SHI-APD Cryogenics, Inc.

A Subsidiary of Sumitomo Heavy Industries Ltd.

HC-10/HC-10L Helium Compressor

Technical Manual

SHI-APD Cryogenics Inc.
1833 Vultee Street
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U.S.A.

Revision B: November 2003 **264648A**

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P/N 264648A

SAFETY

GENERAL

APD equipment is designed to operate safely when the installation, operation and servicing are performed in accordance with the instructions in this technical manual. For Service Center locations, see the Service section of this manual.

SPECIAL NOTICES

Three types of special notices -- **WARNINGS, CAUTIONS** and **NOTES** are used in this technical manual.

WARNING

WARNINGS call attention to actions or conditions that can result in injury or death.

CAUTION

CAUTIONS call attention to actions or conditions that can result in damage to the equipment or in abnormal performance.

NOTE

NOTES give important, additional information, explanations or recommendations related to the appropriate topic or procedure.

WARNINGS and **CAUTIONS**, like other safety instructions, appear within rectangles in the text where they are applicable. Because of their importance, they are summarized in this Safety section, the first section to be read.

WARNINGS

AVOID ELECTRIC SHOCK. All electrical supply equipment must meet applicable codes and be installed by qualified personnel.

Disconnect the power to the compressor before troubleshooting the electrical components.

Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in injury or death.

AVOID INJURY. Never use compressed helium gas from a cylinder without a proper regulator. Overpressure can cause personal injury if the system equipment ruptures.

During operation, some surfaces under the compressor's cover become hot. Allow the compressor to cool for 1/2 hour after shutdown before removing the cover for maintenance.

When handling pressurized gas lines and other pressurized equipment, always wear eye protection. Never apply heat to a pressurized gas line or other pressurized components.

Disconnect gas lines only when the compressor is stopped. Disconnecting the cold head while it is cold can create excessively high internal pressure as the gas warms. Material failure and uncontrolled pressure release can cause injury.

Use two wrenches when disconnecting a gas line coupling to avoid loosening the cold head or compressor coupling. Gas pressure can project the coupling with enough force to cause injury.

The refrigeration system is charged with helium gas. Vent both supply and return Aeroquip couplings to atmospheric pressure before disassembly, except when disconnecting gas lines. Uncontrolled pressure release can cause injury.

Always vent a gas-charged component before beginning to disassemble its couplings. Gas pressure can launch a loose coupling with enough force to cause injury.

CAUTIONS

PRESERVE YOUR WARRANTY. Modification to equipment without the consent of the manufacturer will void the warranty.

Specifications require the use of 99.999% pure helium gas. Using a lesser quality of helium can cause damage to the system and void the warranty.

AVOID GAS LEAKS. Check the condition of the gasket face seal on the male half of each Aeroquip coupling. Be sure the gasket face seal is in place and the sealing surfaces on both the male and female halves are clean before connecting. Replace the gasket face seal if it is damaged or missing.

Keep the gas line couplings aligned when making or breaking a coupling connection. Leaks can occur due to the weight of the gas line or due to a sharp bend near the connection.

CAUTIONS (continued)

AVOID CONTAMINATION. When checking the compressor for shipping damage, do not connect gas lines and cold head. The components may become contaminated with compressor oil.

Follow the charging or venting procedures to prevent reversed flow of system gas. Do not charge through the supply coupling. Do not vent through the return coupling. Reversed flow can contaminate the system with compressor oil.

A leaking coupling on an adsorber should not be repaired in the field. Consult a Service Center. Venting the adsorber will introduce contaminants to the system, which cannot be removed in the field.

PREVENT EQUIPMENT DAMAGE. Damage to gas lines can result from crimping by repeated bending and repositioning.

Always thoroughly drain the coolant from the cooling circuit if the compressor is to be shipped or stored.

If the compressor is wired for 380/415 (+10% -14%) V3~ electrical service, connecting to a higher voltage may damage the control circuit. Similarly, if it is wired for 480 V3~, 60 Hz, it can be damaged by connecting to 380/415 V3~.

Never pull a vacuum on the compressor or on the cold head. The motors will short circuit if started.

After starting the system for the first time, to be certain that the water lines are properly connected, check that the outlet water temperature is warmer than the inlet water.

For an installation using a water chiller or other circulating cooling system:
Use pure ethylene glycol with water for the coolant antifreeze solution. Do not use commercial ethylene glycol sold for automotive cooling systems, which usually contains a fine grit material that can damage the cooling system.

AVOID A MALFUNCTION. Repeatedly charging the system with helium gas rather than locating and repairing gas leaks can cause a malfunction. Impurities are introduced at an abnormal rate and can freeze in the cold head.

Do not allow air to get into the helium gas refrigerant of the system. Moisture from the atmosphere can seriously degrade cold head performance.

AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN. Do not tip the compressor greater than 10 degrees from horizontal, to avoid flowing oil into unwanted places.

SERVICE

SERVICE CENTERS

Eastern U.S.A.

SHI-APD Cryogenics Inc.
1833 Vultee Street
Allentown, PA 18103-4783
U.S.A.

TEL: (800) 525-3071
or
(610) 791-6750
FAX: (610) 791-3904

Western U.S.A.

SHI-APD Cryogenics Inc.
Suite G
1030 E. Duane Avenue
Sunnyvale, CA 94085
U.S.A.

TEL: (408) 736-4406/4407
FAX: (408) 736-7325

U. K.

SHI-APD Cryogenics (Europe) Ltd.
A Subsidiary of Sumitomo Heavy Industries, Ltd.
2 Eros House
Calleva Industrial Park
Aldermaston
Berkshire RG7 8LN
England

TEL: +44 1189 819373
FAX: +44 1189 817601

Asia

Sumitomo Heavy Industries, Ltd.
Service Section
Cryogenics Division
2-1-1 Yato-Cho Nishitokyo-City
Tokyo 188-8585
Japan

TEL: 81 424 68 4265
FAX: 81 424 68 4462

HEADQUARTERS

SHI-APD Cryogenics Inc.
1833 Vultee Street
Allentown, PA 18103-4783
U.S.A.

Sales and Parts

TEL: (800) 525-3072
or
(610) 791-6700
FAX: (610) 791-0440

Service

TEL: (800) 525-3071
or
TEL: (610) 791-6750

INTRODUCTION

Helium Compressor Models HC-10 and HC-10L

The compressors are designed to deliver high-pressure, oil-free helium gas to cryogenic refrigerators. Cold head cables are used with the compressor to supply electrical power to cold heads. Self-sealing couplings allow for easy connection to and disconnection from the rest of the closed-cycle cryogenic refrigeration system.

The information in this manual pertains only to the HC-10 (high voltage model) and the HC-10L (low voltage model) Compressors. Other components used to form an operating system are described in separate technical manuals.

Pressures are stated as gauge, not absolute. Pressure units are bar and pounds per square inch (psig). For reference:

1 bar = 14.5 Psig.
1 MPa = 10 bar

Definition of Symbols used in this manual and on equipment

	Mains Disconnect On		Protective Earth (Ground)
O	Mains Disconnect Off		Dangerous Voltage
	Refer to Manual	V3~	Volts, AC, 3 phase
	Type B Equipment. Type B equipment is non-patient equipment or equipment with grounded patient connections.	AT	Amps, Time delay, to describe the fuse rating

DESCRIPTION

Components

Helium High and Low Pressure Couplings - Both are self-sealing, size 8, male (8M), Aeroquip, bulkhead couplings and are the points of connection on the front panel for the gas lines.

Helium Fill Port - A size 4, male (4M), Aeroquip coupling located on the front of the compressor is used for charging or venting helium gas refrigerant.

Water In and Out Fittings - Both fittings are ½" MNPT mounted on the front panel.

Pressure Gauge - Indicates gas pressure in the supply line. When the compressor is not running, the gauge located on the compressor's front panel shows the equalization pressure.

Cold Head Power Receptacle - Mounted on the front panel for connecting a cable to supply electrical power from the compressor to the cold head.

Circuit Breakers - Two panel-mounted circuit breakers, one in the main power supply and one for the control circuit, protect the compressor from electrical overload.

Fuses - Five (5) 0.4 AT fuses are located in the electrical box. See Replace Fuses.

Electrical Chassis Box - The electrical box contains electrical components and connections and distributes power to all system circuits.

Compressor Power Cord - The power cord supplies electrical power to the compressor.

Compressor - The helium, scroll compressor has a hermetically sealed motor.

Heat Exchanger - Uses water to cool the high-pressure helium from the compressor and the compressor's lubricating oil.

Oil Separator - Removes most of the entrained oil from the gas stream. This unit needs no servicing or replacement.

Oil Capillary - The capillary returns oil collected in the oil separator sump to the compressor for recycling.

Adsorber - The adsorber removes any oil and moisture the gas is carrying which did not drop out in the separator. The adsorber has a finite life and must be replaced every 13,000 operating hours.

Pressure Relief Valve - The relief valve prevents the compressor from operating at an unsafe pressure by venting to the atmosphere.

Oil Filter - A filter in the oil separator drain line protects the return oil capillary.

Water High Temperature Switches - One each is located in the "water in" line and in the "water out" line. They shut down the compressor if the inlet or the outlet water temperature is too high. High outlet water temperature indicates low water flow. The switches reset automatically after cooldown.

Compressor High Temperature Switch - Located inside the compressor motor, the switch senses compressor motor temperature and stops the motor if the temperature is too high. The switch resets after cool down.

Supply Gas High Temperature Switch - Opens if the temperature of the high-pressure helium from the compressor is too high. The switch resets after cool down.

Oil Injection Orifice - This orifice is installed in the oil return manifold and controls the flow rate of oil returned to the compressor.

Internal By-pass Valve - The internal by-pass valve opens to allow the compressor to be operated in the stand-alone mode or when the system gas lines are disconnected, to avoid overloading the motor.

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SPECIFICATIONS

HC-10 Compressor (high voltage model) Details: Two (2) size 8M gas couplings; water-cooled; mains power supply cord with L16-20P NEMA plug; 480 (+10% -14%) V3~, 60 Hz or 380/415 (+10% -14%) V3~, 50 Hz.

HC-10L Compressor (low voltage model) Details: Two (2) size 8M gas couplings; water-cooled; mains power supply cord with L15-30P NEMA plug; 200 (+10% -14%) V3~, 50/60 Hz.

Electrical Characteristics

Service required: Delta connected, 4 wires (3 phase plus protective ground or earth.)

HC-10 (high voltage model) Compressor electric service connections: Use terminals marked "400" or "480" under the front panel power selection access cover to suit the user's electrical service. See the section Change Electric Service Connections in Installation.

Power consumption:	Operation	Startup
	6.0/6.5 kW @ 50 Hz	<8.2 kW @ 50 Hz
	6.5/6.9 kW @ 60 Hz	<8.7 kW @ 60 Hz

Main circuit protection: For the HC-10 compressor, a 16-ampere circuit breaker.
For the HC-10L compressor, a 30-ampere circuit breaker.

Control system circuit protection: For the HC-10 compressor, a 0.5-ampere circuit breaker.
For the HC-10L compressor, a 1.0-ampere circuit breaker.

All circuit breakers are located on the compressor's front panel.

Secondary circuit protection: five (5) 0.4 AT fuses. Fuses are located inside the electrical enclosure, for service by qualified electrical technician only.

Cold head power requirement: 220 V3~, 0.2 amperes, supplied from the compressor.

Cold head power supply: A cable connects the cold head to the compressor.

Class I: Grounded equipment

Ingress protection: IP4X

Compressor control logic provides:

- ON and OFF buttons for local operation of the compressor and the cold head.
- Automatic restart after power interruption.
- Front panel LCD display (16 characters) of elapsed time and system status information.
- Interlock to prevent starting the compressor and the cold head if the main power phase sequence is incorrect.
- Automatic pressure relief from an over pressure condition, set at 27.6 bar (400 psig).
- Automatic shutoff for the following system faults. Operator correction is required before restart.
  - Discharge gas high temperature, switch opens at 93° C (200° F).
  - Compressor motor windings high temperature, switch opens at 160° C (320° F), resets at 69° C (156° F).

    - HC-10 Compressor motor high current draw, trips at 12 amperes.
    - HC-10L Compressor motor high current draw, trips at 30 amperes.
    - Low helium pressure, 2.4 bar (35 psig).
    - Locked rotor
- Error warning for the following system faults:
    - Water supply high temperature: > 35° C (95° F);
    - Water low flow rate, water out: > 44° C (111° F).

See the Compressor Wiring Diagrams, Figures 6 and 7.

Front Panel Connections (See Figure 1.)

- Helium gas connections: size 8, male (8M) Aeroquip couplings, high-pressure supply and low-pressure return.
- Helium fill port: size 4, male (4M) Aeroquip coupling.
- Cooling water connections: size ½" MNPT.
- Cold head cable receptacle.
- Mains power receptacle.
- System diagnostics connector type: 25 position D-subminiature, female.

Front Panel Mounted Items (See Figure 1.)

- Supply pressure gauge (0-40 bar, 0-600 psig)
- LCD display
- ON button
- OFF button
- DISPLAY button (to scroll the LCD display)
- Mains power circuit breaker
- Control system circuit breaker

Environmental Requirements

	Operating	**Storage**
Ambient Temperature	4° C to 40° C (40° F to 104° F)	-23° C to 65° C (-10° F to 149° F)

NOTE

Operating the equipment out of specifications may void the warranty.

Mounting Position

Compressor must be mounted base down and level within 10 degrees of horizontal.

Cooling Requirements

Cooling Water Inlet Temperature:	5° C to 25° C (41° F to 77° F)
Cooling Water Outlet Temperature:	45° C (113° F) maximum
Cooling Water Supply Pressure:	8 bar (116 psig) maximum
Cooling Water Flow Rate:	5 to 8 L/min (1.3 to 2.1 gpm)
Pressure Drop at 8 L/min:	1 bar (14.5 psig)
Water Chiller Cooling Capacity:	7 kW (24,000 BTU/hour)
Alternative Coolant	50% pure ethylene glycol + 50% water
Ethylene glycol/water (50/50) flow rate	6.5 to 10.5 L/min (1.7 to 2.8 gpm)

Water Quality Requirements

Water supplied for cooling the compressor should be filtered through a 300-micron screen and meet the following quality limits:

Item	Once Through or Recycle	Supply Water in Tank
Suspended solids, µg/L	<250	<250
Particle size, µm	<300	<300
pH (25° C)	6.5 to 8.0	6.0 to 8.0
Alkalinity (ppm)	100 max.	50 max.
Hardness (ppm)	200 max.	50 max.
Chloride (ppm)	200 max.	50 max.
Sulfate (ppm)	200 max.	50 max.
Iron (ppm)	1.0 max.	0.30 max.
Sulfur ion (ppm)	None detected	None detected
Ammonium ion (ppm)	1.0 max.	0.20 max.
Silica (ppm)	50 max.	30 max.

Helium Gas Pressures

Equalization pressure at 20° C (68° F) for 12 m long gas lines: 14.6 - 14.8 bar (211 - 215 psig).

Typical operating pressures:	Supply	20.0 - 22.8 bar (290 - 330 psig)
	Return	4.8 - 6.2 bar (70 - 90 psig)

Refrigerant Quality

Refrigerant is 99.995% pure helium gas with a dew point temperature less than -50° C (-58° F) at 20.7 bar (300 psig).

Color Codes

SUPPLY (red) and RETURN (green) identification labels are furnished for the customer to attach to the gas lines, according to the procedure in Install Gas Lines.

SUPPLY (red) - Helium high-pressure gas supply from the compressor to the cold head.

RETURN (green) - Helium low-pressure gas return to the compressor from the cold head.

Space Requirements

Allow 600-mm (24") space in front of the compressor for access to electrical, water and gas connections. Allow 600 mm (24") space on the left side (when facing the front) of the compressor for maintenance of the adsorber.

Maintenance Intervals

Compressor adsorber:	13,000 operating hours (18 months)
Cold head valve and displacer seals:	13,000 operating hours (18 months)

Noise Level

< 65 dB(A)

Dimensions

Depth	453 mm
Height	567 mm excluding eye bolts (614 mm including eye bolts)
Width	446 mm

Three removable eyebolts are furnished for lifting.

Weight (approximate)

Compressor: 97.5 kg (215 pounds)

Regulatory Compliance

CE mark
Conforms to EU directives 89/336/EEC, 73/23/EEC, 98/73/EC
Applicable Standards: EN60204-1, EN60601-1-2:1993, EN55011:1991
IEC 801-2:1991, 801-3:1991, 801-4:1988, 801-5:1990

General Operating Conditions

Normal pressure and temperature data are listed above. User should record monthly the operating conditions in a logbook. Keep this record of data for reference and later comparisons.

Supplier Name and Address

SHI-APD Cryogenics, Inc.
1833 Vultee Street
Allentown, PA 18103-4783
U.S.A.
(610) 791-6700

Supplier will make available on request circuit diagrams, component parts list, descriptions, calibration instructions, or other information that will assist appropriately qualified technical personnel to repair those parts of the equipment that are designated by the manufacturer as being repairable.

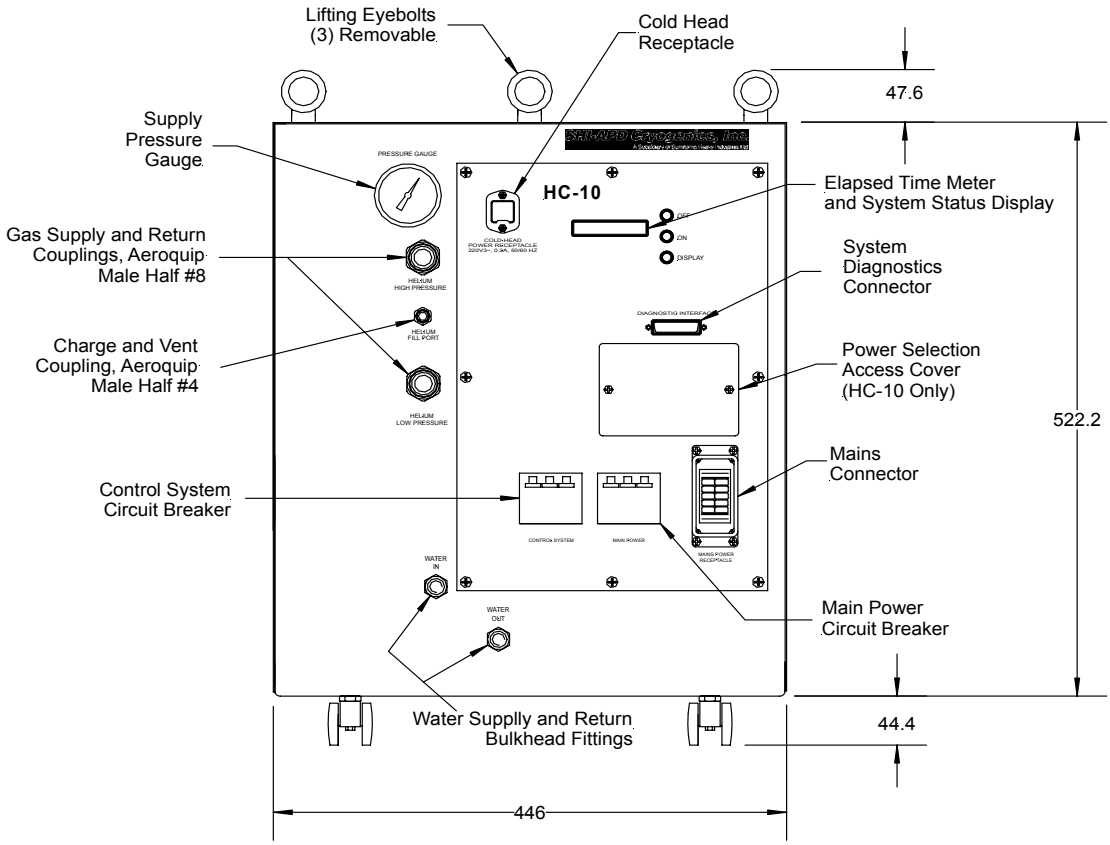

Figure 1 HC-10 and HC-10L Compressor Front View

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INSTALLATION

Introduction

Install the HC-10 or the HC-10L Compressor, Cold head, Cable and the Gas Lines according to the following procedures.

To prevent contaminating the components or the system, it is important to follow the procedures in this manual step by step.

NOTE

Be sure to have 99.995% pure helium gas available for installation of the system. See Refrigerant Quality in Specifications.

Lift the Compressor

Remove the shipping container from the compressor. Insert and tighten the three- (3) furnished eyebolts into the top of the compressor. See Figure 1.

Unpacking, Inspection and Pressure Check

1. Remove all components from their shipping containers and inspect them for damage.

CAUTION

AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN. Do not tip the compressor more than 10 degrees from horizontal to avoid flowing oil into unwanted places.

CAUTION

AVOID CONTAMINATION. When checking the compressor for shipping damage, do not connect gas lines and cold head. The components may become contaminated with compressor oil.

NOTE

Retain the shipping containers if reusable for returning the components to the factory if reconditioning is required.

2. Inspect the following:

2.1 Check the Tip-N-Tell sensor mounted on the compressor. If the Tip-N-Tell sensor shows no mishandling and there is no apparent physical damage, proceed to the section Compressor.

If the Tip-N-Tell sensor indicates mishandling (arrow point is blue), proceed to either Step **2.2** or **2.3:**

2.2 The equalization pressure is within specifications.

WARNING

AVOID ELECTRIC SHOCK. All electrical supply equipment must meet applicable codes and be installed by qualified personnel.

WARNING

AVOID ELECTRIC SHOCK. Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in injuries or death

Connect power to the compressor. See the next sections Compressor, Change Electrical Service Connections and Compressor Checkout. Test run the compressor for two (2) hours minimum. If there are no problems during this time, stop the compressor and proceed to assemble the system.

If the compressor shuts down during the two- (2) hour test, contact the nearest SHI-APD Service Center.

2.3 If the equalization pressure is outside the specified range or there is physical damage to the compressor enclosure or the compressor has been on its side or upside down for an extended period of time (more than one hour), contact the nearest SHI-APD Service Center.

If the compressor has been momentarily tipped (less than one hour) and the equalization pressure is within specifications, allow it to stand upright for two hours before running the two-hour test in Step **2.2**.

CAUTION

PREVENT EQUIPMENT DAMAGE. If the HC-10 compressor is wired for 400 V3~, 50Hz (400 +10% -14% V3~) electrical service, connecting to a higher voltage may damage the control circuit. Similarly, if it is wired for 480 V3~, 60 Hz, it can be damaged by connecting to 400 V3~.

Compressor

Place the compressor in a location that is protected from the elements and where the ambient temperature will always be within the range of 4° C to 40° C (40° F to 104° F).

CAUTION

PREVENT EQUIPMENT DAMAGE. Always thoroughly drain the coolant from the cooling circuit if the compressor is to be shipped or stored.

The compressor must be installed base down, within 10 degrees of horizontal, and preferably at a height convenient for making connections and reading the pressure gauge.

Allow 600-mm (24”) space in front of the compressor for access to electrical, water and gas connections. Allow 600-mm (24”) on the left side (when facing the front) of the compressor for maintenance of the adsorber.

The following installation procedures are based on standard arrangements of equipment, using SHI-APD Cryogenics standard components.

Mains power input wires to the HC-10 (high voltage model) Compressor must be connected to the proper transformer terminals inside the compressor.

Use terminals labeled 400 for 380/415 (+10% -14%) V3~, 50 Hz electrical service.
Use terminals labeled 480 for 480 (+10% -14%) V3~, 60 Hz electrical service.

Look through the transparent Power Selection Access Cover (shown in Figure 1) to determine and confirm that the wires are connected to the correct terminals to suit the user’s electrical service. See Figure 2.

The procedure to change connections for the alternate electrical service, if required, follows.

<u>Change Electrical Service Connections</u> [HC-10 (high voltage model) Compressor only.]

Tool required: #2 Phillips screwdriver.

The following procedure applies to the HC-10 (high voltage) Compressor only, if the wires need to be changed to the other transformer terminals. [The HC-10L Compressor (low voltage model) is permanently configured for 200 (+10% -14%) V3~, 50 Hz. No changes are required.]

WARNING

AVOID ELECTRIC SHOCK. Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in injury or death.

1. **Disconnect the mains power supply cord to the compressor.**
2. Remove the power selection access cover (see Figure 1) to gain access to the electric service terminals. The terminals are shown in Figure 2.
3. Disconnect and reconnect power input wires to appropriate terminals, as determined by the electrical service voltage.
4. Replace the cover.
5. Connect the compressor’s main power cord to the same electrical service.

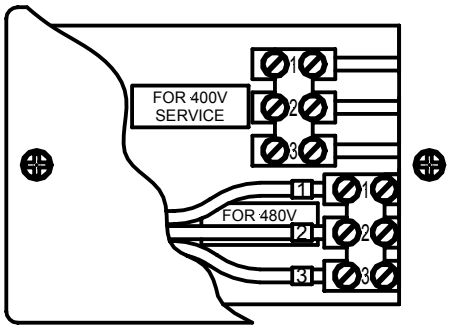

Figure 2 HC-10 Compressor Electric Service Connections

Compressor Checkout

WARNING

AVOID ELECTRIC SHOCK. All electrical supply equipment must meet applicable codes and be installed by qualified personnel. Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in injury or death.

CAUTION

PREVENT EQUIPMENT DAMAGE. If the HC-10 Compressor is wired for 400 V3~, 50 Hz (380/415 +10% -14% V3~) electrical service, connecting it to a higher voltage may damage the control circuit. Similarly, if it is wired for 480 V3~, 60 Hz, it can be damaged by connecting to 400 V3~.

The compressor should be operated before being connected to the other system components.

1. Connect coolant supply and return lines to the water in and water out fittings on the front of the compressor. Connect the supply line to the user's cooling water or coolant supply valve. Turn on the coolant and check the water lines for leaks. Tighten the fittings if necessary. See Specifications for cooling requirements.

2. For the HC-10 (high voltage model) Compressor only, look through the power selection access cover to be sure the compressor is wired to the correct voltage terminals for the electrical service.

3. Connect the power cord to the mains power receptacle on the front panel of the compressor. Be sure to lock the plug in place with the tab on the locking lever. Connect the power cord to the appropriate power source.

4. Close the main power circuit breaker (handle is up). Close the control system circuit breaker. Push the ON button. Run the compressor for ten (10) minutes, then stop.

5. While the compressor is running, lightly touch the water supply and return lines. The return (water out) line should be warmer. If the return water line is cooler than the supply (water in) line, stop the compressor and reverse the water connections.

NOTE

The compressor has reversed-phase protection to prevent it from running in reverse. If it does not start and the LCD displays “Phase Seq – ERR”, disconnect the power cord and interchange any two wires (except ground) at the compressor’s power cord plug. Refer to the Troubleshooting section in this manual.

NOTE

If the compressor starts but does not build pressure, turn it off immediately. It could be running in reverse despite the above-mentioned phase monitor relay. Be sure to rewire the power supply correctly after electrical work. See the Troubleshooting section.

This completes the checkout of the compressor.

Install the Gas Lines

Tools required: Open-end wrenches, 1", 1 1/8", 1 3/16".

Gas lines are shipped with protective dust plugs. Do not remove the plugs until the gas lines are ready to be attached. All bending and routing of gas lines should take place with plugs in place.

WARNING

PREVENT INJURY. Always wear eye protection when handling pressurized gas lines and other pressurized equipment. Never apply heat to a pressurized gas line or other pressurized components.

CAUTION

PREVENT EQUIPMENT DAMAGE. Damage to gas lines can result from crimping by repeated bending and repositioning.

NOTE

Be sure to have 99.995% pure helium gas available at the installation site in case gas needs to be added to the system. See Refrigerant Quality in Specifications in this manual.

1. Identification labels are furnished with the gas lines. Before installing the gas lines, identify each with an appropriate label, SUPPLY (high pressure, color-coded red) or RETURN (low pressure, color-coded green) by applying a label adjacent to each Aeroquip coupling. See Figure 3.

NOTE

Supply and return gas lines are identical. Labels are used to prevent making a wrong connection at installation or at reassembly following maintenance.

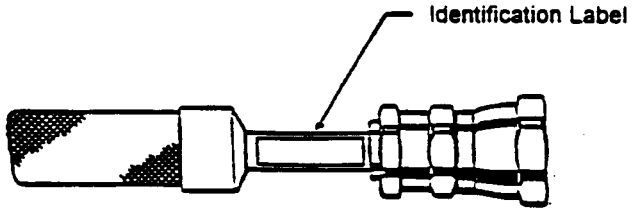

Figure 3 Attach Identification Label

2. Arrange the system components so that the gas lines will be protected from stress and traffic. Observe the minimum bend radius (see below) when routing gas lines. Provide supports for the gas lines where needed.

Gas line type	Diameter	Minimum bend radius
Helically corrugated stainless steel	13 mm (1/2") ID	180 mm (7")
Copper tubing, using a tube bender	17 mm (5/8") OD	57 mm (2 ¼")
Copper tubing, without a tube bender	17 mm (5/8") OD	460 mm (18")

3. Remove the dust caps from the compressor's supply and return gas couplings.

4.. Remove the dust plugs from the Aeroquip couplings on one end of each of the gas lines. Connect the gas lines to the compressor's high-pressure (supply) and low-pressure (return) couplings. Use two wrenches to tighten the coupling. Torque all couplings to 47 ± 7 Nm (35 ± 5 ft. lbs.) See Figure 4. Tighten each coupling before proceeding to the next one.

CAUTION

AVOID GAS LEAKS. Check the condition of the gasket face seal on the male half of each Aeroquip coupling. Be sure the gasket seal is in place and the sealing surfaces on both the male and female halves are clean before connecting. Replace the gasket seal if it is damaged or missing.

Keep the gas line couplings aligned when making or breaking a coupling connection. Leaks can occur due to the weight of the gas line or due to a sharp bend near the connection.

NOTE

Retain the dust caps and plugs to re-cover the couplings when they are not in use. They protect the couplings from damage and prevent the entry of contaminants.

5. Connect the SUPPLY gas line to the SUPPLY coupling on the cold head. Use two wrenches. Tighten the coupling to 47 ± 7 Nm (35 ± 5 ft. lbs.).

6. Connect the RETURN gas line to the RETURN coupling on the cold head. Tighten the coupling to 47 ± 7 Nm (35 ± 5 ft. lbs.).

The system equalization pressure, shown by the compressor gauge after all components have been connected, will determine if charging or venting is required.

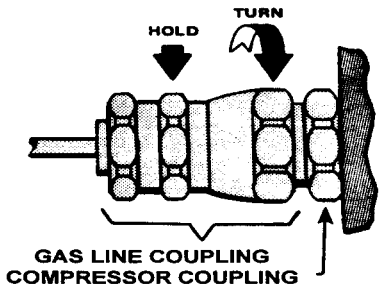

Figure 4 Connect Gas Line to Compressor or Cold head

This completes the installation procedure.

Prestart Check

1. Check that the cooling water lines are connected. Verify that the supply water is connected to the water in connection. Turn on the coolant and check the lines for leaks. Tighten the fittings if necessary. See Cooling Requirements in Specifications.
2. Check that all electric cables are connected:
   - **a.** Power to the compressor.
   - **b.** Cold head cable.
3. Check that the electrical power supply is switched on.
4. When the compressor is at room temperature, 20° C (68° F), the pressure gauge should indicate the equalization pressure. Higher or lower temperatures will result in correspondingly higher or lower pressures, but these pressure changes are normal. Abnormally lower readings indicate that some of the gas charge has been lost.

System Diagnostic Connector

A female DB-25 connector is located on the front panel to supply remote indication of the operating status of the compressor. See Figure 8 in the Troubleshooting section of this manual for connection information.

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OPERATION

Starting

Close the main power circuit breaker. Close the control system breaker. Push the ON button. The compressor and the cold head will start.

Stopping

Push the OFF button. The compressor and the cold head will stop. Open the main power circuit breaker (push handle down).

Restarting After a Power Failure

When the power comes on, the microprocessor will determine if the last shutdown was due to a power outage. If the operator turns off the system by the main breaker, it will be detected as a power outage. If the compressor power was interrupted by a power outage, the compressor and the cold head will restart automatically after a one (1) second delay.

If the compressor stops for other reasons, compressor troubleshooting is required.

CAUTION

PREVENT EQUIPMENT DAMAGE. After starting the system for the first time, to be certain that the water lines are properly connected, check that the outlet water temperature is warmer than the inlet water.

System Status Display

Normal conditions: When all systems are operating normally, with no system errors, the following lines are displayed on the LCD in the order listed below by scrolling the display. Press the DISPLAY button to scroll the LCD. Scrolling past the bottom of the display will start back at the top and repeat. If the DISPLAY button is pressed and not pressed again after 30 seconds, the display will return to the first line (ET).

Elapsed time in hours to one decimal place
Helium Press-OK
Helium Temp-OK
Water Temp-OK
Water Flow-OK
Motor Temp-OK
Phase Seq (sequence)-OK
Motor Amps-OK
Locked Rotor-OK
Micro-OK

Error conditions: If a system error occurs that causes an alarm or shutdown condition, the monitor point as listed above will change from “OK” to “ERR” and that monitor point will be scrolled to the top for display.

Any point that has not failed will continue to display OK if the operator manually scrolls the display.

If additional points fail before the operator resets the first error(s), the latest point to fail will change from “OK” to “ERR” and will be scrolled to the top for display. In this way, the operator will see the most recent fault displayed on the LCD and, by manually scrolling the display, can see other error conditions that lead up to the latest.

MAINTENANCE

WARNING

AVOID EXPOSURE. People with pacemakers or ferrous implants should avoid exposure to strong magnetic fields. The long-term effects of high magnetic fields are not well understood. Keep personal exposure to a minimum.

WARNING

AVOID INJURY. When released in a high magnetic field, ferrous tools and parts can become hazardous projectiles.

CAUTION

PREVENT DEGRADED PERFORMANCE. Failure to replace the adsorber can result in oil carryover to the cold head, degraded performance and difficult oil cleanup.

CAUTION

AVOID CONTAMINATION. A leaking coupling on an adsorber should not be repaired in the field. Consult a Service Center. Venting the adsorber will introduce contaminants to the system that cannot be removed in the field.

CAUTION

PRESERVE YOUR WARRANTY. Modification to equipment without the consent of the manufacturer will void the warranty.

HC-10/HC-10L Compressor Adsorber Replacement

The compressor's adsorber should be replaced every 13,000 operating hours (18 months). The used adsorber has no salvage or repair value. Venting the compressor is not required when replacing the adsorber because the couplings are self-sealing.

Adsorber Removal

Tools required: #2 Phillips screwdriver
Open-end wrenches, 1", 1 1/8", 1 3/16"

1. Stop the compressor and disconnect the power to the compressor.
2. Disconnect the supply (red) gas line from the supply coupling on the compressor. Screw a dust plug into the disconnected gas line.

NOTE

Always hold the stationary nut on the gas line coupling with one wrench while turning the moveable coupling with the other wrench.

3. Remove the compressor's cover panel.

4. Disconnect the self-sealing coupling on the inlet side of the adsorber. Use two wrenches.

> **CAUTION**
>
> **AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN.** Do not tip the compressor greater than 10 degrees from horizontal, to avoid flowing oil into unwanted places.

5. Use a Phillips screwdriver to remove the two screws holding the adsorber to the base.
6. Remove the locknut on the Aeroquip supply coupling on the front panel.
7. Pull the adsorber back until the supply coupling clears the front panel. Remove the adsorber. Remove the lockwasher from the Aeroquip supply coupling. Retain all hardware to reuse with the new adsorber.

> **WARNING**
>
> **AVOID INJURY.** The adsorber is charged with helium gas. Follow the used adsorber venting procedure for safe disposal of the used adsorber.

Adsorber Installation

Tools required: #2 Phillips screwdriver
Open-end wrenches, 1", 1 1/8", 1 3/16"
Loctite® 242
Snoop®

1. Remove the caps from the gas lines of the new adsorber. **Do not vent the new adsorber.**
2. Install the lock washer on to the supply coupling of the new adsorber. Insert the supply coupling through the front panel and position the adsorber.
3. Apply Loctite 242 to the threads of the two screws that fasten the adsorber to the base. Insert and tighten the screws to secure the new adsorber to the base.
4. Install the Nylon washer and the locknut on the supply coupling. Torque the locknut to 54 Nm (40-ft. lbs.).
5. Connect the adsorber's self-sealing coupling on its inlet side to the oil separator's outlet coupling. With two wrenches, torque the Aeroquip coupling to 47 ± 7 Nm (35 ± 5 ft. lbs.).
6. Reconnect the supply (red) gas line to the supply coupling on the compressor. Torque the coupling to 47 ± 7 Nm (35 ± 5-ft. lbs.).
7. Using Snoop®, leak check all Aeroquip couplings just completed. Wipe off the Snoop® to prevent rusting. See the Leak Check procedure in Maintenance in this manual.
8. Check the equalization pressure. See Specifications.
9. Reinstall the compressor's cover panel.

This completes the procedure for replacing an adsorber.

Used Adsorber Venting and Disposal

For safe disposal of the used adsorber:

1. A venting adapter fitting is included with the new adsorber. Attach it to one of the self-sealing couplings on the **used** adsorber. Vent the **used** adsorber to atmospheric pressure.

2. Discard the used adsorber and the adapter fitting.

Charging or Venting

Charging or venting is required whenever the equalization pressure of the system is outside the range as stated in the Specifications. See Specifications for equalization pressures at different ambient temperatures.

Venting a component to atmospheric pressure is required if the component needs to be disassembled for repairs or maintenance, including repairs to its self-sealing couplings.

WARNING

AVOID INJURY. Never use compressed helium gas from a cylinder without a proper regulator. Overpressure can cause personal injury if the system equipment ruptures.

CAUTION

AVOID CONTAMINATION. Follow the charging and venting procedure to prevent reversed flow of system gas. Do not charge through the supply coupling. Do not vent through the return coupling. Reversed flow can contaminate the system with compressor oil.

NOTE

Adapter fittings for charging and venting are available as optional service tools from SHI-APD. See the Parts section of this manual.

Charging Procedure

Tools required: Adapter fitting with valve, 4F Aeroquip, P/N 253757B.
Open-end wrenches, 5/8", 3/4".
Helium gas cylinder with pressure regulator and charge line.

CAUTION

AVOID A MALFUNCTION. Repeatedly charging the system with helium gas rather than locating and repairing gas leaks can cause a malfunction. Impurities are introduced at an abnormal rate and can freeze in the shield cooler.

To charge helium gas to the system:

1. Stop the compressor.

2. Locate an adapter fitting, P/N 253757B. Slightly open the adapter fitting's valve. Use two wrenches to attach it to the 4M Aeroquip helium fill port on the front of the compressor. Close the valve.
3. Connect a charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium with a dew point less than -50° C (-58° F) at 20.7 bar (300 psig).
4. When connecting the charge line to the adapter fitting, thoroughly purge the charge line from the regulator. Slightly open the valve on the adapter fitting and release a small volume of gas from the compressor. While both the charge line and the adapter fitting are purging, connect them together. It is important to remove all air contaminants to prevent them from entering the system.
5. Adjust the regulator to the required equalization pressure. See the Specifications section in this manual. **Slowly** open the valve on the adapter fitting. Charge the system with helium gas to the equalization pressure.
6. Close the valves on the adapter fitting and on the gas cylinder.
7. Disconnect the charge line from the adapter fitting. Remove the adapter fitting. Store the charge line to keep it clean.
8. Leak check the Aeroquip couplings using the procedure on page 31 in this manual

This completes the charging procedure.

Venting Procedure to Adjust the Equalization Pressure

Tools required: Adapter fitting with valve, 4F Aeroquip, P/N 253757B.
Open-end wrenches, 5/8", 3/4".

NOTE

This venting procedure is not to be used for gas cleanup of the compressor.

To vent helium gas from the system:

1. Stop the compressor.
2. Be sure the valve on the adapter fitting P/N 253757B is closed. Using two wrenches, install this adapter fitting on the 4M Aeroquip helium fill port.
3. **Slowly** open the valve on the adapter fitting. Vent the system until the required equalization pressure is attained. See Specifications. Close the valve on the adapter fitting.
4. Remove the adapter fitting from the compressor. Use two wrenches.

This completes the venting procedure to adjust the equalization pressure.

Gas Cleanup

If the equalization pressure shown by the compressor's pressure gauge is less than 1.4 bar (20 psig), gas cleanup of the compressor is required. Look for helium leaks. Perform gas cleanup.

When all system components are connected and the equalization pressure of the system is less than 1.4 bar (20 psig), check for leaks. Repair leaks. Perform gas cleanup of the system.

CAUTION

PREVENT EQUIPMENT DAMAGE. Never pull a vacuum on the compressor or on the cold head. The motors will short circuit if started.

WARNING

AVOID INJURY. Extreme cold can cause frostbite. When handling system components, be careful not to touch any frosted parts.

WARNING

AVOID INJURY. Do not splash cryogenic liquids on any areas of clothing or exposed skin. Damage to skin tissue will result. Always wear eye protection.

WARNING

AVOID ASPHYXIATION. Be sure the work area is well ventilated.

WARNING

AVOID INJURY. For a cold head mounted in an evacuated sleeve that remains cold, break the vacuum with helium. Do not allow air or nitrogen to enter the sleeve. Air and nitrogen can liquefy and freeze, then create high pressure when they warm.

WARNING

AVOID INJURY. When released in a high magnetic field, ferrous tools and parts can become hazardous projectiles.

WARNING

AVOID EXPOSURE. People with pacemakers or ferrous implants should avoid exposure to strong magnetic fields. The long-term effects of high magnetic fields are not well understood. Keep personal exposure to a minimum.

WARNING

AVOID INJURY. Disconnect gas lines only when the compressor is stopped. Disconnecting the cold head while it is cold can create excessively high internal pressure as the gas warms. Material failure and uncontrolled pressure release can cause injury.

Tools required: 2 adapter fittings with valve, 8F Aeroquip, 255919B2.
Open-end wrenches, 1", 1 1/8" and 1 3/16".
Helium gas cylinder with pressure regulator and charge line.

Gas cleanup is required if the compressor's interior has been opened to the atmosphere or the equalization pressure is 1.4 bar (20 psig) or lower. Gas cleanup is performed with the compressor disconnected from the other system components.

NOTE

If the compressor's interior has been exposed to the atmosphere for an extended period, gas cleanup may not suffice to guarantee system gas purity. Contact an SHI-APD Service Center.

1. Disconnect the gas lines from the compressor. Plug the disconnected gas line couplings.
2. Locate two adapter fittings P/N 255919B2. Be sure their valves are closed. Attach them to the supply and return Aeroquip couplings on the compressor.
3. Connect a charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium gas with a dew point less than -50° C (-58° F) at 20.7 bar (300 psig). Adjust the gas cylinder pressure regulator to 0.35 bar (5 psig).
4. While connecting the charge line to the adapter fitting on the compressor's return coupling, thoroughly purge the charge line from the regulator. It is important to remove all air contaminants to prevent them from entering the system.
5. Adjust the pressure regulator to 15.2 bar (220 psig). Open the valve on the adapter fitting and charge the compressor to 15.2 bar (220 psig).
6. Close the valve on the adapter fitting used for charging.
7. Run the compressor for at least 30 minutes to heat the oil to operating temperature. Stop the compressor.
8. Open the vent valve on the supply coupling of the compressor. Watch the compressor's pressure gauge. When the pressure falls to 0.35 to 0.7 bar (5 to 10 psig), close the vent valve. Open the charge valve to increase the pressure to 15.2 bar (220 psig). Close the charge valve.
9. Start the compressor.
10. After running 30 to 45 seconds, stop the compressor. Open the vent valve and vent the compressor to 0.35 to 0.70 bar (5 to 10 psig). Close the vent valve.

11. Repeat steps 8, 9 and 10 ten (10) times, and then go to Step 12.

12. Open the charge valve on the adapter fitting. Charge the compressor to the equalization pressure. Close the charge valve.

13. Allow the compressor to cool. Read the pressure gauge with the compressor at 20° C (68° F). Adjust the equalization pressure by charging or venting to conform to the Specifications.

14. Close the gas cylinder valve and adjust the pressure regulator to zero psig.

15. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.

16. Remove both adapter fittings.

17. If other components need cleaning, perform the appropriate procedures. Otherwise, reconnect the supply and return gas lines. Torque the gas line couplings to 47 ± 7 Nm (35 ± 5 ft. lbs.).

18. Leak check the Aeroquip couplings. See Leak Check.

This completes the gas cleanup procedure for the compressor.

Leak Check

In addition to identifying suspected leaks, check the compressor for helium leaks each time it has undergone any amount of disassembly. Use a helium mass spectrometer leak detector if available. Follow its manufacturer's instructions.

If a leak detector is not available, use a commercial leak detection solution such as Snoop®. However, small leaks may not be detected. Also, it is important to:

- fully coat the joint being tested;
- allow time for bubbles to form at a small leak;
- look carefully for the smallest bubble formations.

After solution testing is completed, use water to wash all residues from joints and couplings.

In either method of testing, do not assume that the first found leak is the only one. Check all joints.

Leak detection by instruments can be misleading. Leaking gas can form patterns that indicate leaks at sound joints. Large leaks or a high gas concentration can make isolation difficult.

Leaks occur most frequently at threaded joints. However, they can occur also at brazed and welded joints.

The flat gasket in the face of the Aeroquip male coupling seals the joint. A leak at this gasket face seal can be detected only when a gas line is connected. A leak here can be caused by:

- the coupling not fully tightened;
- a worn, damaged, or missing gasket seal;
- dirt on or under the gasket seal;
- dirt on the female coupling's mating surface;
- damaged parts on either coupling which prevent proper mating or sealing.

Leak Repair

Leaks in flexible metal tubing cannot be repaired. Discard the damaged gas line and install a new one.

Leaks at welded joints require special skills to repair. Consult a SHI-APD Service Center.

Replacing worn or damaged parts can repair leaks at the self-sealing couplings. Vent the compressor before beginning to disassemble it.

Tightening the coupling frequently stops leaks at threaded joints. Continued leakage after tightening requires coupling repair. Install new O-rings or Teflon tape as required.

Replace the Power Cord

1. Stop the compressor and disconnect the power to the compressor at the power source.
2. At the mains power receptacle, open the locking lever. Pull the power cord plug from the receptacle.
3. Look at the pins in the receptacle and orient the plug of the replacement power cord to suit. Insert the plug of the replacement power cord into the receptacle. Lock the plug to the receptacle by closing the locking lever.

Replace a Slide Rail

Tool required: #2 Phillips screwdriver

CAUTION

AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN. Do not tip the compressor greater than 10 degrees from horizontal, to avoid flowing oil into unwanted places.

NOTE

This procedure assumes that the compressor's casters have been removed.

1. Elevate the compressor for access to its bottom. Do not tip the compressor more than 10 degrees.
2. Using a Phillips screwdriver, remove the three screws and lock washers that attach the slide rail to the bottom panel of the compressor. Retain the screws and washers.
3. Install a replacement slide rail using the hardware previously removed.
4. Lower the compressor to rest on its slide rails.

Replace the Front Locator Plate

Tool required: #2 Phillips screwdriver

1. Using a Phillips screwdriver, remove the three screws and washers holding the front locator plate to the compressor's front panel. Remove the locator plate.
2. Attach a new locator plate to the front panel using the previously removed screws and washers.

Remove or Replace a Caster

Tools required: #2 Phillips screwdriver
Open-end wrench, 7 mm
Ratchet drive wrench
3" extension for ratchet drive wrench
20" extension for ratchet drive wrench (for the caster nearest the adsorber)
Socket wrench, 17 mm

CAUTION

AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN. Do not tip the compressor greater than 10 degrees from horizontal to avoid flowing oil into unwanted places.

NOTE

Use the following procedure to remove or replace casters on compressors shipped prior to November 2001.

1. Stop the compressor and disconnect the power from the compressor.
2. Remove the compressor's cover.
3. Elevate and support the corner of the compressor near the caster to be replaced. Do not tip the compressor more than 10 degrees.
4. Use a ratchet wrench, appropriate extension and a 17 mm socket to remove the hex nut on top of the caster stem from inside the compressor enclosure. Keep the caster stem from turning by holding it between its wheels with a 7 mm open-end wrench. Remove the caster.
5. Install a new caster using the tools in step 4.
6. Lower the compressor to rest on its casters.
7. Replace the compressor's cover.
8. Reconnect the power to the compressor.

NOTE

Use the following procedure to remove or replace casters on compressors shipped during and after November 2001.

Tool required: Open-end wrench, 7 mm

1. Stop the compressor and disconnect the power from the compressor. It is not necessary to remove the compressor's cover.
2. Elevate and support the compressor base about 3 ½" to 4" above the work surface. Do not tip the compressor more than 10 degrees.
3. Using a 7 mm open-end wrench on the flat of the caster's stem, turn the stem to remove it from the nut inside the compressor's base. Continue to remove the other casters.

4. Install new casters if required, using the 7 mm wrench.
5. Lower the compressor to rest on either its casters or its Nylon slide rails.
6. Reconnect the power to the compressor.

Replace a Lifting Eyebolt

Tool required: Screwdriver or wrench extension, if required

1. Use a tool through the eyebolt for removal if it is too tight to turn by hand.
2. Inert a replacement eyebolt. Tighten it hand tight or slightly more by use of a tool to turn it.

Replace an Aeroquip Coupling Face Seal

Tool required: Needle or a narrow, flat blade screwdriver

From repeated connecting and disconnecting the coupling, the gasket face seal just inside the face of a male coupling might begin to leak and require replacement.

1. Carefully pierce or pry the old gasket face seal and pull it from its recessed ring in the body of the coupling. Discard the face seal.
2. Using isopropyl alcohol on a clean, cotton swab, carefully remove any remaining adhesive from the coupling's recess. Avoid getting alcohol on the face of the poppet.
3. Dry the recessed surface with a clean, lint free cloth.
4. Do not apply any adhesive. Press a new gasket seal into the recessed ring.

TROUBLESHOOTING

WARNING

AVOID ELECTRIC SHOCK. Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in injury or death.

WARNING

AVOID ELECTRIC SHOCK. Disconnect the power to the compressor before troubleshooting the electrical components.

WARNING

AVOID INJURY FROM BURNS. During operation, some surfaces under the compressor's cover become hot. Allow the compressor to cool for ½ hour after shutdown before removing the cover for maintenance.

CAUTION

PRESERVE YOUR WARRANTY. Modification to equipment without the consent of the manufacturer will void the warranty.

Compressor Motor

Compressor motor checks for winding continuity, resistance and grounding will isolate most motor electrical problems. When the checks indicate a faulty compressor, a replacement is needed. Contact a Service Center.

Winding Continuity, Grounding and Resistance Checks

Tools needed: Ohmmeter or multimeter
#2 Phillips screwdriver

The following electrical measurements to check the compressor motor may be made either at the compressor terminals or at the motor contactor.

1. Disconnect the power to the compressor.
2. Remove the cover, side panels and rear panel from the compressor.
3. Remove the terminal box cover from the side of the compressor motor to expose the three terminals T_1, T_2 and T_3. It is not necessary to remove the wires from their terminals.
4. With an ohmmeter, check the resistance across pairs of compressor terminals. Resistance should be about 2.6 ± 10% ohms in each leg, at room temperature. If there is no continuity, there is an open circuit in the motor windings. Consult an SHI-APD Service Center.

5. With the ohmmeter, check for continuity between the motor windings and one of the unpainted tubes entering the compressor housing. Use the three compressor terminals and one of the stainless steel tubes from the compressor. If there is continuity, there is a short circuit to ground in the motor windings. Consult an SHI-APD Service Center.
6. If the motor passes these electrical checks, replace the terminal box cover and the compressor's cover.

Check the Oil Level

Two oil sight glasses are mounted in the compressor's shell, one near the top and one below. After the compressor has been running at least twenty (20) minutes, oil levels should be visible about the middle of each sight glass.

When the compressor is not running, oil may not be visible in the top sight glass.
Oil is not to be added to the compressor in the field.

Locked Rotor Fault

Consult a SHI-APD Service Center.

Replace Fuses

Tool required: #2 Phillips screwdriver.

Five (5) 0.4AT fuses, FU1 through FU5, are located in the electrical box. Their fuse blocks are attached to a bracket fastened to the transformer. See Figure 5. If the LCD display reads Fuse ERR, check FU3, FU4 and FU5. If both circuit breakers are closed and the LCD display is blank, check FU1 and FU2.

1. Stop the compressor and disconnect the power to the compressor.
2. Remove the compressor's cover.
3. Remove the cover from the electrical box.
4. Remove, inspect or check each fuse to find a blown fuse(s). Replace the defective fuse(s).
5. Reinstall the cover on the electrical box.
6. Reinstall the compressor's cover.
7. Reconnect the power to the compressor.

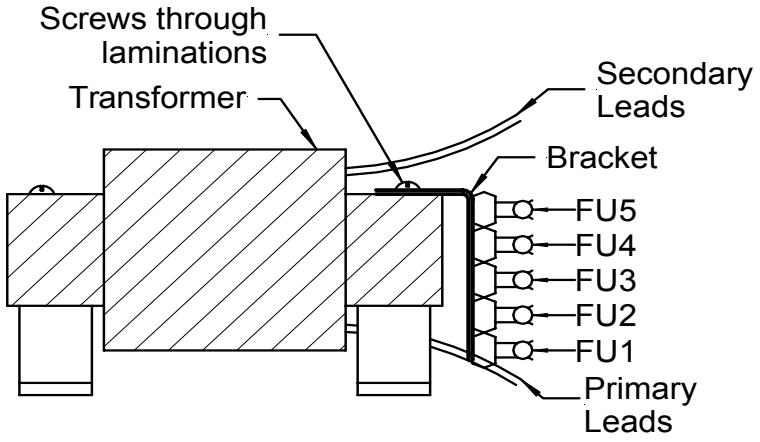


Figure 5 Fuse Blocks Mounted to Transformer

Service the Electrical Chassis

Tools required: #0 Phillips screwdriver
#2 Phillips screwdriver
Phillips torque screwdriver, 1.1-1.4 Nm (10-12 in. lbs.)
Needle nose pliers
Open-end wrenches 1", 1 1/8", 1 3/16"
Loctite® 242
Snoop®

Failures in the electrical system may make it necessary to replace the electrical chassis assembly or remove it to repair individual components. Perform the following steps to remove the electrical chassis assembly from the compressor.

1. Read and record the elapsed time on the LCD display of the old unit. Contact an SHI-APD Service Center to report the elapsed time meter reading.

WARNING

AVOID ELECTRIC SHOCK. Disconnect the power to the compressor before troubleshooting the electrical components.

2. Stop the compressor and disconnect the power to the compressor.
3. Use a Phillips screwdriver to disconnect the electrical cable from the compressor motor at the compressor's electrical junction box.
4. Use needle nose pliers to disconnect the two wires from each of the three- (3) temperature switches (ST2, ST3 and ST4). Remove the adsorber to gain access to the two water temperature switches. Follow the procedure Adsorber Removal in the Maintenance section. Retain all hardware and parts for reinstallation.
5. Disconnect the pressure switch (SP1) wires at the connector fastened to the heat exchanger bracket.

6. Remove the screws and lock washers on the front panel of the electrical chassis. Retain the screws and washers.
7. Carefully pull the electrical chassis away from the front panel of the compressor. Carefully feed the wiring harness through the grommet in the electrical enclosure while removing the chassis. The electrical enclosure remains in the front panel of the compressor.
8. Install the new electrical chassis. Reconnect the wires and cable removed in steps 3, 4 and 5. Using a Phillips torque screwdriver, tighten the electrical cable wires to the compressor's terminals in the junction box to 1.1 to 1.4 Nm (10 to 12 in. lbs.).
9. Reinstall the adsorber, using the procedure Adsorber Installation in the Maintenance section. Include leak checking the Aeroquip couplings with Snoop®.
10. Reinstall the front panel of the electrical chassis.
11. Replace the compressor's cover.
12. Reconnect the power to the compressor.
13. Start the compressor to check that it runs properly.

This completes the procedure for replacing the electrical chassis.

Replace the Supply Gas High Temperature Switch

Tools required: #0 Phillips screwdriver
#2 Phillips screwdriver
Needle nose pliers

1. Stop the compressor and disconnect the power to the compressor.
2. Using a Phillips screwdriver, remove the compressor's cover. Retain the screws and lock washers for reinstallation.
3. The gas high temperature switch is fastened to the supply gas tube, the highest stainless steel tube attached to the compressor. With the needle nose pliers, disconnect the two wires from the switch.
4. Use the #0 Philips screwdriver to remove the switch from the supply gas tube. Retain the screws and lock washers.
5. Attach a replacement switch, using the hardware previously removed.
6. Reattach the two wires to the terminals on the switch.
7. Replace the compressor's cover.
8. Reconnect the power to the compressor.

Replace the Water High Temperature Switch(s)

Tools required:
#0 Phillips screwdriver
#2 Phillips screwdriver
Needle nose pliers
Open-end wrenches 1", 1 1/8", 1 3/16"
Loctite® 242
Snoop®

1. Stop the compressor and disconnect the power to the compressor.
2. Using a Phillips screwdriver, remove the compressor's cover. Retain the screws and lock washers for reinstallation.
3. The water temperature switches are fastened to the water supply and water return copper tubes directly behind the front panel. The adsorber must be removed to gain access to the temperature switches. Follow the procedure Adsorber Removal in the Maintenance section. Retain all hardware and parts for reinstallation.
4. Having determined which switch needs to be replaced, use a needle nose pliers to remove the two wires from the switch terminals.
5. Use a #0 Phillips screwdriver to remove the screws and lock washers fastening the switch to the water tube. Retain the screws and washers.
6. Install a replacement switch using the hardware previously removed.
7. Reattach the two wires to the switch terminals.
8. Reinstall the adsorber, using the procedure Adsorber Installation in the Maintenance section. Include leak checking the Aeroquip couplings with Snoop®.
9. Replace the compressor's cover.

Error Conditions

An error condition will cause either a system alarm or a shutdown. The following table lists the alarm and the shutdown errors that are monitored.

LCD Display First Line	Type	Error	Indication	System Diagnostic Connector, +24V on pin number
Helium Temp-ERR	Shutdown	High helium discharge temperature	ST2, Temperature switch, open on high temperature error.	18
Water Temp-ERR	Alarm	High water supply temperature.	ST3, Temperature switch, open on high water inlet temperature error.	14
Water Flow-ERR	Alarm	Low water flow	ST4, Temperature switch, open on high water outlet temperature error.	15

(Table is continued on the next page.)

LCD Display First Line	Type	Error	Indication	System Diagnostic Connector, +24V on pin number
Motor Temp-ERR	Shutdown	High compressor motor winding temp	ST1, motor winding Klixon opens. No current flow to compressor motor.	20
Phase Seq-ERR	Alarm	Phase sequence	Monitored by microprocessor	17
Motor Amps-ERR	Shutdown	Locked rotor	Auxiliary contact on overload relay is open.	
Locked Rotor-ERR	Shutdown	3 locked rotor errors	Monitored by microprocessor	
Micro-ERR	Alarm	Microprocessor internal diagnostics as required	Monitored by microprocessor	

If the compressor has been shut down by one of these interlocks, do not restart until the problem has been found and corrected. Refer to the Troubleshooting Guide to identify the problem.

In the event of a shutdown error, the compressor motor and cold head valve motor are turned off. The microprocessor will annunciate the error condition via 24 VDC signals at the System Diagnostics Connector and via the LCD Display. Signals are available on the 25-pin connector for output to an external device. See Figure 8.

Clearing Error Conditions

When an error is corrected, the message(s) can be cleared from the display and the system diagnostics connector by any of the following procedures:

- Apply a momentary signal to pin 3 of the system diagnostics connector, or
- Press the ON and DISPLAY buttons simultaneously, or
- Open the control system circuit breaker, then close it to turn the power on.

Restarting after an Error Condition

When the shutdown is caused by any of the high-temperature switches, the compressor will restart only after it has cooled enough for the switch to close. After waiting for the compressor to cool, clear the error message then push the ON button to restart. Should the compressor fail to start, allow more cooling time. Repeat the restart procedure. Check cooling water temperature and flow. Compare with Specifications.

The motor high winding temperature relay automatically resets after the compressor shuts down and the relay cools. This typically takes about 30 minutes. To restart the compressor, clear the error message then push the ON button. If the compressor fails to start, allow more cooling time. Repeat the restart procedure.

If the circuit breaker opens, reset it by pushing the lever to OFF (handle down), then to ON (handle up). The compressor and the cold head should start automatically.

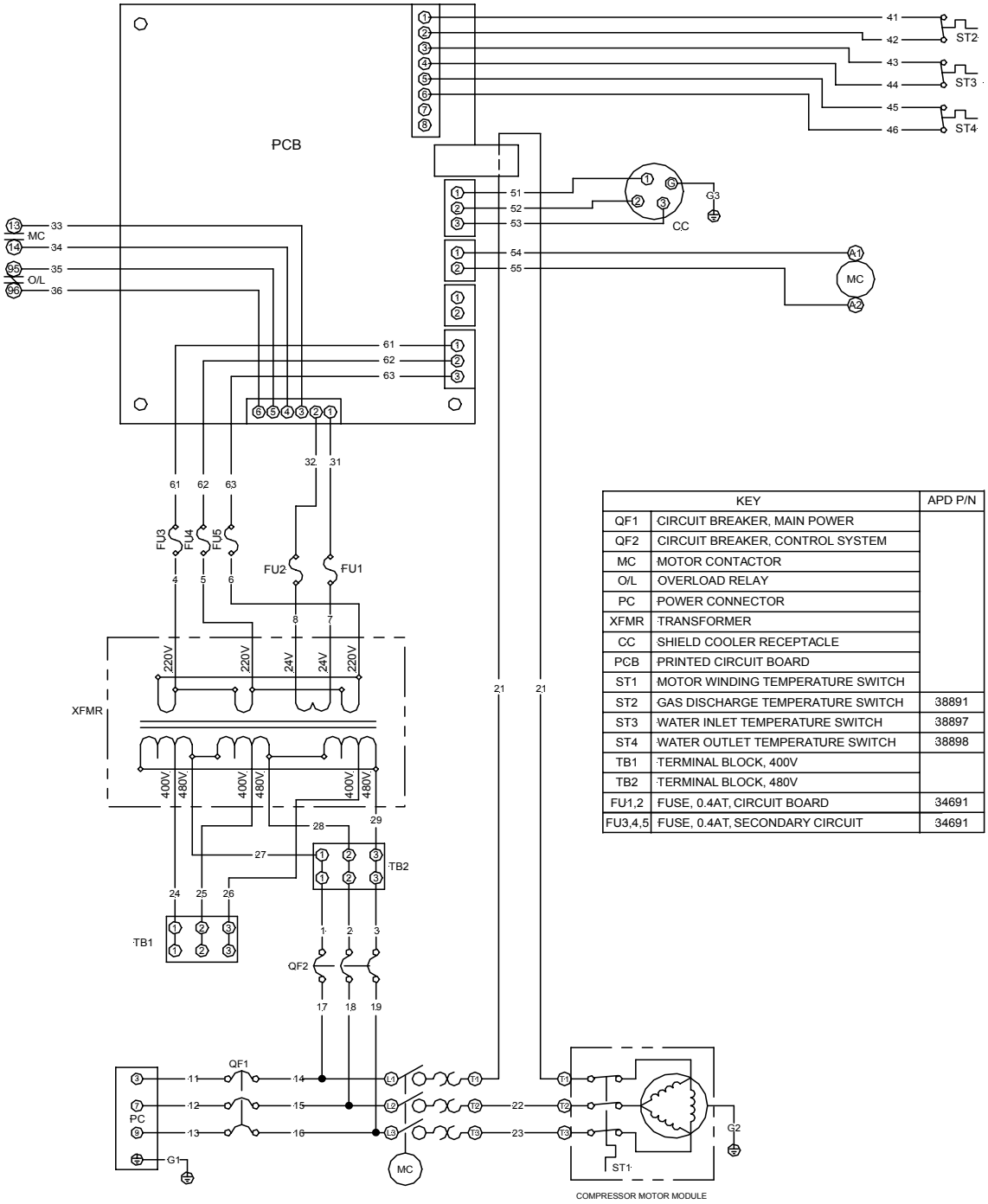
Troubleshooting Guide

The Troubleshooting Guide that follows lists problems that can occur in the system and suggests causes and corrective actions.

Problem	Possible Cause	Corrective Action
System shutdown LCD reads Helium Press-ERR	Helium gas leak.	Locate leak and repair. Recharge the system. Restart. Leaks other than at Aeroquip couplings require factory service.
System shutdown LCD reads Helium Temp-ERR	Oil has been pumped from the coolant loop to the compressor's lower sump.	Try two times to restart the compressor. If it does not start, consult a Service Center.
		Check the oil level in the upper sight glass of the compressor. Oil should be visible after the compressor has been operating for 15 minutes. Contact a Service Center if the oil is not visible.
	Supply water temperature is too high.	Scroll LCD display. If Water Temp-ERR is indicated, supply water temperature is too high. Provide 5° C to 25° C cooling water.
	Water flow rate is inadequate.	Scroll LCD display. If Water Flow-ERR is indicated, the water flow rate is too low. Set water flow rate at 5 to 8 L/min.
System shutdown LCD reads Motor Temp-ERR	Compressor motor windings high temperature switch opens. Compressor motor windings have overheated.	Scroll LCD display. If Water Temp-ERR or Water Flow-ERR is indicated, cooling water is inadequate. Refer to specifications. Consult a Service Center if the problem persists. Allow about 30 minutes for the windings to cool enough for the switch to reset.

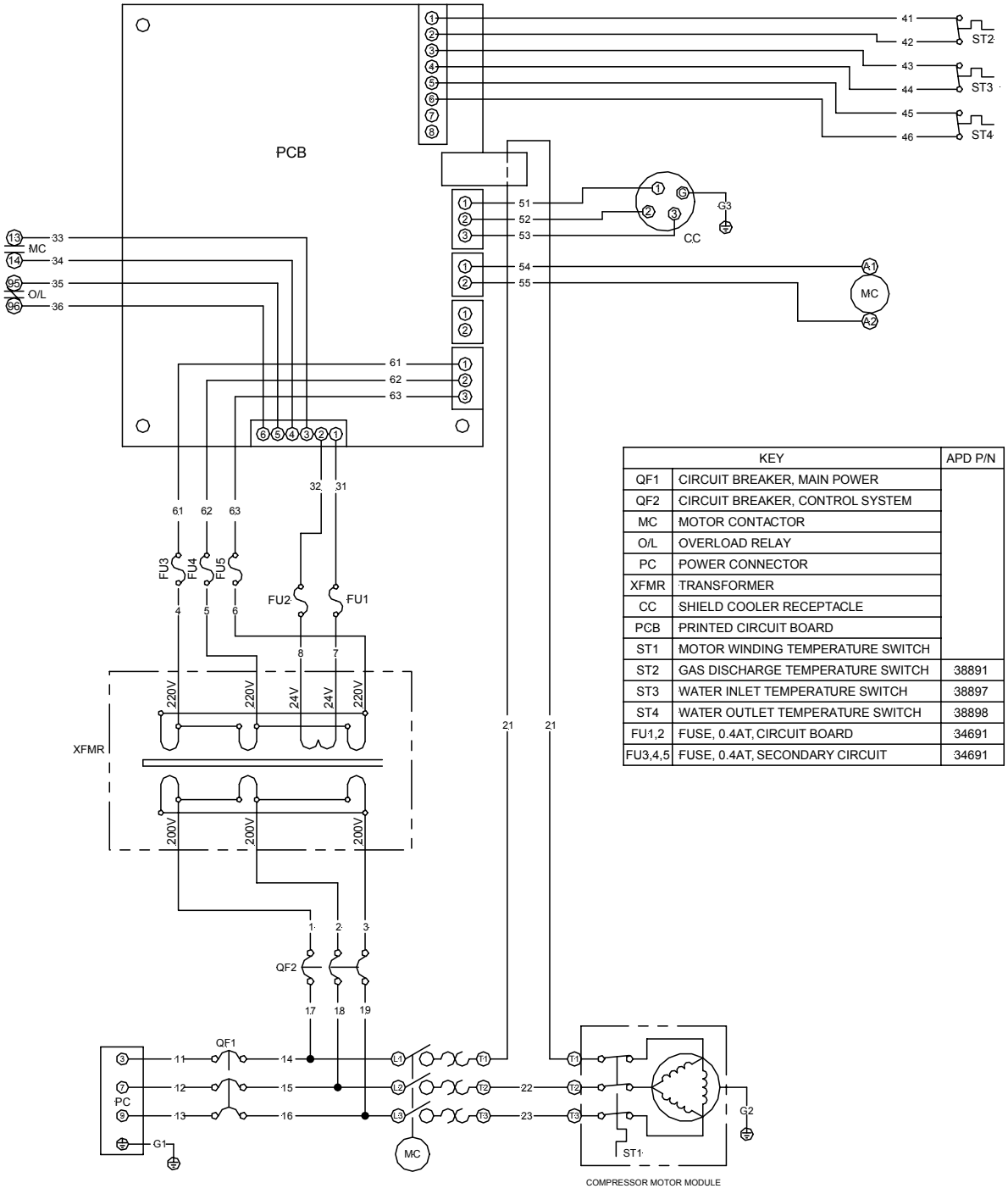
Problem	Possible Cause	Corrective Action
System shutdown LCD reads Motor Amps-ERR.	Compressor motor high current switch opened.	If water and power checks indicate utilities are within specifications, interlocks may be faulty. Consult a Service Center.
System shutdown LCD reads Locked Rotor-ERR.	Compressor has shutdown on three (3) Motor Amps-ERR.	Do not attempt to restart. Consult a Service Center.
Compressor and cold head motor do not start when the start switch on the compressor is pushed.	No electrical power.	Check that the power source is on and the power conductors are connected.
	Wrong voltage.	Compare customer's electric service with system specifications.
	Main power phase sequence is wrong.	Interchange any two- (2) incoming power leads (except ground) at the compressor's power cord plug or at the user's disconnect switch.
	Defective component in the power circuit.	Refer to Compressor Motor troubleshooting in this section.
	Tripped circuit breaker on the front panel.	Reset the circuit breaker.
Compressor starts but shuts down later.	Insufficient coolant for the compressor	Check the coolant flow and temperature. Refer to Specifications.
	Circuit breaker is open.	Reset the circuit breaker. Compare electric service with the system specifications. Consult a Service Center if the problem persists.
System starts but gas pressure is abnormally high or low.	Wrong equalization pressure.	Refer to Specifications and the section on Charging or Venting.
	Gas line couplings are not fully engaged.	Be sure that all gas couplings are fully engaged and torqued.

Problem	Possible Cause	Corrective Action
System starts but gas pressure is abnormally high or low. (continued)	Gas lines are connected wrong.	Reconnect. See the Installation section.
Cold head motor does not start when the compressor starts.	Cold head cable is not connected.	Stop the compressor. Connect the cable. Check connections at the cold head and at the compressor.
	Open circuit in the cold head cable.	Disconnect the cable. Check each conductor for continuity. Replace the cable if necessary.
Cold head motor hums but does not start.	Open circuit in the cold head cable.	Disconnect the cable. Check each conductor for continuity. Replace the cable if necessary
	Valve disc stalled on the valve stem.	Check the system equalization pressure. Consult a Service Center.
Cold head motor runs, but there is no cooldown.	Gas line couplings are not fully engaged.	Be sure that all gas couplings are fully engaged and torqued.
	Gas Lines are connected wrong.	Reconnect. See the Installation section.
Intermittent operation.	Compressor is cycling on and off.	Check input power, coolant flow and temperature. Compare with Specifications.
Loss of refrigeration capacity.	Compressor malfunction.	Check input power, coolant flow and temperature. Compare with Specifications.
Compressor shuts down, LCD display is blank, and circuit breaker is closed.	Fu1 or Fu2 fuse is blown.	Contact a Service Center to have a qualified electrical technician replace the fuse inside the electrical enclosure.
System shuts down, no error message on the LCD.	Fu3, Fu4 or Fu5 fuse is blown.	Contact a Service Center to have a qualified electrical technician replace the fuse inside the electrical enclosure.



KEY		APD P/N
QF1	CIRCUIT BREAKER, MAIN POWER	
QF2	CIRCUIT BREAKER, CONTROL SYSTEM	
MC	MOTOR CONTACTOR	
O/L	OVERLOAD RELAY	
PC	POWER CONNECTOR	
XFMR	TRANSFORMER	
CC	SHIELD COOLER RECEPTACLE	
PCB	PRINTED CIRCUIT BOARD	
ST1	MOTOR WINDING TEMPERATURE SWITCH	
ST2	GAS DISCHARGE TEMPERATURE SWITCH	38891
ST3	WATER INLET TEMPERATURE SWITCH	38897
ST4	WATER OUTLET TEMPERATURE SWITCH	38898
TB1	TERMINAL BLOCK, 400V	
TB2	TERMINAL BLOCK, 480V	
FU1,2	FUSE, 0.4AT, CIRCUIT BOARD	34691
FU3,4,5	FUSE, 0.4AT, SECONDARY CIRCUIT	34691

Figure 6 HC-10 Compressor Wiring Diagram



KEY		APD P/N
QF1	CIRCUIT BREAKER, MAIN POWER	
QF2	CIRCUIT BREAKER, CONTROL SYSTEM	
MC	MOTOR CONTACTOR	
O/L	OVERLOAD RELAY	
PC	POWER CONNECTOR	
XFMR	TRANSFORMER	
CC	SHIELD COOLER RECEPTACLE	
PCB	PRINTED CIRCUIT BOARD	
ST1	MOTOR WINDING TEMPERATURE SWITCH	
ST2	GAS DISCHARGE TEMPERATURE SWITCH	38891
ST3	WATER INLET TEMPERATURE SWITCH	38897
ST4	WATER OUTLET TEMPERATURE SWITCH	38898
FU1,2	FUSE, 0.4AT, CIRCUIT BOARD	34691
FU3,4,5	FUSE, 0.4AT, SECONDARY CIRCUIT	34691

Figure 7 HC-10L Compressor Wiring Diagram

Pin #	Function
3	Reset. System error conditions are acknowledged and cleared from the display and memory on momentary application of a +24 VDC signal to this pin. Input is optoisolated.
4	System OFF. The compressor and cold head will turn off on the momentary application of +24 VDC to this pin. Input is optoisolated.
6	ON/OFF. The compressor and cold head will turn on when +24 VDC signal is applied to this pin. They will turn off when the signal is removed. Input is optoisolated.
12	Chassis ground.
13	Protective ground from main power supply.
14	High water temp. If the temperature of the water supply to the heat exchanger is too high, this pin will carry a +24 VDC signal.
15	Low water flow. If the temperature of the water leaving the heat exchanger is too high, this pin will carry a +24 VDC signal.
16	Low helium pressure. If the pressure of the helium gas at the compressor suction is too low, this pin will carry a +24 VDC signal.
17	Power error. On a phase or fuse error, this pin will carry a +24 VDC signal.
18	Gas temp error. On a high helium gas discharge temperature error, this pin will carry a +24 VDC signal.
19	Run status. When the compressor and cold head are running, this pin will carry a +24 VDC signal.
20	Motor winding temperature error. On a compressor motor winding high temperature error, this pin will carry a +24 VDC signal.
24	Ground for DC signal power source.
25	Source for +24 DC, 100 mA signal power.

Figure 8 System Diagnostics Connector Pin Function

PARTS

Ordering

The nameplates fastened to the cold head and the compressor identify the components as follows:
- Model Number
- Part Number
- Customer's Part Number (when applicable)
- Serial Number
- Date of Manufacture

Furnish this complete information when ordering parts. Also, order parts by part number and name.

NOTE
Be sure to have 99.995% pure helium gas available for servicing the system.

HC-10/HC-10L Compressor Parts

Variations for electrical service: HC-10 for 480 (+10% -14%) V3~, 60 Hz and 380/415 (+10% -14%) V3~, 50 Hz.
HC-10L for 200 (+10% -14%) V3~, 50/60 Hz.

Item	Quantity	Part Name	Part Number
1	1	Electrical chassis assembly for HC-10, S/N K00020 and up.	F300246A
1	1	Electrical chassis assembly for HC-10L.	F300214A
2	1	Mains power supply cord with L16-20P plug for HC-10.	300066B6
2	1	Mains power supply cord with L15-30P plug for HC-10L.	300203B6
3	5	Fuse, 0.4 A, 250 V, time delay, 5 x 20mm.	34691
4	1	Temperature switch, gas discharge, opens at 200° F	38891
5	1	Temperature switch, water in, opens at 35° C (95° F).	38897
6	1	Temperature switch, water out, opens at 44° C (111° F).	38898
7	1	Adsorber assembly.	F300138A
8	1	Front locator plate.	300050C
9	2	Slide rail.	300052B
10	4	Caster.	49137
11	4	Hex nut, M10x1.5, for caster.	72865
12	4	Lock washer, M10, for caster.	72463
13	3	Eyebolt.	73213

		HC-10/HC-10L Compressor Parts (continued)	
Item	**Quantity**	**Part Name**	**Part Number**
14	2	O-ring, 8M Aeroquip coupling.	47102
15	2	Gasket face seal, 8M Aeroquip coupling.	77002
18	1	Nylon washer, green, 8M Aeroquip coupling.	78013
19	1	Nylon washer, red, 8M Aeroquip coupling.	78014
20	2	Lockwasher, 8M Aeroquip coupling.	46401
21	2	Lock nut, 8M Aeroquip coupling.	72899
22	2	Dust cap, 8M Aeroquip coupling.	44642
23	1	O-ring, 4M Aeroquip coupling.	77005
24	1	Gasket face seal, 4M Aeroquip coupling.	77003
25	1	Nylon washer, 4M Aeroquip coupling.	78022
26	1	Lockwasher, 4M Aeroquip coupling.	46301
27	1	Lock nut, 4M Aeroquip coupling.	46001
28	1	Dust cap, 4M Aeroquip coupling.	44639

		Service Tools	
Item	**Quantity**	**Part Name**	**Part Number**
1	1	Adapter fitting with valve, 4F Aeroquip x 1/4” Swagelok	253757B
2	2	Adapter fitting with valve, 8F Aeroquip x 1/4” Swagelok	255919B2
3	1	Adapter fitting with valve, 8M Aeroquip x 1/4” Swagelok	SK8217A2
4	1	Adapter fitting, 8M Aeroquip to 8M Aeroquip	257246C5
5	1	Wrench, 1 3/16” open end x 1 3/16” ratchet end	SK30017C1
6	1	Wrench, 1 1/8” open end x 5/8” open end	SK30017C2
7	1	Wrench, 1” open end x 3/4” open end	SK30017C3
8	1	Wrench, 7 mm open end	
9	1	Wrench, 5 mm hex key	
10	1	Wrench, ratchet drive	

		Service Tools (continued)	
Item	**Quantity**	**Part Name**	**Part Number**
11	1	Wrench, 5 mm hex drive socket	
12	1	Wrench, 17 mm socket	
13	1	Extension, 3” for ratchet drive wrench	
14	1	Extension, 20” for ratchet drive wrench	
15	1	#0 Phillips screwdriver	
16	1	Phillips torque screwdriver, 10 – 12 in. lbs.	
17	1	Ohmmeter or multimeter	
18	1	Helium gas, 99.995% pure with pressure regulator and charge line.	
19		Loctite® 242	
20		Snoop® solution for leak detection	
21	1	Needle nose pliers	
22	1	Narrow, flat blade screwdriver	

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