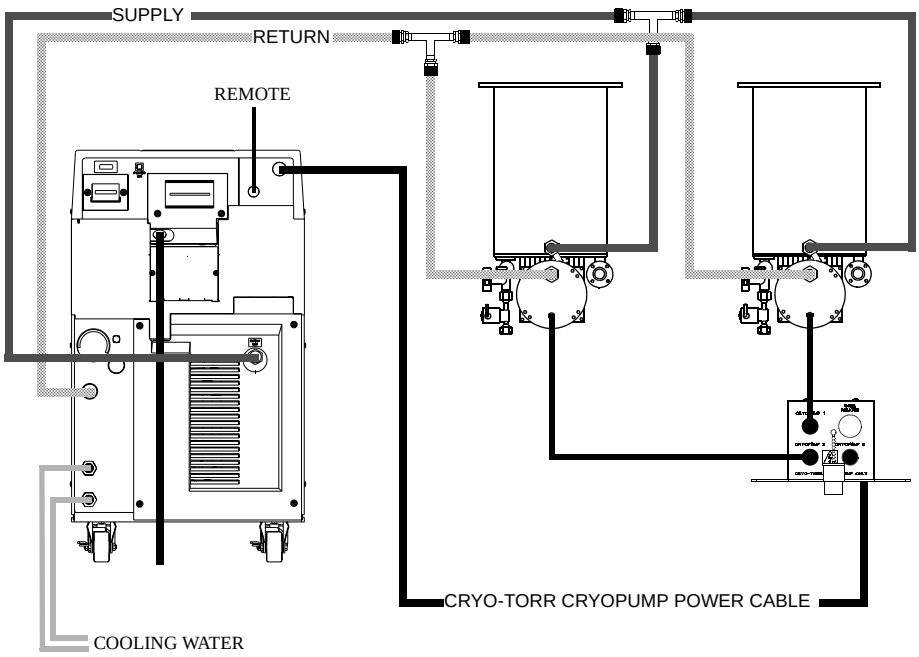


Figure 1-7: 9700A Compressor Connected to Multiple Cryo-Torr Cryopumps

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2 Safety

Overview

This chapter describes safety conventions for the Brooks Automation Product. All personnel involved in the operation or maintenance of the product must be familiar with the safety precautions outlined here.

NOTE: *These safety recommendations are basic guidelines. If the facility where the Product is installed has additional safety guidelines they should be followed as well, along with the applicable national and international safety codes.*

Introduction

Follow all safety precautions during installation, normal operation, and when servicing CTI-Cryogenics products.

This chapter explains the safety conventions used throughout this manual. CTI-Cryogenics uses a specific format for cautions and warnings, which includes standard signal words and safety shapes.

See also the *Customer Support* appendix or call your local Customer Support Center for assistance.

Signal Word Descriptions

All cautions and warnings contain signal words, which call attention to safety messages and designate the degree of hazard seriousness. The following table shows the signal words and their meanings that may be used in this document.

Table 2-1: Safety Signal Words

Term	Example	Definition
CAUTION	CAUTION	A signal word that indicates a situation or unsafe practice, which if not avoided may result in **equipment damage**. A CAUTION is highlighted in yellow.
CAUTION	⚠ CAUTION	A signal word accompanied by a safety shape that indicates a potentially hazardous situation or unsafe practice. If not avoided, the action may result in **minor or moderate personal injury or equipment damage**. A CAUTION is highlighted in yellow.
WARNING	⚠ WARNING	A signal word accompanied by a safety shape that indicates indicates a potentially hazardous situation. If not avoided, the action may result in **serious injury or death**. A WARNING is highlighted in orange.

Safety Shape Descriptions

All cautions and warnings contain safety shapes, which have specific safety meanings. The following table shows some of the safety shapes used in this document and their meanings.

Table 2-2: Safety Shapes

Example	Term	Shape Definition
	General Warning	Indicates a general hazard. Details about this hazard appear in the safety notice explanation.
	High Voltage	Indicates a high voltage hazard.
	Hot Surface	Indicates a surface is hot enough to cause discomfort or a burn.

References

For more information about safety standards, see the following documents:

- ISO 7010: 2003(E), Graphic symbols - Safety colours and safety signs - Safety signs used in workplaces and public areas
- ISO 3864-1: 2002(E), Graphic symbols - Safety colours and safety signs - Part 1: Design principles for safety signs in workplaces and public areas

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3 Unpacking and Inspection

Introduction

The 9700A Compressor is shipped in a carton that incorporates a ramp system, which makes removing the Compressor from the carton safe and easy.

Shipping Carton Inspection

Inspect the exterior of the shipping carton for visible signs of damage before opening the shipping carton. Report any damage to the shipping company at once.

Removal from Shipping Carton

There are two methods of removing the 9700A Compressor from the shipping carton: using the ramp within the carton, or using a lifting device.

Using the Ramp

1. Cut the two straps on the exterior of the shipping pallet.
2. Lift the cardboard carton straight up and remove it from the pallet.
3. Cut the tape which holds the ramp in the vertical position.
4. Swing the ramp down until the end touches the floor as shown in Figure 3-1.
5. Remove any excess shipping material from around the Compressor.
6. Carefully roll the Compressor down the ramp and onto the floor as shown in Figure 3-1.

WARNING

Maintain control over the movement of the Compressor as it rolls down the ramp. Injury to personnel may result if the Compressor is allowed to roll freely .

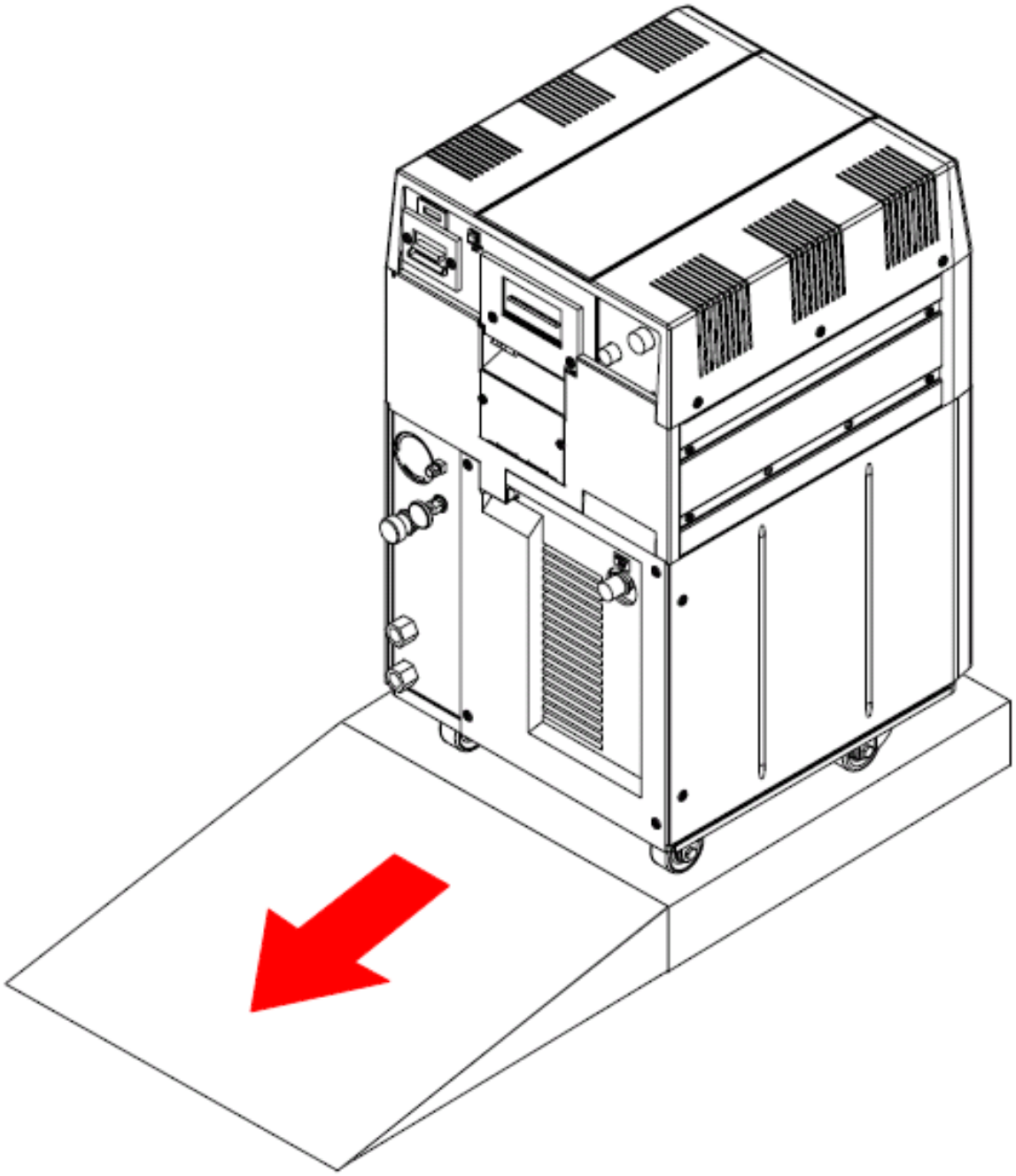

Figure 3-1: Using the Shipping Carton Ramp

Using a Lifting Device

CAUTION

The lifting device must be capable of lifting 350 pounds (159 kg).

1. Cut the two straps on the exterior of the shipping pallet.
2. Lift the cardboard carton straight up and remove it from the pallet.
3. Cut the tape which holds the ramp in the vertical position.
4. Remove the ramp from the shipping carton.
5. Remove any excess shipping material from around the Compressor.

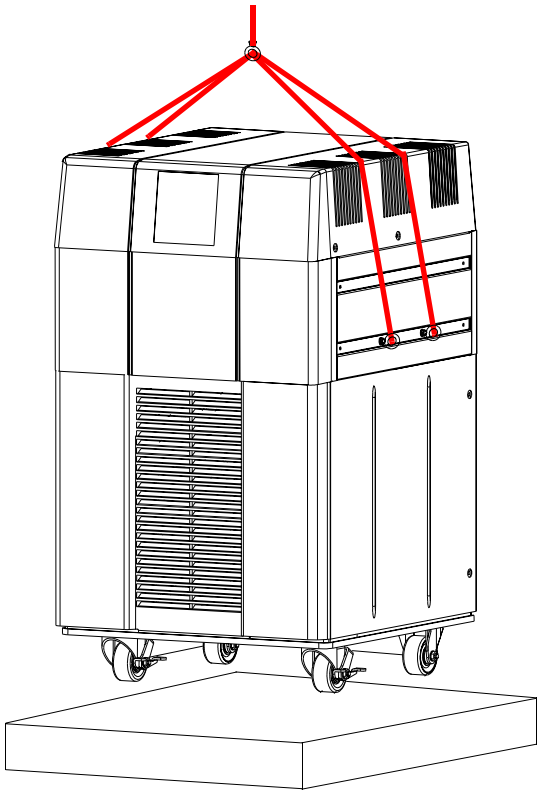

Figure 3-2: Attaching Eye Bolts and Lifting Slings to the 9700A Compressor

6. Install the four customer supplied 3/8 inch x 16 eye bolts into the holes on each side of the 9700A Compressor as shown in Figure 3-2.

CAUTION

The lifting sling minimum length must be 48 inches to prevent damaging the sides of the 9700A Compressor when being lifted from the shipping carton.

7. Attach one (1) lifting sling (minimum 48 inches in length) to each eye bolt as shown in Figure 3-2.
8. Attach the lifting slings to the lifting device and lift the 9700A Compressor off the shipping the shipping carton.
9. Slide the shipping carton out from under the 9700A Compressor.
10. Lower the 9700A Compressor onto it's casters and remove the lifting slings and eyebolts.

Compressor Inspection

Inspect the Compressor for visible signs of damage as indicated in the following paragraphs.

Compressor

Inspect the exterior of the Compressor for visible signs of damage, evidence of an oil leak, and check the Helium Pressure Gauge for proper helium pressure. Report any damage to the shipping company at once.

Helium Static Pressure Verification

Refer to Chapter 4 - Operation for more information on the static helium charge pressure of the 9700A Compressor.

Shipping Carton Contents

The shipping carton should contain the following items:

- Compressor
- Two barbed fittings for flexible water lines
- Installation, Operation, and Maintenance manual
- Compressor remote start connector and strain relief

4 Installation

Introduction

This chapter provides the instructions for installing the 9700A Compressor and connecting it to single or multiple On-Board or Cryo-Torr Cryopump configurations. Figure 4-1 highlights the major tasks for 9700A Compressor installation and refers to the appropriate installation procedures in this chapter.

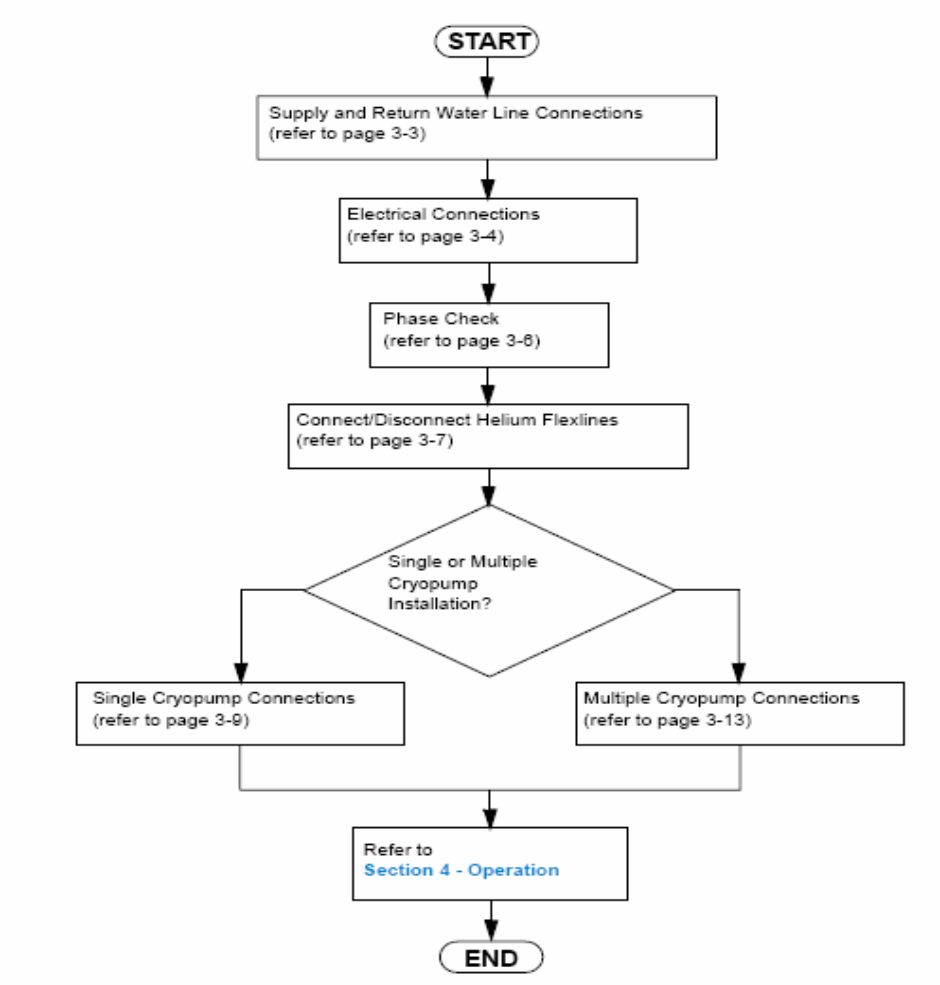

Figure 4-1: 9700A Compressor Installation Flowchart

Supply and Return Water Line Connections

NOTE: *The water used for cooling the 9700A Compressor must meet the specifications outlined in Chapter 1 - 9700A Compressor Decription.*

Hard Water Lines

1. Apply a light coating of standard plumbing thread sealant to the hard line pipe threads.

2. Install the Supply hard line into the INPUT connection on the rear panel of the 9700A Compressor. Tighten the fitting by hand.

3. Install the Return hard line into the OUTPUT connection on the rear panel of the 9700A Compressor. Tighten the fitting by hand.

CAUTION

Do not overtighten the ferrules. Damage to the input and output connector threads can occur.

4. Tighten the fittings with a wrench.

5. Allow water to flow and check for leaks at the rear of the 9700A Compressor.

Flexible Water Lines

1. Apply a light coating of standard plumbing thread sealant to the barbed fitting threads.

2. Install the barbed fittings into the INPUT and OUTPUT connections on the rear panel of the 9700A Compressor.

CAUTION

Do not overtighten the barbed fittings. Damage to the INPUT and OUTPUT connector threads may occur.

3. Tighten the barbed fittings with a wrench.

4. Connect the Supply flexible water line to the INPUT barbed fitting and secure with a hose clamp.

5. Connect the Return flexible water line to the OUTPUT barbed fitting and secure with a hose clamp.

6. Allow water to flow and check for leaks at the rear of the 9700A Compressor.

Electrical Connections

CAUTION

The following procedures provide information for making all three phase (200 - 230 VAC) electrical connections to the 9700A Compressor.

WARNING

Helium flexlines are part of the protective earth ground (bonding) from compressor to cryopumps. Make sure the flexlines have been installed before operating the system.

Power Cable Preparation

WARNING

The 9700A Compressor power cord must be installed by qualified personnel in accordance with the National Electrical Code, ANSI/NFPA 70-1987, as well as all local codes. The cable used for making the 9700A Compressor power cable must be a 10 gauge, 3 conductor cable with ground rated at 600 VAC. The power cord installation shall include the installation of a readily accessible disconnect/device into the fixed wiring supplying power. Follow all local high voltage safety precautions when performing this procedure to reduce the possibility of electrical shock. Make sure all electrical power is OFF before proceeding with this procedure.

1. Cut a 10 AWG (6.00 mm^2), 3 conductor cable with ground to an appropriate length.

2. Strip the cable jacket back 4 in. (101.6 mm).

3. Strip the insulation back 3/8 in. (9.3 mm) on each individual conductor.

4. Install a #10 ring tongue terminal on the end of each conductor using the appropriate size double crimping tool.

5. Remove the access panel as shown in Figure 4-2 and described Note below.

6. Remove the circuit breaker terminal cover as shown in Figure .

7. Install the cable into the 9700A Compressor through the cable strain relief.

8. Remove the 10-32 nut and install the grounding wire on the ground stud. Install the nut and tighten to 18 in.-lbs (0.21m-kg).

NOTE: *Use a slotted screwdriver that can hold a screw when performing steps 9 and 10. Remove the screws from the 9700A Compressor circuit breaker terminals X, Y, and Z as shown in Figure 4-2.*

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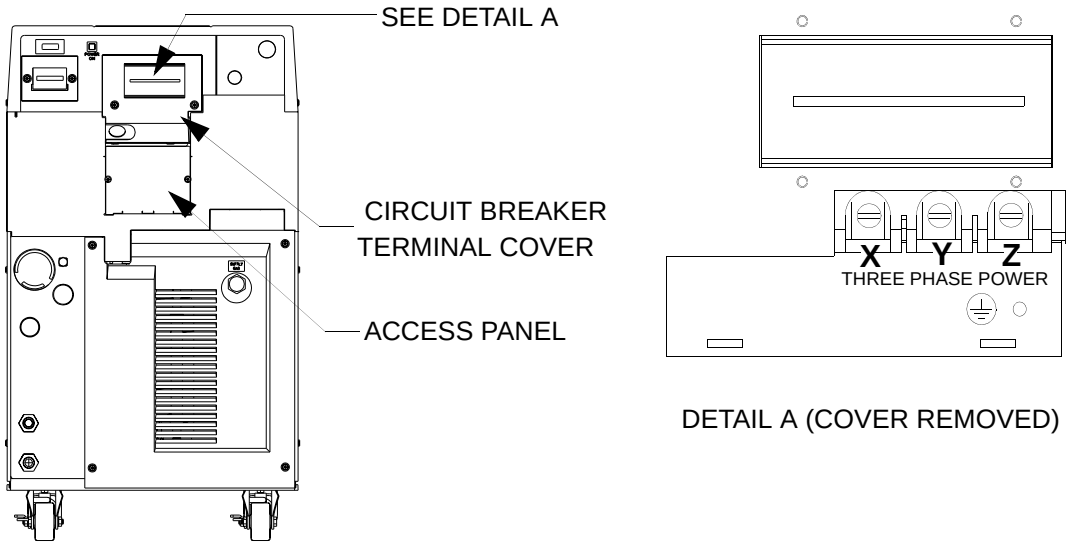

Figure 4-2: 9700A Compressor Circuit Breaker Terminals

NOTE: *The phase order in which the conductor terminal lugs are connected to circuit breaker terminals X, Y, and Z will be determined during the Phase Check Procedure.*

NOTE: *For installation where one of the three phase legs is at or near ground potential, connect that leg to terminal Y on the 9700A Compressor as shown in* Figure 4-2.

9. Install the conductor terminal lugs to the circuit breaker terminals X, Y, and Z as shown in Figure 4-2.

10. Torque the screws to 12 in.-lbs (0.14m-kg).

11. Allow enough cable to stay in the electrical enclosure to prevent strain on the electrical connections and tighten the screws on the cable strain relief.

12. Install the power source end of the power cable according to the local electrical codes.

13. Install the circuit breaker terminal cover.

14. Proceed with Phase Check.

Phase Check

WARNING

Follow all high voltage safety precautions when performing this procedure to prevent the possibility of electrical shock.

1. Make sure power is applied to 9700A Compressor circuit as described in Table 1-2.

NOTE: *The circuit breaker will trip immediately during step 2 if the power phase connections are not correct.*

2. Turn the 9700A Compressor circuit breaker to the ON position. If the circuit breaker trips, refer to step 3. If the circuit breaker does not trip, refer to step 4.

3. If the circuit breaker trips, perform the following steps:

    a. Turn the 9700A Compressor circuit breaker to the OFF position.

    b. Shut power OFF at the power source.

    c. Remove the circuit breaker terminal cover.

    d. Reverse the wiring order of 9700A Compressor circuit breaker terminals X and Y.

    e. Torque the circuit breaker terminal screws to 12 in.-lbs.

    f. Install the circuit breaker terminal cover.

    g. Turn power ON at the power source.

    h. Repeat steps 1- 2 of this procedure.

4. If the circuit breaker does NOT trip, perform the following steps:

    a. Shut power OFF at the power source.

    b. Install the circuit breaker terminal cover.

    c. Turn power ON at the power source.

Connecting/Disconnecting Helium Flex Lines

CAUTION

Make sure the helium flex lines are connected and disconnected from the 9700A Compressor using the following procedure and as shown in Figure 4-3. Failure to follow this procedure could damage connector O-ring seals or cause a helium circuit leak.

Connecting

1. Remove all dust plugs and caps from the Gas Supply and Return lines, and the 9700A Compressor and cryopump Supply and Return connectors. Check for the presence of a flat gasket in the male connector, and no gasket in the female connector.

2. Connect the Gas Return line to the GAS RETURN connector on the rear of the 9700A Compressor and then to the GAS RETURN connector on the cryopump. Using two wrenches as shown in Figure 4-3, tighten the connector.

3. Connect the Gas Supply line to the GAS SUPPLY connector on the rear of the 9700A Compressor and then to the GAS SUPPLY connector on the cryopump. Using two wrenches as shown in Figure 4-3, tighten the connector.

4. Attach the Supply and Return line identification labels to each end of the appropriate lines.

Disconnecting

1. Using two wrenches as shown in Figure 4-3, disconnect the two self sealing coupling connectors quickly to minimize helium leakage.

.

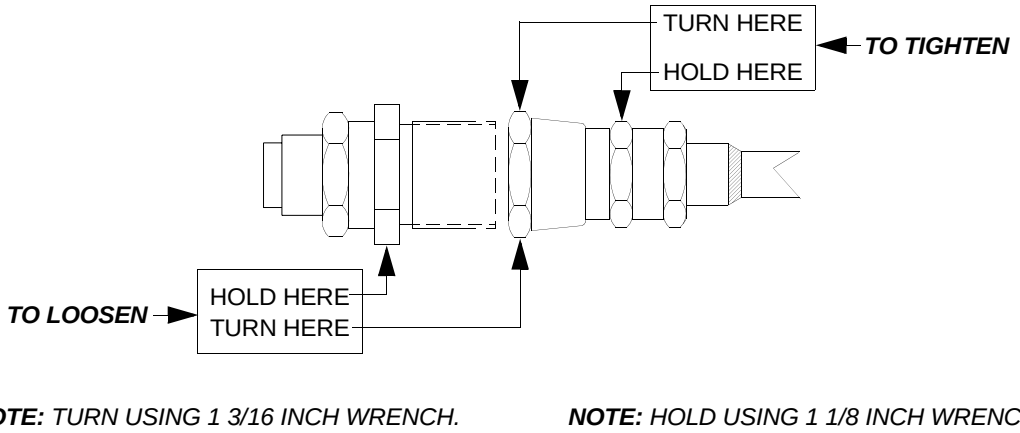

Figure 4-3: Connecting/Disconnecting Helium Flex Line Self Sealing Couplings

Single On-Board Pump Connections

CAUTION

Make sure the 9700A Compressor power is OFF before making any connections to the rear panel.

1. Connect the Helium Supply and Return lines between the 9700A Compressor and the On-Board Pump as described in Connecting/Disconnecting Helium Flex Lines in this chapter.

2. Connect one end of the On-Board power cable to one of the PUMP POWER CONNECTORS on the rear panel of the 9700A Compressor as shown in Figure 4-4.

3. Connect the opposite end of the On-Board power cable to the On-Board Pump power cable connector as shown in Figure 4-4

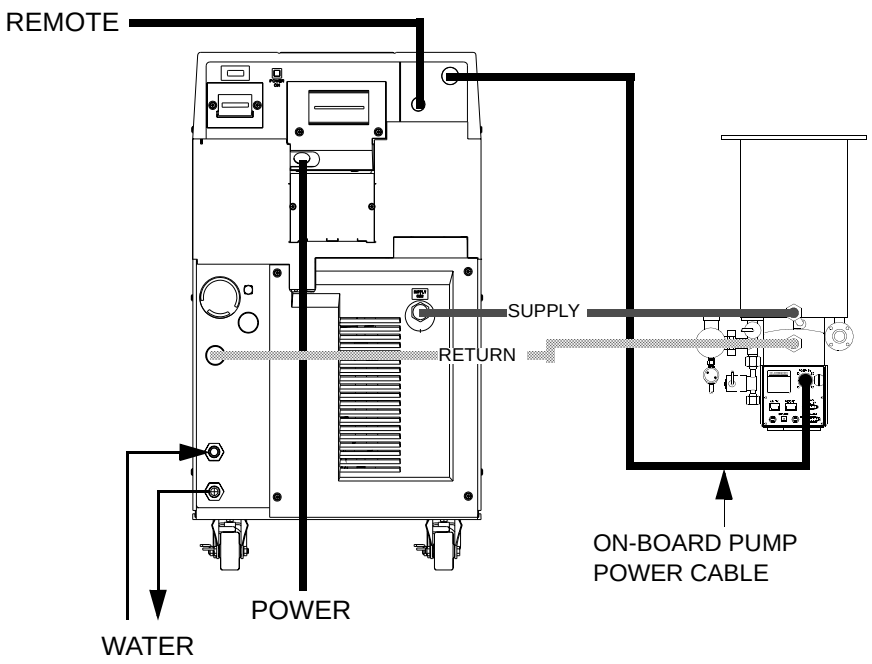

Figure 4-4: Single On-Board Pump Connections

4. If applicable, connect the compressor remote cable to the REMOTE connector as shown in Figure 4-4.

5. Refer to Chapter 5 - Operation to verify the system helium static charge pressure and to start the 9700A Compressor.

Single Cryo-Torr Cryopump Connections

CAUTION

Make sure the 9700A Compressor power is OFF before making any connections to the rear panel.

1. Connect the Helium Supply and Return lines between the 9700A Compressor and the Cryo-Torr Cryopump as described in Connecting/Disconnecting Helium Flex Lines in this chapter.

2. Connect one end of the Cryo-Torr power cable to one of the PUMP POWER CONNECTORS on the rear panel of the 9700A Compressor as shown in Figure 4-5.

3. Connect the opposite end of the Cryo-Torr power cable to the Cryo-Torr Cryopump power cable connector.

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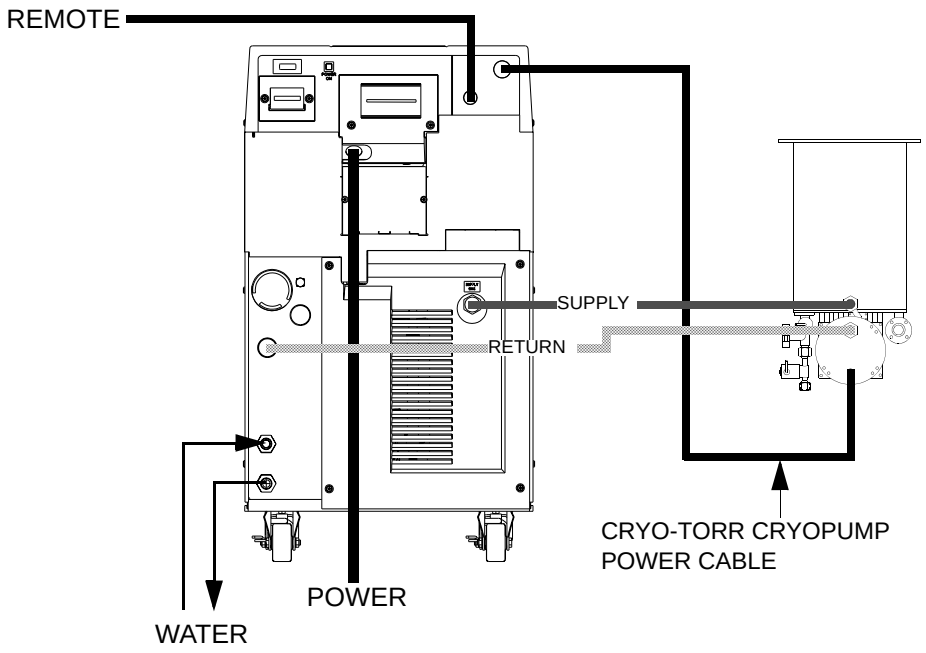

Figure 4-5: Single Cryo-Torr Cryopump Installation

4. If applicable, connect the compressor remote cable to the REMOTE connector.

5. Refer to Chapter 5 - Operation to verify the system helium static charge pressure and to start the 9700A Compressor.

Multiple On-Board Pump Connections

CAUTION

Make sure the 9700A Compressor power is OFF before making any connections to the rear panel.

Helium Line Connections

CAUTION

9700A Compressors cannot be connected to a helium manifold to which models other than 9700A Compressors are connected due to differences in helium running pressure.

CAUTION

The use of several 9700A Compressors on a single manifold feeding a common supply header and a common return header requires special precautions. Contact CTI-CRYOGENICS for a review of the intended installation and specific technical instructions.

1. Connect the Supply and Return lines to the 9700A Compressor as described in Connecting/Disconnecting Helium Flex Lines in this chapter.

2. Connect the Gas Return Line to the customer supplied helium manifold and then to the GAS RETURN connector on the On-Board Cryopump.

3. Connect the Gas Supply Line to the customer supplied helium manifold and then to the GAS SUPPLY connector on the On-Board Cryopump.

Power Cable Connections

1. Connect the On-Board power cable between the CRYOPUMP POWER CONNECTOR on the rear panel of the 9700A Compressor and the On-Board Splitter Box power connector as shown in Figure 4-6.

2. Connect the On-Board Pump power cables to the CRYOPUMP 1, 2, or 3 connectors on the On-Board Splitter Box and the respective On-Board Pumps.

NOTE: *Your installation (number of pumps per 9700A Compressor) will vary based upon the On-Board Cryopump models used. Refer to Appendix A - Customer Support Information to consult your local CTI-CRYOGENICS Customer Support Center for information on specific compressor/pump applications.*

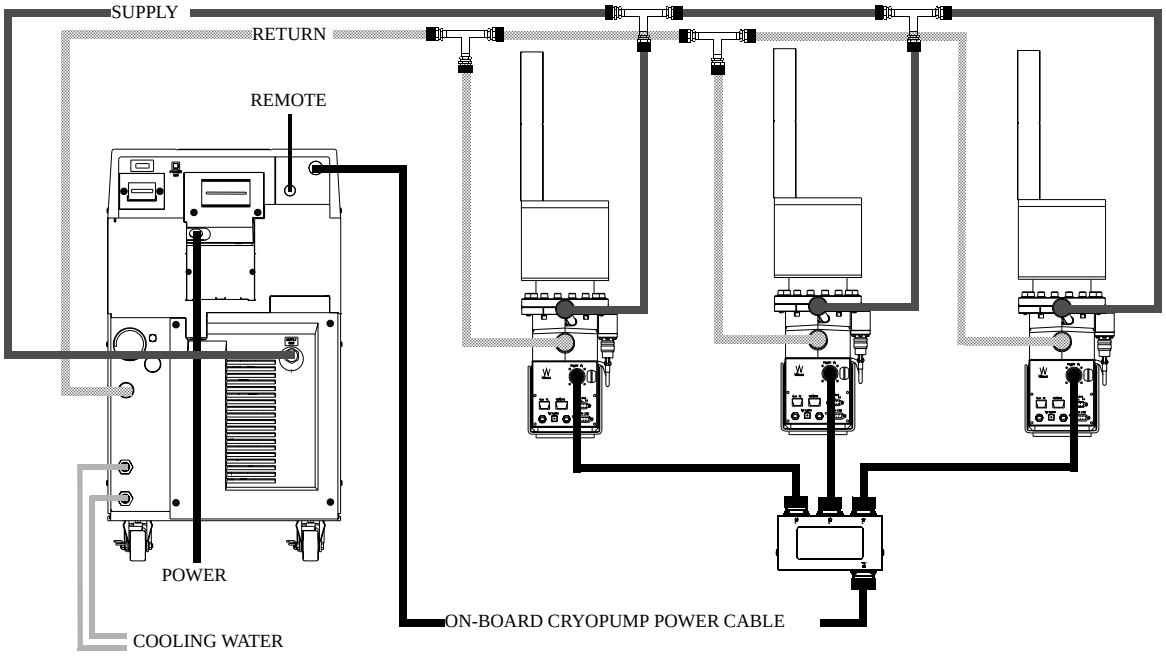

Figure 4-6: Connecting Multiple On-Board Pumps to the 9700A Compressor

Multiple Cryo-Torr Cryopump Connections

CAUTION

Make sure the 9700A Compressor power is OFF before making any connections to the rear panel.

Helium Line Connections

CAUTION

Several 9700A Compressors on a single manifold feeding a common supply header and a common return header requires special precautions. Contact CTI-CRYOGENICS for a review of the intended installation and for specific technical instructions.

1. Connect the Supply and Return lines to the 9700A Compressor as described in Connecting/Disconnecting Helium Flex Lines in this chapter.
2. Connect the Gas Return Line to the customer supplied helium manifold and then to the Gas Return connector on the Cryo-Torr Cryopump.
3. Connect the Gas Supply Line to the customer supplied helium manifold and then to the Gas Supply connector on the Cryo-Torr Cryopump.

Power Cable Connections

1. Connect the Cryo-Torr power cable between the CRYOPUMP POWER CONNECTOR on the rear panel of the 9700A Compressor and the CRYOPUMP ELECTRICAL INPUT on the Cryo-Torr Interface as shown in Figure 4-7.
2. Connect the Cryo-Torr Power Cables between the CRYOPUMP 1, 2, or 3 connectors on the Cryo-Torr Interface and the respective Cryo-Torr Cryopumps.
3. Connect the User Remote cable to the Cryo-Torr Interface.
4. Connect the Remote cable between the Cryo-Torr Interface and the 9700A Compressor.

NOTE: *Your installation may vary based upon the Cryo-Torr Cryopump models used. Refer to Appendix A - Customer Support Information to consult your local CTI-CRYOGENICS Customer Support Center for information on specific compressor/cryopump applications.*

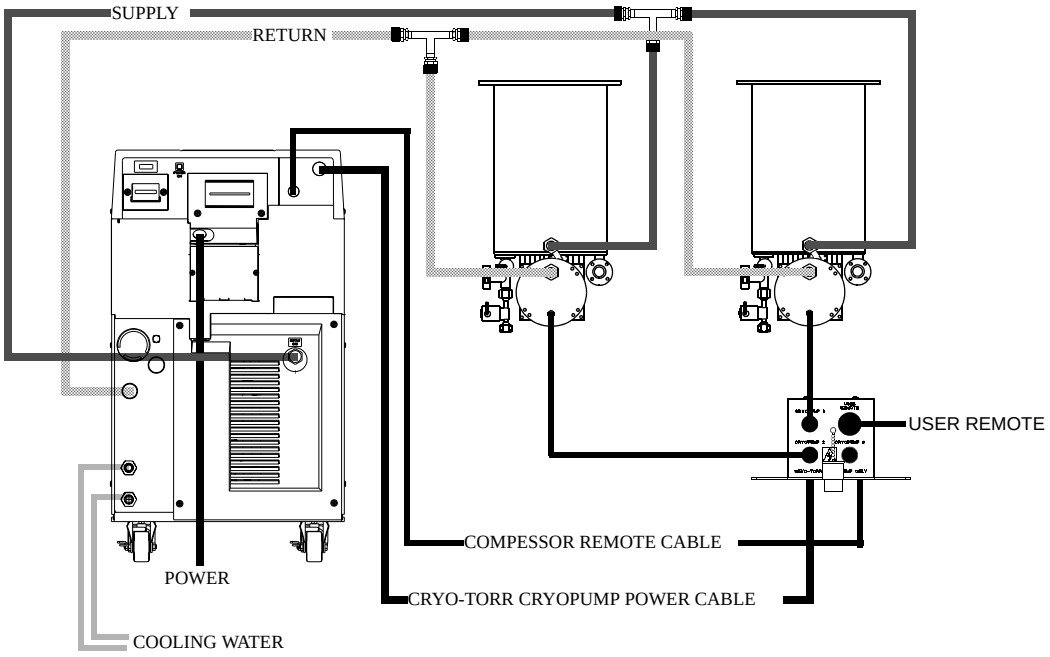

Figure 4-7: Multiple Cryo-Torr Cryopump Installation

5 Operation

Adjusting System Helium Pressure

The CTI-CRYOGENICS high vacuum pump system consists of a compressor, flex lines, and cryopumps. Each component is charged with helium before shipment. After all cryopumps, helium lines, and manifolds are attached to the compressor, the system *static helium charge pressure* must be verified *before* system operation. Once the static helium system pressure has been verified, the system is ready for operation. After cooldown, the *normal system operating pressure* is recorded.

NOTE: *The 9700A Compressor is designed for continuous operation and should remain ON even when the cryopumps are in a regeneration cycle.*

Static Helium System Pressure Verification

The proper system static helium charge pressure is necessary so that the cryopumps operate at maximum performance as well as to assure that the compressor will operate below the maximum design motor winding temperature which will maximize the life of the compressor motor.

1. Make sure the Compressor and Cryopump(s) are OFF.
2. Make sure all system components are connected together as described in Chapter 4 - Installation.
3. Allow all system components to acclimate to a temperature between 60° F and 80° F (15.5° C - 26.6° C).
4. Read the compressor helium pressure gauge located on the compressor rear panel as shown in Figure 1-5. Compare the gauge reading to the appropriate 50/60 Hz line frequency value (depending upon your system installation) indicated in Table 5-1.
5. If the static helium charge pressure is not within the ranges as indicated in Table 5-1, then adjust the charge pressure as described in Chapter 7 Maintenance.

Table 5-1: 9700A Compressor Helium Static Charge

Line Frequency	Helium Static Charge Pressure
60 Hz	220 - 230 psig (15.2 - 15.9 bars)
50 Hz	255 - 265 psig (17.6 -18.3 bars)

NOTE: *The use of a higher helium charge pressure for 50 Hz operation is necessary in order to compensate for the slower speed at which the compressor operates at 50 Hz. The static charge level for 60 Hz remains at 220 - 230 PSIG.*

CAUTION

Exceeding the recommended system static helium charge pressure will result in the compressor and cryopump safety relief valves opening and releasing excess helium gas.

Compressor Operation

The system may be operated once the helium charge pressure is correct. Perform the following steps to start the compressor:

1. Set the System Circuit Breaker to the ON (UP) position.
2. Set the Control Circuit Breaker to the ON (UP) position.
3. Close all Cryopump gate valves.
4. Refer to the appropriate **On-Board Module Programming and Operation** manual or **Cryo-Torr Cryopump Installation and Service** manual (that came with your pump) and perform the cryopump start-up procedure.
5. Once the second stage temperature for all cryopumps is below 17K, record the compressor pressure gauge reading as the *normal system operating pressure*.

NOTE: *During compressor operation, the compressor gauge reads the pressure of the gas entering the compressor prior to it being compressed.*

6. Affix a copy of the data next to the compressor gauge on each compressor. This data is to be verified for each tool installation and whenever a configuration change is made affecting the amount of system helium gas and line volume.

The compressor pressure reading will decrease from the normal system operating pressure during cryopump regeneration or if fewer cryopumps are being operated. These are normal variations in the compressor pressure reading and should not be cause for concern.

If you have concerns about system performance changing, then check the *normal system operating pressure* which was determined in Compressor Operation in this chapter. If the normal system operating pressure is not correct, check the system for leaks.

Once the leaks have been repaired, helium must be added to return the system to *normal operating system pressure* as described in Suggested Maintenance Equipment of Helium Circuit Components

On occasion, it may be necessary to replace components such as cryopumps, helium gas lines or compressors, or change the configuration of the system. Whenever any of these conditions occur, **Static Helium System Pressure Verification** should be performed to ensure that static helium pressure has not changed.

The use of several compressors on a single manifold feeding a common supply header and a common return header requires special precautions. Contact CTI-CRYOGENICS for a review of the intended installation and for specific technical instructions.

9700A Compressors cannot be connected to a helium manifold to which models other than 9700A Compressors are connected due to differences in helium running pressure.

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6 Maintenance

Scheduled Maintenance

It is recommended to have the following equipment and disposable supplies available as listed in Table 6-1.

NOTE: *Refer to Appendix A - Customer Support Information and contact the local Customer Support Center to obtain the CTI-CRYOGENICS parts listed in this table.*

Table 6-1: Suggested Maintenance Equipment

Supply	CTI-CRYOGENICS P/N
Helium, 99.999% pure	-
Pressure regulator (0-3000/0-400 psi) Assy.	8031403
Helium charging line terminating in a 1/4-inch female flare fitting	7021002P001

Adsorber Replacement

Use the following procedure to change the adsorber every three years.

1. Set the System Circuit Breaker on the rear of the 9700A Compressor to the OFF position.

2. Remove the four screws that secure the rear panel to the Compressor and remove the rear panel.

NOTE: *Use two wrenches in Step 3 to prevent loosening the body of the coupling.*

3. Using a 1-3/16 in. wrench, and a 1-1/8 in. wrench, as shown in Figure 6-1, disconnect the two self sealing coupling connectors quickly to minimize helium leakage.

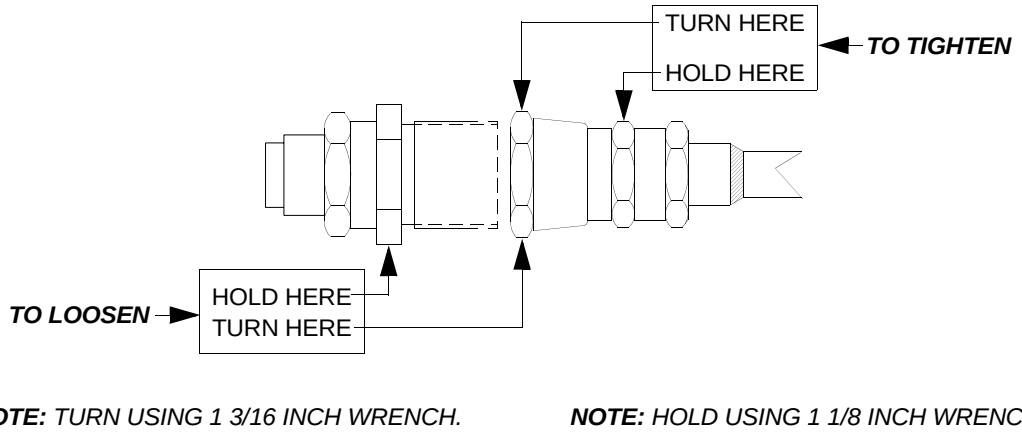


Figure 6-1: Disconnecting Self Sealing Couplings

4. Using a 7/16 in. (11mm) wrench, remove the adsorber mounting bolt as shown in Figure 6-2.

5. Move the adsorber from under the mounting tabs in the base as shown in and remove the adsorber from the Compressor.

6. Install the replacement adsorber under the mounting tabs and secure it into place with the bolt removed during Step 4.

7. Using two wrenches as shown in Figure 6-1, connect the two self sealing couplings quickly to minimize helium leakage.

8. Install the Compressor rear panel.

9. Ensure that the pressure gauge reads the proper value as shown in Table 6-1. If additional gas pressure is required, refer to **Adding Helium** within this section. If gas pressure needs to be reduced, refer to **Reducing Helium Pressure** within this section.

10. Record the adsorber replacement date on the label as shown in Figure 6-2, and also note that the next adsorber replacement should be performed every three years.

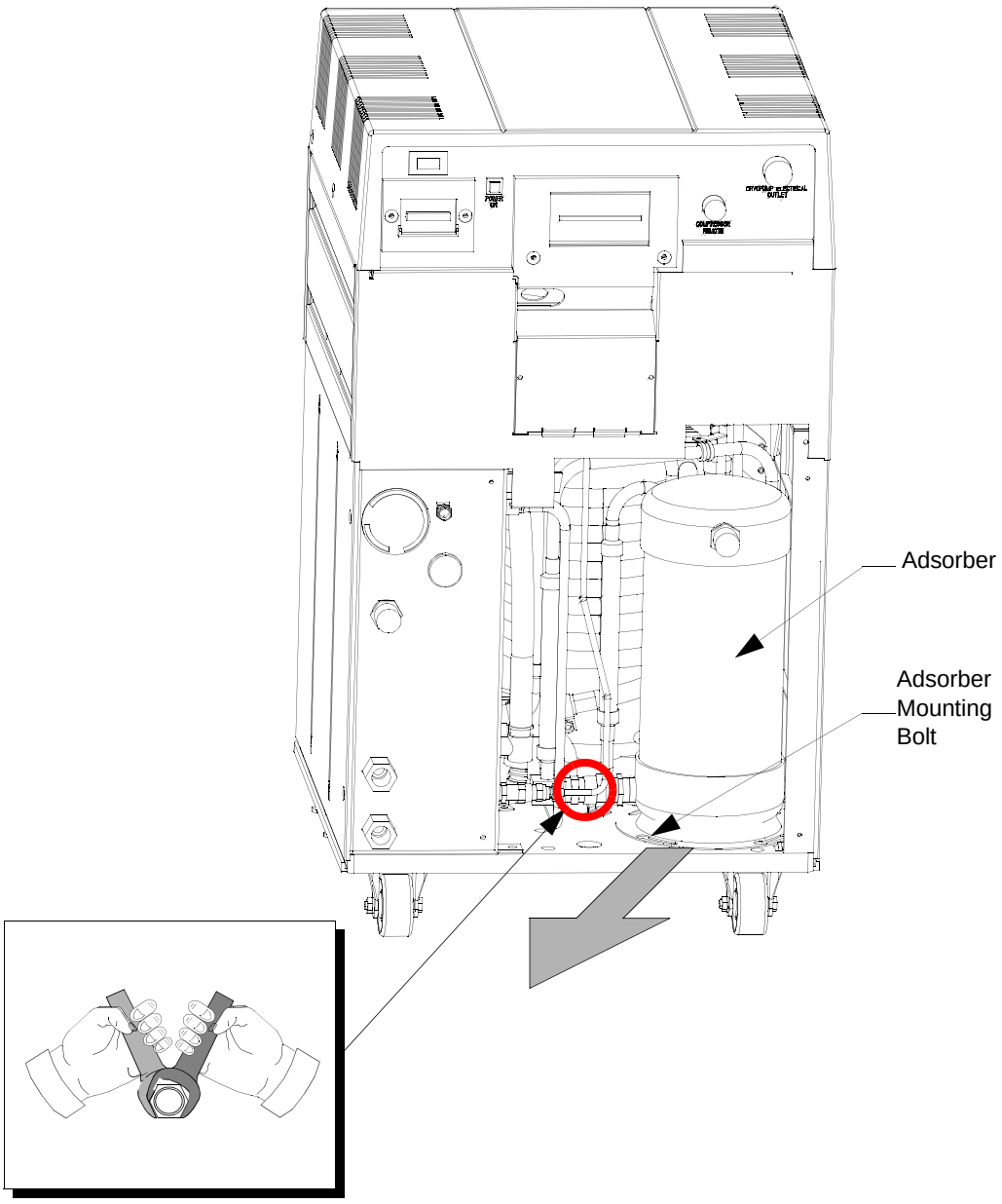


Figure 6-2: Adsorber Location in the 9700A Compressor (Rear Panel Removed)

Adjusting System Helium Pressure

NOTE: *These procedures can be performed on a compressor that is turned ON or OFF. However, the helium pressure gauge should be set to the static helium charge pressure value if the compressor is turned OFF or set to the normal system operating pressure if the compressor is turned ON. Refer to Chapter 4 - Operation for more information.*

Reducing Helium Pressure

NOTE: *You must obtain the normal system operating pressure from the Compressor Operation procedure in Chapter 4 - Operation in order to perform this procedure. If the normal system operating pressure is unknown, then shut the compressor OFF and perform the Static Helium System Pressure Verification procedure in Chapter 4 - Operation instead.*

1. Remove the flare cap from the gas charge fitting as shown in Figure 6-3.

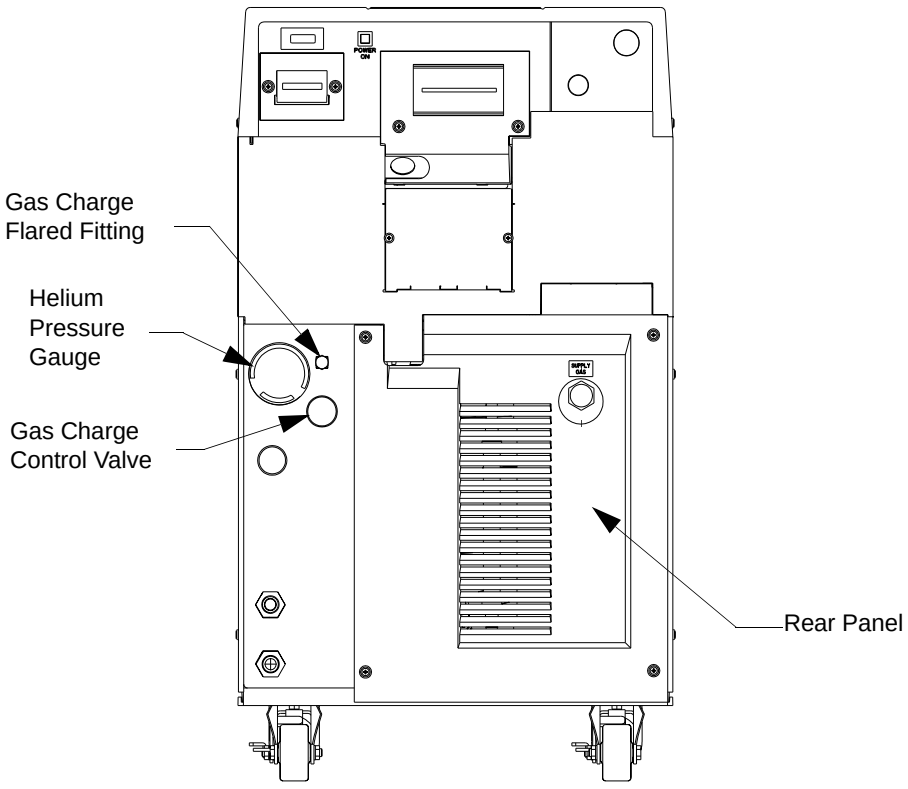


Figure 6-3: Helium Pressure Control Components

2. Open the gas charge control valve *very slowly* to allow a slight amount of helium to escape. Leave the valve open until the helium pressure gauge indicates one of the following:

   - The appropriate value is in Table 6-1 if the compressor is OFF and acclimated to a temperature between 60° F and 80° F (15.5° C - 26.6° C).
   - The value previously recorded in the Compressor Operation procedure in Chapter 4 - Operation if the compressor is ON.

3. Close the gas charge control valve and install the flare cap.

Increasing Helium Pressure

Use the following procedure to increase the helium pressure if the indicated pressure is below the appropriate value as shown in Table 6 -1.

CAUTION

If helium is being added more than once every several months, check for leaks caused by improperly connected self-sealing connections or any mechanical joint within the Compressor.

Adding Helium

NOTE: *You must obtain the normal system operating pressure from the **Compressor Operation** procedure in Section 4 - Operation in order to perform this procedure. If the normal system operating pressure is unknown, then shut the compressor OFF and perform the **Static Helium System Pressure Verification** procedure in Section 4 - Operation instead.*

This procedure ensures that both the regulator and the charging line will be purged of air and that the air trapped in the regulator will not diffuse back into the helium bottle. For best results, CTI-CRYOGENICS suggests a dedicated helium bottle, regulator, and line, which are never separated, for adding helium.

NOTE: *You are required to supply the helium charging line terminating in a 1/4-inch female flare fitting, and a two-stage pressure regulator rated at 0-3000/0-400 psig for this operation.*

CAUTION

Use only 99.999% pure helium gas. Helium circuit contamination may result if a lower quality of helium is used.

1. Attach a regulator (0-3000/0-400 psig) and charging line to a helium bottle (99.999% pure).

NOTE: *Do not open the bottle at this time.*

2. Purge the regulator and charging lines as follows:
    a. Open the regulator a small amount by turning the adjusting knob clockwise until it contacts the diaphragm, then turn it approximately 1/8 to 1/4 turn more, so that the regulator is barely open.
    b. Loosely connect the charge line to the helium pressure regulator.
    c. Slowly open the bottle valve, and purge theregulator and line for 10 to 15 seconds. Turn the regulator knob counterclockwise until the helium stops flowing.

3. Remove the flare cap of the gas charge flared fitting on the rear of the Compressor.

4. Loosely connect the charging line from the helium pressure regulator to the 1/4-inch male flare fitting installed on the helium charge valve. Purge the charge line again, as in step *a*, for 30 seconds, and tighten the charge line flare fitting onto the gas charge fitting while the helium is flowing.

5. Set the helium pressure regulator to 300 psig (20.7 bars). If the compressor is ON, proceed with step a. If the compressor is OFF, proceed with step *b*.
    a. Obtain the previously recorded *normal system operating pressure* from the **Compressor Operation** procedure in Section 4 - Operation. Open the gas charge control valve *very slowly* and allow helium to flow until the compressor gauge reading is the same as the value obtained from Chapter 4 - Operation. Quickly close the gas charge control valve.
    b. Obtain the appropriate (50 or 60 Hz) *static system operating pressure* from Table 6-1. Open the gas charge control valve *very slowly* and allow helium to flow until the compressor gauge reading is the same as the appropriate value in Chapter 4 - Operation. Quickly close the gas charge control valve.

6. Ensure that the helium charge valve on the Compressor is tightly closed. Shut off the helium pressure regulator on the helium bottle and remove the charging line from the male flare fitting. Reinstall the flare cap.

7 Appendices

Overview

The following appendices are included to provide the user with a single location for specific information related to the Brooks Automation Product.

Contents

Appendix A: Customer Support Information

Customer Support Center Locations

To locate a Customer Support Center near you, please visit our website ***www.brooks.com*** on the world wide web and select *CONTACT* on the home page.

Guaranteed Up-Time Support (GUTS®)

For 24-hour, 7-day per week Guaranteed Up-Time Support (GUTS) dial:

1 800-367-4887 - Inside the United States of America

+1 ***508-337-5599*** - Outside the United States of America

Product Information

Please have the following information available when calling so that we may assist you:

- Product Part Number
- Product Serial Number
- Product Application
- Specific Problem Area
- Hours of Operation
- Equipment Type
- Vacuum System Brand/Model/Date of Manufacture

E-mail

For your convenience, you may also e-mail us at:

techsupport@brooks.com

Appendix B: Flow Diagrams

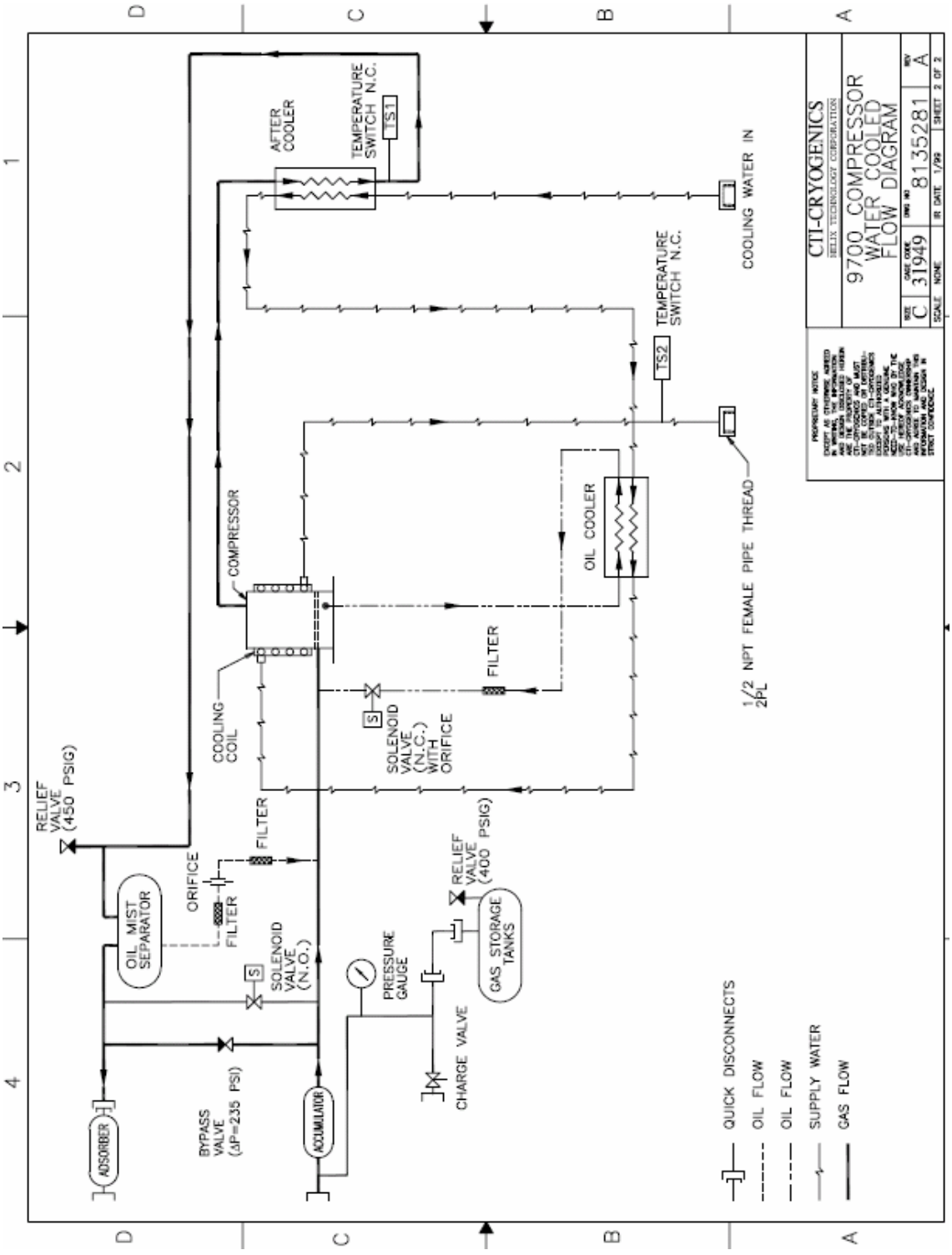


Figure 7-1: 9700A Compressor Water Cooled Flow Diagram

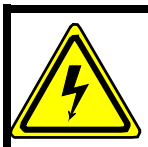
Appendix C: Troubleshooting Procedures

Troubleshooting the Compressor

The compressor troubleshooting procedures are summarized in Table 1.

Technical Inquiries

Please refer to Appendix A - Customer Suppport Information of this manual for a complete list of the CTI-CRYOGENICS' world wide customer support centers.



WARNING

Disconnect the compressor before performing any troubleshooting procedures. Do not change or modify any compressor internal wiring circuits, this may cause failure of the compressor and cold head due to improper phasing.

WARNING

The compressor pump is hot after operating. Wait for the pump to cool down before working on the inside of the compressor.

Table C-1: Compressor Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
1) System circuit breaker (CB1) trips immediately to the OFF (0) position when switched to the ON (1) position.	1) Incorrect phasing of input power.	1) Check phasing of input power. Refer to in .
2) System (CB1) and Control Circuit (CB2) circuit breakers remain in the ON (1) position when switched ON but the compressor will not run.	1) No power coming from source.	1) Check source fuses, circuit breakers, and wiring associated with the power source. Repair as needed.
	2) Insufficient power	2) Verify adequate phase-to-phase input voltage. Refer to Table 1-2.
	3) Remote control jumper plug not in place. This will apply only if remote circuit *is not* being used.	3) Check to insure that remote jumper plug is fully seated. See Figure 1-4 for location. Refer to *Compressor Remote Connector* in Chapter 1 - 9700A Compressor Description in for more information.
	4) Improperly wired external remote control circuit. **NOTE:** Only applies if remote control feature is being used.	4) Verify correct installation of remote control feature. Refer to .

Table C-1: Compressor Troubleshooting Procedures (Continued)

Problem	Possible Cause	Corrective Action
3) System circuit breaker (CB1) will not remain in the ON (1) position when switched ON. The Control Circuit circuit breaker (CB2) trips when excessive current is being drawn by the cold head or 24 volt compressor control circuits.	1) Damaged On-Board power cable, connectors, or drive motor. 2) Damaged component in the compressor power or control circuit.	1) Check for compressor operation with cryopump cable disconnected from compressor. Refer to to contact the Customer Support Center if the compressor operates improperly. 2) Refer to to contact the Customer Support Center.
4) System circuit breaker (CB1) remains in the ON (1) position and the compressor stops after several minutes of operation and remains OFF (0).	1) Thermal protective switches are open. 2) Very cold water has caused a restriction of oil flow through the oil injection orifice during start-up.	1) Check for inadequate water cooling. Refer to . 2) Recheck for proper cooling water temperature. Refer to . Restart compressor repeatedly until continuous operation is achieved.
5) System circuit breaker (CB1) trips after a period of running.	1) Loss or degradation of power from the source. 2) Defective motor windings.	1) Check that line voltage is correct on all phases. 2) Check running current on all phases. 3) Refer to to contact the local Customer Support Center.

Appendix D: Schematics

Introduction

The schematic in Appendix D supports the 9700A (Low Voltage) Compressor CTI-CRYOGENICS P/N 8135443P001.

Table D-1: Basic Control Assembly Legend

Identifier	Description
1M	Compressor Motor
J15	Module Power Receptacle
J1/P1	Autoset Power Connector
J2/P2	Unload Solenoid Connector
J3/P3	Oil Solenoid Connector
J4/P4	Thermostat
J5/P5	Thermostat
J6/P6	Compressor Contactor Coil
J7/P7	Output Connector
CB1	Main Circuit Breaker (25A)
CB2	Control Circuits Circuit Breaker (7A)
ETM1	Elapsed Time Meter
M1	Contactor 7.5 HP IEC
M1OL	Relay, Overload (16-24A)
PM1	Phase Monitor OMRON RDR-TFY-M
PWB1	PWB Autoset
T3	Transformer Assembly Control
LT1	Lamp, 24-28V LED Green
J8/P8	ETM1 Connector
J9/P9	LT1 Connector
J10/P10	T3 Input Connector
J11	Open

Table D-1: Basic Control Assembly Legend (Continued)

Identifier	Description
J12	Module Signal Connector
J13/P13	Phase Monitor
J14	Open
J15	Cryo Power Output
K2	Over Temperature Lockout Relay

Table D-2: On-Board/Cryo Electrical Module Legend

Identifier	Description
JT1	Open
JT2	Open
JT3/PT3	T2 Cold Head Supply, 2 phase
JT4/PT4	T1 Cold Head Supply, 2 phase
JT5/PT5	T2 Cold Head Transformer Output
JT6/PT6	T1 Cold Head Transformer Output
JT7/PT7	T4 Supply
JT8/PT8	T4 Low Voltage Output (23/26 VCT)
J18	Power Output
J19	Signal Output
P12	Signal Connector
P15	Power Connector
K2	Cold Head Voltage Relay
K1	Signal Voltage Relay
T1	Cold Head Supply
T2	Cold Head Supply
T4	Low Voltage Supply
J16	Three Phase Inverter Output

Table D-2: On-Board/Cryo Electrical Module Legend (Continued)

Identifier	Description
J20	Inverter Input

Table D-3: On-Board Output Module P/N 8135148G001 Legend

Identifier	Description
J30	On-Board Output Receptacle
J31	Remote Control Receptacle
P18	Power Connector
P19	Signal Connector
P31	Remote Jumper

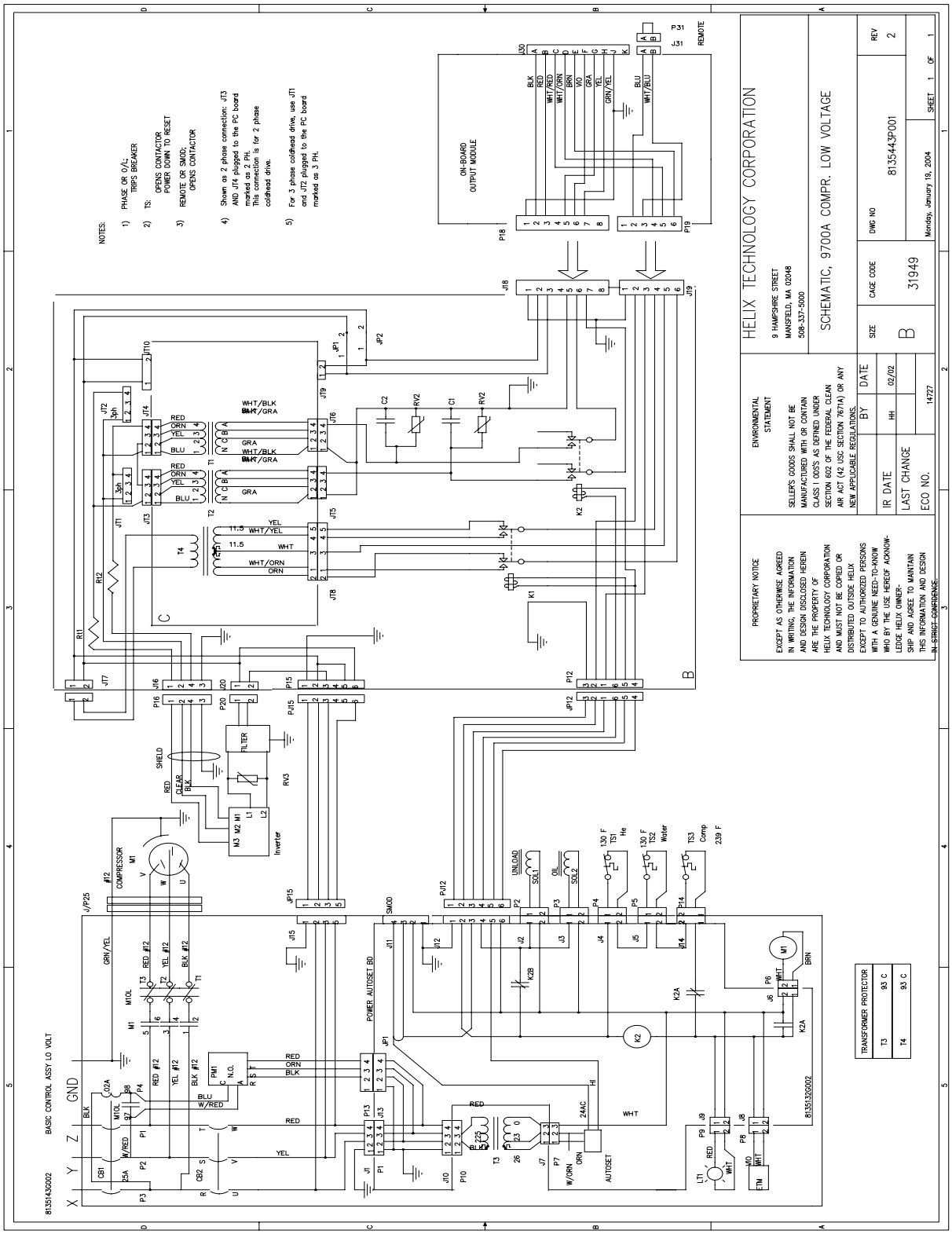


Figure 7-2: 9700A Compressor, Low Voltage P/N 8135443P001

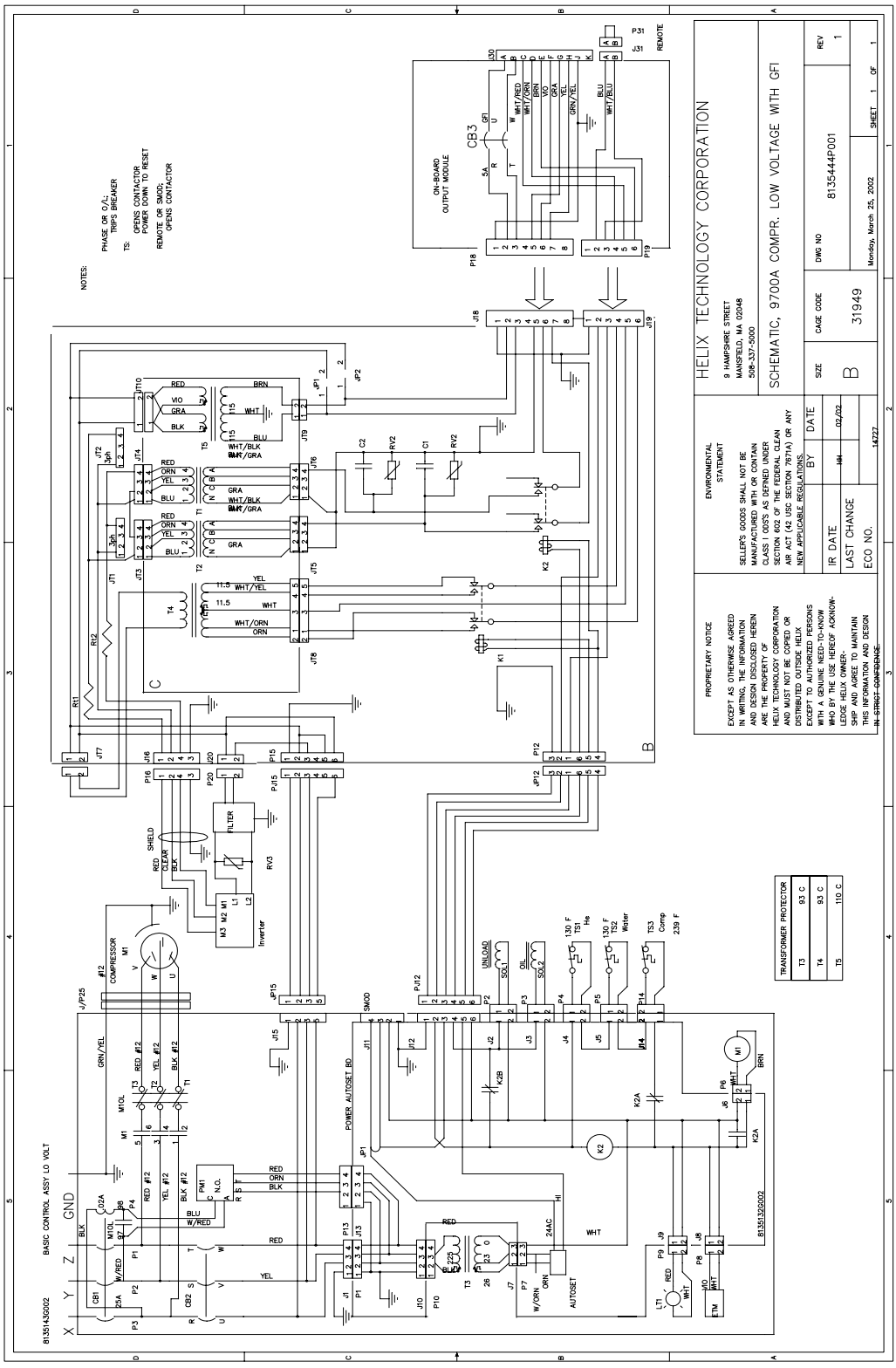


Figure 7-3: 9700A Compressor, Low Voltage, P/N 8135444P001

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