

***SHI-APD Cryogenics, Inc.***

A Subsidiary of Sumitomo Heavy Industries Ltd.

# **HC-8E2, HC-8E3 and HC-8E4 Helium Compressors**

## **Technical Manual**

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



# TABLE OF CONTENTS

	<u>Page</u>
<b>SAFETY</b> .....	1
<b>SERVICE</b> .....	4
<b>INTRODUCTION</b> .....	5
Helium Compressors, Models HC-8E2, HC-8E3 and HC-8E4 .....	5
<b>PRINCIPLES OF OPERATION</b> .....	7
<b>DESCRIPTION</b> .....	9
Components .....	9
<b>SPECIFICATIONS</b> .....	13
Electrical Characteristics .....	13
Cooling Requirements .....	13
Refrigerant Quality .....	13
HC-8E2 Helium Gas Pressures .....	14
HC-8E3 Helium Gas Pressures .....	14
HC-8E4 Helium Gas Pressures .....	15
Compressor Lubricant .....	15
Compressor Weight .....	15
Compressor Dimensions .....	15
Space Requirements .....	15
Mounting Position .....	15
Environmental Requirements .....	16
Protective Earth Terminal .....	16
Maintenance Intervals .....	16
Installation Kit .....	16
Gas Manifold Kit (Optional Accessory) .....	16
Adapter Fittings .....	16
Remote On/Off Cable (Optional Accessory) .....	16
Supplier Name and Address .....	17
<b>INSTALLATION</b> .....	19
Introduction .....	19
Unpacking, Inspection and Pressure Check .....	19
Compressor Position .....	21
Field Wire the Compressor .....	21
Compressor Checkout .....	23
Interconnections .....	23
Remote On/Off Cable (Optional Accessory) .....	25
Compressor Shipping Preparation .....	26
<b>OPERATION</b> .....	27
Prestart Check .....	27
Starting .....	27
Stopping .....	27
Restarting after a Power Failure .....	27

# TABLE OF CONTENTS

(continued)

	<u>Page</u>
<b>MAINTENANCE</b> .....	29
Adsorber Replacement .....	30
Adsorber Removal .....	30
Adsorber Installation .....	31
Used Adsorber Venting and Disposal .....	31
Charging and Venting .....	32
Charging Procedure .....	32
Venting Procedure to Adjust the Equalization Pressure .....	33
Venting Procedure to Vent to Atmospheric Pressure .....	33
Gas Cleanup .....	34
Leak Check .....	36
Leak Repair .....	36
Replace the Compressor Shell High Temperature Switch .....	37
<b>TROUBLESHOOTING</b> .....	39
Automatic Shutdown .....	39
Troubleshooting Guide .....	40
Compressor Motor .....	42
Winding Continuity, Grounding and Resistance Checks .....	42
Current Measurement .....	43
<b>PARTS</b> .....	49
Ordering .....	49
HC-8E2/HC-8E3/HC-8E4 Compressor Parts Identification and Numbers .....	49
Adapter Fittings .....	54
Cables .....	55
<b>ILLUSTRATIONS LIST</b>	
<b>Figure 1</b> HC-8E2, HC-8E3 and HC-8E4 Flow Diagram .....	7
<b>Figure 2</b> HC-8E2 and HC-8E3 Parts Identification on Front Panel .....	10
<b>Figure 3</b> HC-8E4 Parts Identification on Front Panel .....	11
<b>Figure 4</b> Connect and Remove the Water Lines .....	23
<b>Figure 5</b> Gas Manifolds Installed .....	24
<b>Figure 6</b> Connect Gas Line to Compressor or Manifold .....	25
<b>Figure 7</b> Compressor Shell High Temperature Switch .....	38
<b>Figure 8</b> Compressor Terminals .....	43
<b>Figure 9</b> HC-8E2/HC-8E3 Wiring Diagram .....	45
<b>Figure 10</b> HC-8E2/HC-8E3 Electrical Schematic .....	46
<b>Figure 11</b> HC-8E4 Wiring Diagram .....	47
<b>Figure 12</b> HC-8E4 Electrical Schematic .....	48
<b>Figure 13</b> Parts Identification .....	52
<b>Figure 14</b> Parts Identification .....	53
<b>Figure 15</b> Adapter Fitting, 8F and 8M, with Valve .....	54
<b>Figure 16</b> Adapter Fitting, 8F, with Valve .....	54

# SAFETY

## GENERAL

The HC-8E2, HC-8E3 and HC-8E4 Helium Compressors are designed to operate safely when the installation, operation and servicing are performed in accordance with the instructions in this technical manual. Consult the nearest SHI-APD Cryogenics Service Center with any questions you may have concerning the use or maintenance of these compressors. 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. They appear as follows and serve the purposes stated.

### **WARNING**

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

### **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 procedure or discussion presented.

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

## WARNINGS

**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.

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

**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.

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.

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 compressor is charged with helium gas. Vent both supply and return Aeroquip couplings to atmospheric pressure before disassembly, except when disconnecting the adsorber or the 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.

The adsorber is charged with helium gas. Follow the used adsorber venting procedure for safe disposal of the used adsorber.

## CAUTIONS

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

Specifications require the use of 99.995% pure helium gas. Using a lesser quality of helium can damage 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 starts but runs roughly and the supply pressure does not increase, turn it off immediately. This is an indication that the power supply leads are connected in the wrong phase sequence and the compressor is operating in the reverse direction. The compressor's circuit breaker may also trip. Disconnect the power to the compressor. Interchange any two incoming power leads (except ground) at the compressor's power cord plug or at the customer's disconnect switch. Reconnect the power and restart the compressor.

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 5 degrees from horizontal, to avoid flowing oil into unwanted places.

## Service Centers

## Headquarters

### Eastern U.S.A.

SHI-APD Cryogenics Inc.  
1833 Vultee Street  
**Allentown, PA 18103-4783**

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

SHI-APD Cryogenics Inc.  
1833 Vultee Street  
**Allentown, PA 18103-4783**

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

### Western U.S.A.

SHI-APD Cryogenics Inc.  
456 Oakmead Parkway  
**Sunnyvale, CA 94085-4708**

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

SHI Cryogenics Group Shanghai  
Technical Support Center  
Sumitomo Heavy Industries (Shanghai) Ltd.  
Department M, 3<sup>rd</sup> Floor  
205 Taigu Road, Waigaoqiao Free Trade Zone, Pudong  
Shanghai 200131

### **People's Republic of China**

TEL: 86 21 5868 2721  
FAX: 86 21 5868 2725

# INTRODUCTION

## Helium Compressors Models HC-8E2, HC-8E3 and HC-8E4

The Compressors are single-stage, water-cooled, rotary, designed to deliver high-pressure, oil-free helium gas to cryogenic refrigerators. Cold head cables are used to supply electrical power to cryopumps (up to two operating simultaneously). Self-sealing couplings allow for easy connection to and disconnection from the rest of the closed-cycle cryogenic refrigeration system.

The HC-8E2 and HC-8E3 Compressors differ from each other only by different values of phasing components in their electrical chassis.

The HC-8E4 Compressor has no phasing components. It furnishes three-phase power to the three-phase valve motor in the cold head. ||

The information in this manual pertains only to the HC-8E2, HC-8E3 and HC-8E4 Compressors. Other components used to form an operating system are described in separate technical manuals.

Pressures are stated as gauge, not absolute. Psig is pounds per square inch gauge and kPa is Kilopascals gauge,

$$\text{kPa} = 6.895 \times \text{Psig}.$$

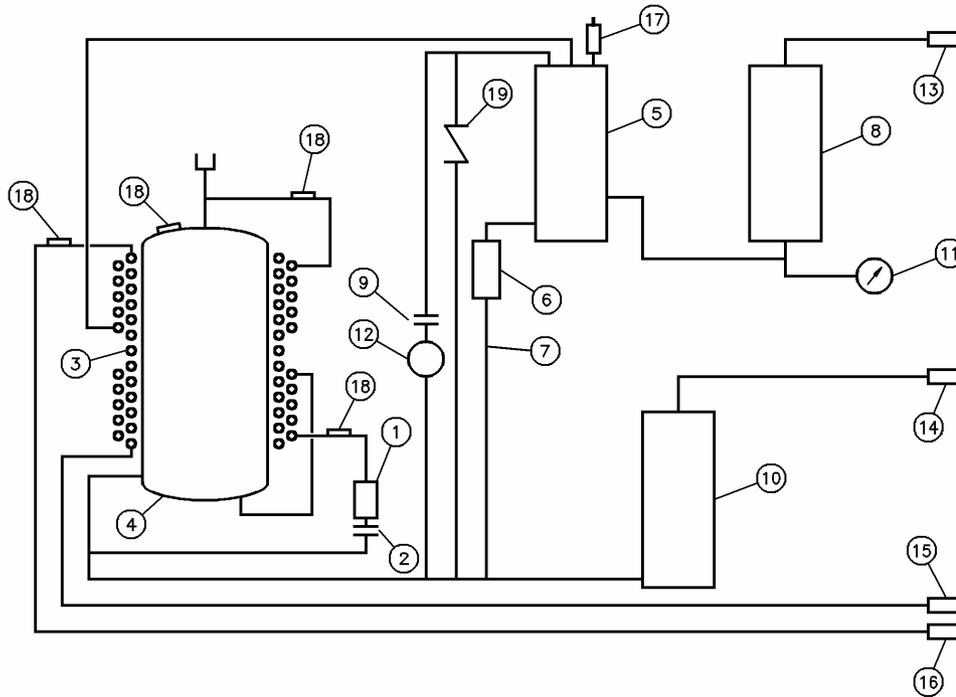
Definition of Symbols used in this manual and on equipment:

	Power Switch On		Protective Earth (Ground) Terminal
	Power Switch Off		WARNING Risk of Electric Shock
	CAUTION Refer to Manual	<b>V ~</b>	Volts, AC, 1 Phase
		<b>V3 ~</b>	Volts, AC, 3 Phase

(This page is intentionally blank.)

# PRINCIPLES OF OPERATION

The compressor continuously draws low-pressure helium from the system return line. It compresses, cools and cleans the gas, then delivers it through the system gas supply line to the cold head. See Figure 1.



- |                             |  |
|-----------------------------|--|
| 1. Oil Injection Filter     | 11. Gas Supply Pressure Gauge                                      |
| 2. Oil Injection Orifice    | 12. Gas Equalization Solenoid Valve                                |
| 3. Heat Exchanger           | 13. Gas Supply Coupling  |
| 4. Compressor Capsule       | 14. Gas Return Coupling  |
| 5. Oil Separator            | 15. Water Supply Fitting   |
| 6. Oil Capillary Filter     | 16. Water Return Fitting   |
| 7. Oil Capillary            | 17. Pressure Relief Valve  |
| 8. Adsorber                 | 18. Temperature Switches (water, oil,<br>gas and compressor shell) |
| 9. Internal By-pass Orifice |  |
| 10. Surge Bottle            | 19. Internal Relief Valve  |

**Figure 1 HC-8E2, HC-8E3 and HC-8E4 Flow Diagram**

When gas leaves the compressor, the gas contains heat and compressor lubricant. Both must be removed. From the compressor, the hot gas with its entrained oil flows over the motor winding, where the gas loses some of its suspended oil, then out of the shell and through one circuit of a three-circuit heat exchanger, where it is cooled. Next, the gas passes through the oil separator and the adsorber for oil and moisture removal. From the adsorber, the high-pressure gas is supplied to the cold head through gas lines.

Through the system gas return line, low-pressure gas from the cold head flows into the compressor.

A gas line containing an internal by-pass solenoid valve connects the high-pressure line to the low-pressure line. The by-pass valve will open to prevent overloading the motor when the system gas lines are not connected to the compressor.

Oil is separated from the gas in three stages. The first stage is by precipitation when the gas passes over the motor windings. The second stage is in the oil separator whose element collects oil mist from the gas; oil is agglomerated and returned to the compressor. The third stage is the adsorber that removes any remaining oil the gas is carrying.

Oil collected in the separator flows back to the compressor through a capillary tube. The differential gas pressure across the system is the moving force, and the capillary size limits the amount of gas bypassed. The small amount of oil collected in the adsorber remains there and is removed only by replacing the adsorber.

Oil in the compressor capsule also collects heat. The shell-wrapped heat exchanger removes heat from the compressor motor and from the warm oil by direct conduction through the compressor shell. Gas pressure pushes oil through the heat exchanger's outer tubes that cool the warm oil from the compressor. This cooled oil is then reinjected into the gas return line, which returns the oil to the compressor to reabsorb heat and lubricate the compressor.

## DESCRIPTION

The components of the HC-8E2, HC-8E3 and HC-8E4 Compressor are identified schematically in Figure 1. Figures 2 and 3 identify front panel components. Features and functions of individual components are described in the following paragraphs.

### **Components (See Figures 2 and 3)**

**Gas Supply and Return Couplings:** Both are self-sealing, size 8, male, Aeroquip, bulkhead couplings and are the points of connection on the front panel for the rest of the system.

**Water Supply and Return Fittings:** Both fittings are compression-type bulkhead fittings mounted on the front panel.

**Elapsed Time Meter:** The battery-operated LCD digital display, elapsed time meter shows the compressor's cumulative running time in hours up to a total of 99,999 hours.

### **WARNING**

**AVOID INJURY.** The compressor's elapsed time meter contains a lithium battery. Do not remove the battery. Do not recharge, disassemble, mutilate, wet or dispose of the meter in fire. Contact local environmental authorities for proper disposal of the lithium battery.

**Pressure Gauge:** A pressure gauge indicates gas pressure in the supply line. When the compressor is not running, the gauge shows the equalization pressure.

**Cold Head Receptacles and Optional Cold Head Cable(s):** Two receptacles, labeled Cold Head 1 and Cold Head 2, mounted on the front panel and cold head cable(s) supply electrical power from the compressor to the cold head(s). HC-8E2 and HC-8E3 Compressors have two, 4 socket receptacles; the HC-8E4 Compressor has two, 5 socket receptacles.

**Accessory Receptacle and Optional Remote On/Off Cable:** The accessory receptacle mounted on the front panel is a 14-socket connector for supplying remote on/off capability. The remote on/off cable is available as an option.

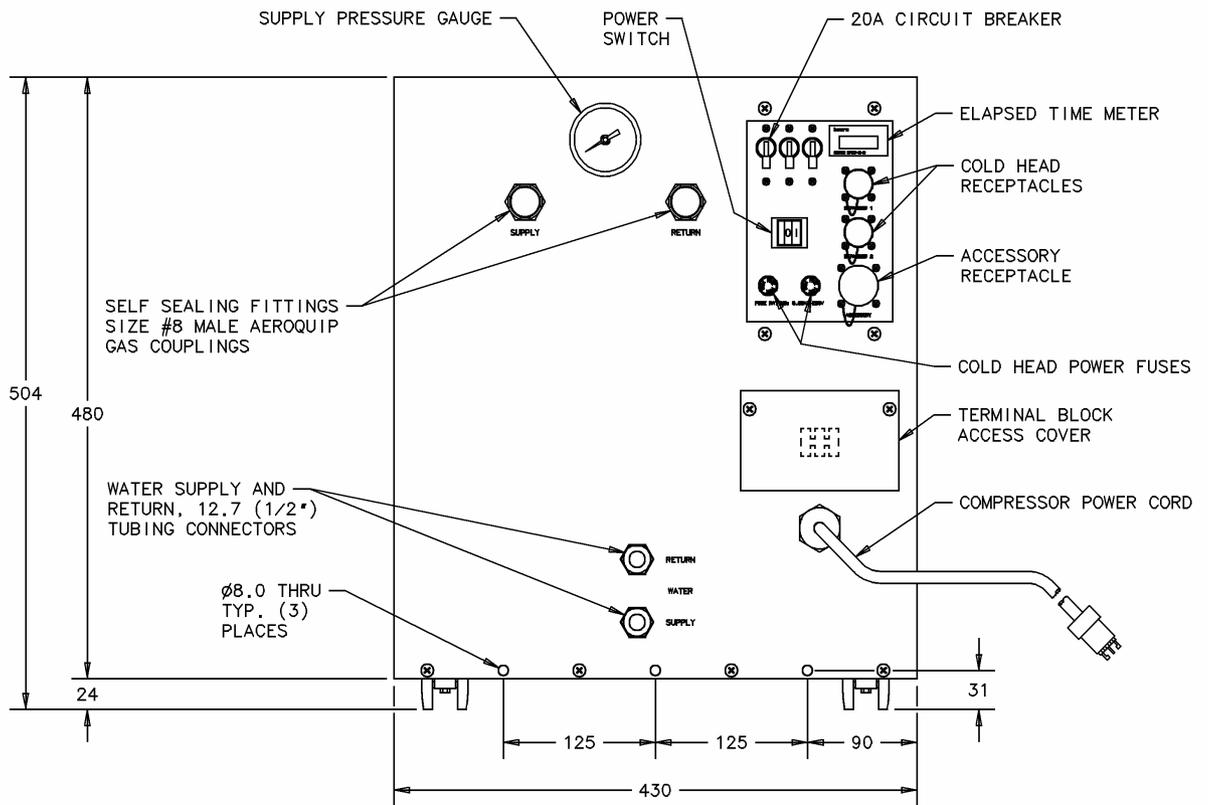
**Circuit Breaker:** A panel-mounted, 20 ampere, circuit breaker in the main power supply protects the compressor from electrical overload and also serves as an on/off switch.

**Power On/Off Switch:** This on/off rocker switch starts and stops the compressor. The switch lights to indicate that power is on to the compressor.

**Fuses:** HC-8E2 and HC-8E3 have (2) 0.63-ampere fuses in the cold head receptacle circuits located on the front panel of the compressor. HC-8E4 has (3) 0.63 ampere fuses in the cold head circuits located inside in the electrical chassis and (2) 4.0 ampere fuses on the front panel in the cold head circuits.

**Electrical Chassis:** The electrical chassis contains electrical components and connections and distributes power to all system circuits. The wire terminals are accessible by removing a cover from the front panel of the compressor. Components are accessible by removing the right side cover from the compressor capsule.

**Compressor Power Cord:** Terminating with a 4-prong, NEMA L15-20P plug, the power cord supplies electrical power to the compressor.



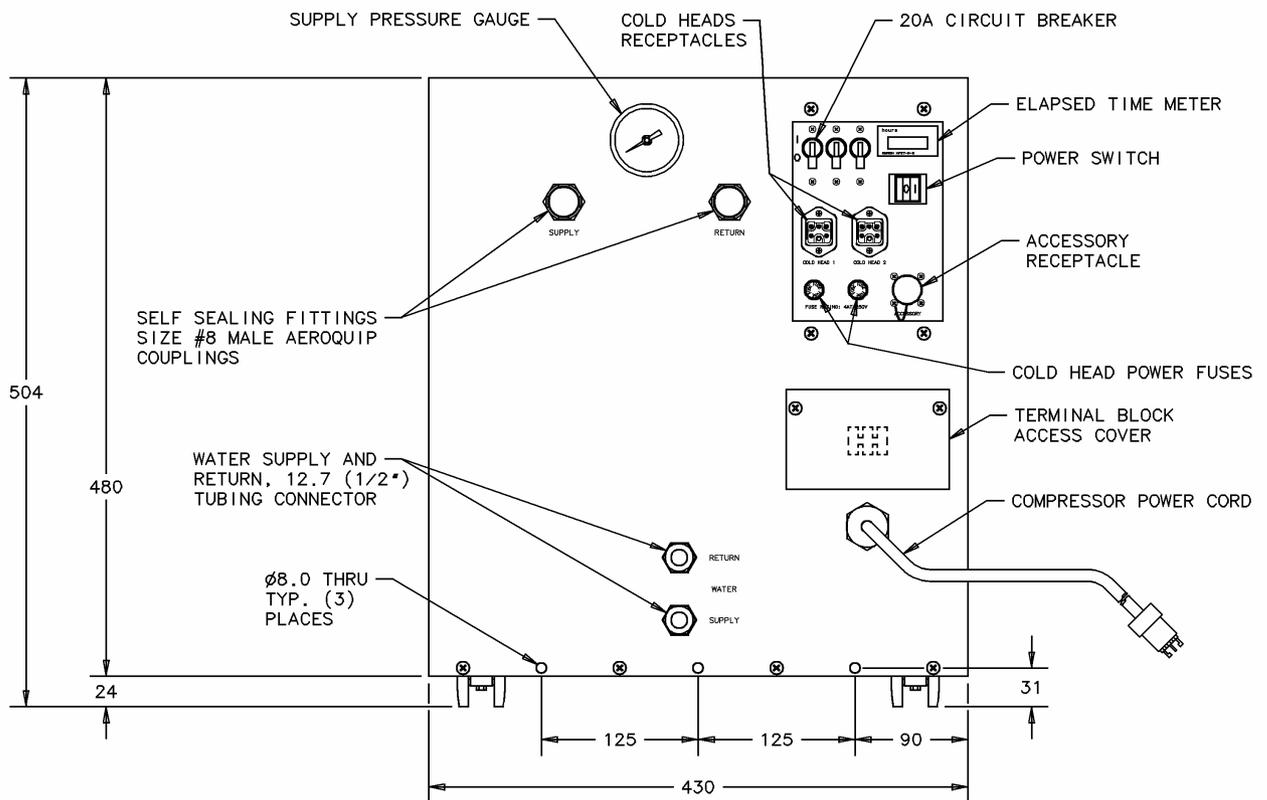
**Figure 2 HC-8E2 and HC-8E3 Compressors  
Parts Identification on Front Panel  
(Dimensions in mm)**

**NOTE**

Three (3) 8 mm holes at the bottom of the front panel may be used for bolts to prevent movement of the compressor.

**Compressor Capsule:** The rotary, positive displacement compressor capsule is hermetically sealed. Electrical connections to the motor are made at terminals under a protective cover on top of the housing.

If oil needs to be added to the compressor, an oil charging vessel (with oil), P/N 263775A3 is available as an accessory from SHI-APD.



**Figure 3 HC-8E4 Compressor  
Parts Identification on Front Panel**  
(Dimensions in mm)

**NOTE**

Three (3) 8 mm holes at the bottom of the front panel may be used for bolts to prevent movement of the compressor.

**Heat Exchanger:** The heat exchanger consists of three coils wrapped around the compressor capsule. One cools helium, another cools the compressor shell and another cools oil in the oil injection circuit. This circuit cools oil that has absorbed heat from the compressor and reinjects the cooled oil, which continues to absorb heat from the compressor.

**Gas Equalization Solenoid Valve:** This solenoid valve opens when the compressor is stopped. The valve allows the helium gas pressure across the compressor to equalize, to prevent oil from being blown out of the compressor into the low-pressure (return) gas line.

**Oil Separator:** The bottom of the oil separator serves as a sump. A cartridge above the sump contains fibrous material that acts as the separating agent. Entrained oil coalesces on it, forming large droplets that drain into the sump. This unit needs no servicing or replacement.

**Oil Capillary:** The capillary returns oil collected in the oil separator sump to the low-pressure side of the compressor for recycling.

**Adsorber:** The adsorber removes any oil and moisture the gas is carrying which did not drop out in the separator. This vessel contains activated charcoal for oil adsorption. The adsorber has a finite life and must be replaced every 30,000 operating hours.

**Pressure Relief Valve:** The relief valve prevents the compressor from operating at an unsafe pressure.

**Oil Filters:** There are two oil filters. One filter in the oil separator drain line protects the return oil capillary. The other filter in the oil injection circuit protects the compressor.

**Surge Bottle:** The surge bottle located in the return gas line dampens the pressure pulsations.

**Water High Temperature Switch:** Located in the water return line, it shuts down the compressor if the outlet water temperature is too high. The switch opens at 52° C (125° F) and resets automatically after cooldown.

**Shell High Temperature Switch:** Located on top of the compressor next to the compressor motor terminals, the switch opens at 87° C (187° F) and stops the compressor if the shell temperature is too high. The switch resets automatically after it cools.

**Gas High Temperature Switch:** Located on the supply gas line near the top of the compressor, the switch opens at 93° C (200° F) and stops the compressor if the gas temperature is too high.

**Oil High Temperature Switch:** Located on the oil return line, the switch opens at 60° C (140° F) and stops the compressor if the oil temperature is too high.

**Oil Injection Orifice:** This orifice is installed downstream of the oil filter in the oil injection line and controls the flow rate of oil into the compressor's gas return line.

**Internal Relief Valve** – The internal by-pass valve opens to allow the compressor to be run when the system gas lines are disconnected, to avoid overloading the compressor capsule.

# SPECIFICATIONS

## Electrical Characteristics

Service required (3 phase plus ground) Delta connected: 220/230 ±10%,V3~, 60 Hz or 220 ±10%,V3~, 50 Hz.

Power required: 4.5 kW, 12.5 amperes full load at 220 V3~, 60 Hz;  
58 amperes starting current, 68 amperes locked-rotor current.

Power Cord Connector: NEMA L15-20P (3 pole, 4 wire, 20 A, 250 V3~) male plug to connect to customer's receptacle.

Power Conductor Requirements for hard wiring (if not using the compressor power cord):  
Use 12 AWG (3.3 mm<sup>2</sup>) copper wire rated at 250 V~ minimum, protected with oil-resistant insulation. Three power leads and one grounding conductor are required.

Power should be provided through a separately fused safety switch with 20-ampere fuses.

Fuses are SLO-BLO, type T. Fuse ratings are 250 volts, 0.63 ampere and 4.0 amperes. See the Description and the Parts sections.

Cold Head Receptacles: Two receptacles on the compressor front panel accommodate the cold head cable(s)

Accessory Receptacle on the compressor used with an optional accessory cable provides remote on/off switching capability.

Control Logic provides:

Automatic restart after power interruption

Remote start/stop capability (using optional accessory cable).

## Cooling Requirements

Cooling Water Inlet Temperature:	4° C to 21° C (40° F to 70° F)
Cooling Water Outlet Temperature:	41° C (105° F) maximum
Cooling Water Pressure:	205 kPa (30 psig) minimum 690 kPa (100 psig) maximum
Cooling Water Flow:	5.7 to 9.5 liters/min (1.5 to 2.5 gpm) minimum
Pressure Drop at Minimum Flow:	100 kPa (15 psid)
Water Chiller Cooling Capacity:	5.1 kW (17,500 BTU/hr)
HVAC Requirement:	500 W maximum

## Refrigerant Quality

Refrigerant is 99.995% pure helium gas with a dew point less than -50° C (-58° F) at 2070 kPa (300 psig).

**CAUTION****PRESERVE YOUR WARRANTY and AVOID CONTAMINATION.**

Specifications require the use of 99.995% pure helium gas with a dew point less than -50° C (-58° F) at 2070 kPa (300 psig). Using a lesser quality of helium can damage the system and void the warranty.

**HC-8E2 Helium Gas Pressures**

<b><u>Cold Head or Cryopump Connected</u></b>	<b><u>Quantity Connected</u></b>	<b><u>Equalization Pressure @ 20° C (68° F) kPa (psig)</u></b>	<b><u>Operating Supply Pressure kPa (psig)</u></b>	<b><u>Operating Return Pressure kPa (psig)</u></b>
Compressor only		1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	415 - 550 (60 - 80)
DE-202 Cold Head (APD-6 Cryopump)	2	1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	480 - 690 (70 - 100)
DE-204SL Cold Head	1	1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	480 - 690 (70 - 100)
DE-204SL Cold Head	2	1895 - 1930 (275 - 280)	2070 - 2275 (300 - 330)	690 - 900 (100 - 130)
DE-208R Cold Head (APD-22 Cryopump)	1	1895 - 1930 (275 - 280)	2070 - 2275 (300 - 330)	690 - 900 (100 - 130)
DE-208L Cold Head	1	1895 - 1930 (275 - 280)	2000 - 2205 (290 - 320)	760 - 965 (110 - 140)

**HC-8E3 Helium Gas Pressures**

<b><u>Cold Head or Cryopump Connected</u></b>	<b><u>Quantity Connected</u></b>	<b><u>Equalization Pressure @ 20° C (68° F) kPa (psig)</u></b>	<b><u>Operating Supply Pressure kPa (psig)</u></b>	<b><u>Operating Return Pressure kPa (psig)</u></b>
Compressor only		1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	415 - 550 (60 - 80)
M204S Cold Head (Marathon 8, 8LP and 250 Cryopumps)	1	1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	480-690 (70-100)
M204S Cold Head	2	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)
M208R Cold Head (Marathon 16 Cryopump)	1	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)
M208S Cold Head (Marathon 12 Cryopump)	1	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)

**HC-8E4 Helium Gas Pressures**

||

<b>Cold Head or Cryopump Connected</b>	<b>Quantity Connected</b>	<b>Equalization Pressure @ 20° C (68° F) kPa (psig)</b>	<b>Operating Supply Pressure kPa (psig)</b>	<b>Operating Return Pressure kPa (psig)</b>
Compressor only		1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	415 - 550 (60 - 80)
CH-204S Cold Head (Marathon CP-8 Cryopump)	1	1895 - 1930 (275 - 280)	2135 - 2275 (310 - 330)	480-690 (70-100)
CH-204S Cold Head	2	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)
CH-208R Cold Head (Marathon CP-16 Cryopump)	1	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)
CH-208L Cold Head (Marathon CP-12 Cryopump)	1	1895 - 1930 (275 - 280)	2070-2275 (300-330)	690-900 (100-130)

Equalization Pressures at different ambient temperatures:

<b>T° C</b>	<b>P kPa</b>	<b>T° F</b>	<b>P psig</b>
4	1795 - 1830	40	260 - 265
10	1830 - 1863	50	266 - 270
15.6	1866 - 1900	60	271 - 276
20.0	1895 - 1930	68	275 - 280
26.7	1940 - 1975	80	281 - 286
37.8	2010 - 2046	100	292 - 297
40	2025 - 2060	104	294 - 300

The Pressure Relief Valve is set at 2760 kPa (400 psig).

**Compressor Lubricant** LB-300X, specially processed by SHI-APD.

**Compressor Weight** 75 kg (165 pounds).

**Compressor Dimensions** (H x W x D) 504 mm x 430 mm x 485 mm (19.8" x 16.9" x 19.1")

**Space Requirements** Allow at least 600 mm (24") from the front, back and both sides of the compressor for maintenance.

**Mounting Position** Compressor must be mounted base down and level within 5 degrees.

**Environmental Requirements**

	<b><u>Operating Environment</u></b>	<b><u>Storage</u></b>
Ambient Temperature	4° C to 40° C (40° F to 104° F)	-23° C to 65° C (-10° F to 149° F)
Relative Humidity	30% to 70%	10% to 90%
Atmospheric Pressure (Absolute Units)	52 kPa to 110 kPa (7.5 psia to 16.0 psia)	52 kPa to 110 kPa (7.5 psia to 16.0 psia)
Magnetic Field Limits	Compressor $\leq$ 150 gauss	

**NOTE**

Operating the equipment out of specifications may void the warranty.

**CAUTION**  
Equipment is designed for indoor use only.

**Protective Earth Terminal** Compressor Chassis



**Maintenance Intervals** Compressor adsorber replacement not to exceed 30,000 hours.

**Installation Kit** An installation kit, P/N 257409A, is included for connecting the cooling water supply and return lines. The kit contains:

<b><u>Item</u></b>	<b><u>Quantity</u></b>	<b><u>Description</u></b>	<b><u>Part Number</u></b>
<b>1</b>	40 Ft.	1/2" O.D. Nylon Tubing	60760
<b>2</b>	2	Nut, 1/2" O.D. Tubing	12306
<b>3</b>	2	Ferrule, Front, 1/2" O.D. Tubing	12307
<b>4</b>	2	Ferrule, Rear, 1/2" O.D.	12308

**Gas Manifold Kit (Optional Accessory):** Kit P/N 266532A contains two manifolds (P/N 266531B) that are required to operate two cold heads from one compressor. The kit is available from SHI-APD.

**Adapter Fittings (Optional Accessories):** Valved Swagelok/Aeroquip fittings for charging, venting or gas cleanup are available from SHI-APD. See the Parts section of this manual.

**Remote On/Off Cable (Optional Accessory):** A cable is available from SHI-APD to connect to the Accessory receptacle on the front panel to operate the compressor from a remote location. See the Parts section in this manual.

**Supplier Name and Address**

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



(This page is intentionally blank.)

# INSTALLATION

The HC-8E2, HC-8E3 and HC-8E4 Compressors are shipped in an operable condition.

Installation consists of: Unpacking

Examining for damage

Placing the compressor at its point of use

Connecting utilities

Checking compressor operation

Connecting other system components.

## Introduction

Install the Compressor 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 at installation. See Refrigerant Quality in Specifications.

## Unpacking, Inspection and Pressure Check

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

### CAUTION

**AVOID EQUIPMENT DAMAGE.** Remove the shipping bolt retaining the compressor motor before running the compressor.

### CAUTION

**AVOID EQUIPMENT FAILURE, CONTAMINATION OR NUISANCE SHUTDOWN.** Do not tip the compressor more than 5 degrees from horizontal to avoid flowing oil into unwanted places.

**1.1** If there is any evidence of external damage to any of the containers, be sure the carrier's driver sees the damage. Note it on the shipping documents and have the driver acknowledge it by his initials on the delivery receipt.

**1.2** Remove all components from their shipping containers and inspect them for damage. If there was external damage to the compressor, remove its covers and check for internal damage. Notify the carrier immediately and take photographs of the damage to document your claim to the carrier. Keep the damaged shipping container.

**1.3** If there was external damage to any of the other shipping containers, remove the contents and inspect all items for damage. Notify the carrier immediately and take photographs of the damage to document your claim to the carrier. Keep the damaged shipping container.

2. Raise the left rear corner of the compressor to locate the hex head shipping bolt. Support the compressor base with blocks only high enough to gain access to the bolt. Do not raise the corner more than 50 mm (2").

3. Use a 17-mm wrench to remove the bolt. Retain the bolt for future use. The shipping bolt must be reinstalled prior to shipment. See the section Compressor Shipping Preparation.
4. Remove the blocks and lower the compressor onto its wheels.

**NOTE**

Retain the shipping container if reusable for returning the compressor to the factory if reconditioning is required.

5. 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 Position.

If the Tip-N-Tell sensor indicates mishandling (arrow point is blue), proceed to either Step 5.1 or 5.2:

 <b>WARNING</b>
<b>AVOID ELECTRIC SHOCK.</b> All electrical supply equipment must meet applicable codes and be installed by qualified personnel.

 <b>WARNING</b>
<b>AVOID ELECTRIC SHOCK.</b> 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

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

- 5.1 If the compressor has been momentarily tipped (less than one hour) and the equalization pressure is within the specifications, allow it to stand upright for a period of two (2) hours. Connect power to the compressor. See the next sections Compressor, Field Wire the Compressor 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.

- 5.2 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.

**Compressor Position**

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.

**⚠ 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**

**AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN.** Do not tip the compressor greater than 5 degrees from horizontal to avoid flowing oil into unwanted places and causing a nuisance shutdown.

**CAUTION**

**AVOID EQUIPMENT DAMAGE.** If the compressor starts but runs roughly and the supply pressure does not increase, turn it off immediately. This is an indication that the power supply leads are connected in the wrong phase sequence and the compressor is operating in the reverse direction. The compressor's circuit breaker may also trip. Disconnect the power to the compressor. Interchange any two incoming power leads (except ground) at the compressor's power cord plug or at the customer's disconnect switch. Reconnect the power and restart the compressor.

The compressor must be installed base down, within 5 degrees of horizontal, and preferably at a height convenient for making connections and reading the pressure gauge. Be sure the compressor cannot inadvertently roll from its location, particularly if it is elevated.

Allow at least 600 mm (24") clearance in front and from the left side (when facing the front) of the compressor for maintenance.

**Field Wire the Compressor**

Tools required: #2 Phillips screwdriver  
Flat blade screwdriver  
(2) Open end wrenches, 33mm (1 5/16")

The HC-8E2, HC-8E3 and HC-8E4 Compressors are normally furnished with a power cord attached. However, the compressors can be hard wired to customer's power source if required.

To hard wire the compressor, first remove the power cord from the compressor.

1. Disconnect the power cord from the customer's power source.
2. Using two 33 mm wrenches, loosen, but do not remove, the power cord strain relief on the front panel. Use one wrench to hold the strain relief body and one to turn the jam nut.
3. Remove the cover on the front panel to gain access to the terminal block.
4. With a flat-blade screwdriver, loosen the power cord terminal screws and the ground connection. Remove the four wires.
5. Remove the complete power cord.

Instructions for field wiring follow. Use 12 AWG (3.3 mm<sup>2</sup>) copper wire with oil-resistant insulation. Three power leads and one grounding conductor are required. Be sure that the customer's electrical service conforms to the specifications.

When using 3/4" rigid conduit:

1. Remove the strain relief fitting from the compressor's front panel. Attach 3/4" conduit to the front panel using a connector sized for a 28-mm (1 3/32") hole. This is the National Electrical Code's standard size for 3/4" (26.7 mm) conduit.
2. Attach 3/4" conduit to the front panel using a connector sized for a 28-mm (1 3/32") hole. This is the National Electrical Code's standard size for 3/4" (26.7 mm) conduit.
3. Feed the conductors through the conduit. Insulated conductors should extend approximately 125 mm (5") from the end of the conduit into the compressor enclosure. Strip 9 mm (0.35") of cover from the end of each conductor. Twist the stranded conductors to prevent fraying when feeding the wires into the terminal block.
4. Connect the three power leads to the terminal block. Connect the ground wire to the grounding screw next to the terminal block.
5. Reinstall the terminal block access cover.

When using flexible cable:

1. Strip off 100 to 150 mm (4" to 6") of the cable's outside cover to expose the individual insulated conductors. Strip 9mm (0.35") from the end of each conductor. Twist the stranded conductors to prevent fraying when feeding the wires into the terminal block. Feed the cable through the strain relief fitting.
2. Connect the three power leads to the terminal block. Connect the ground wire to the grounding screw next to the terminal block.
3. Secure the cable by tightening the cap of the strain relief fitting. Use two wrenches to prevent turning the body of the strain relief fitting.
3. Reinstall the terminal block access cover.

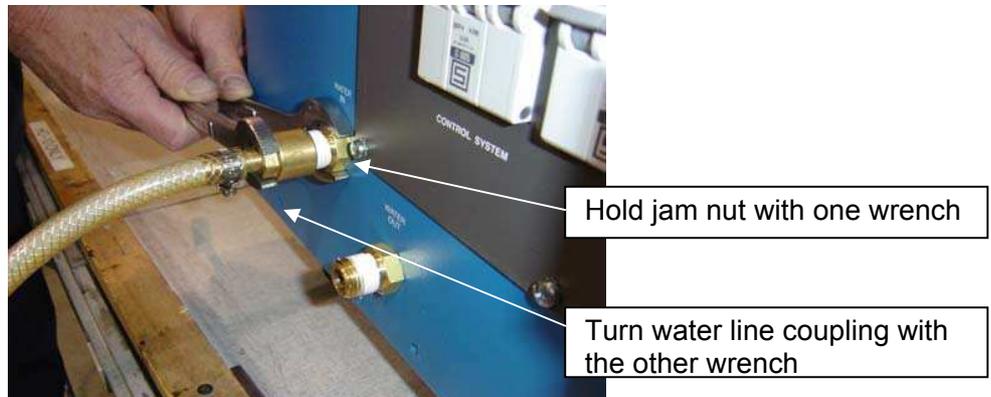
This completes the procedure for hard wiring the compressor.

**Compressor Checkout**

Tools required: Open end wrenches 15/16" and one sized to fit customer's water line coupling.

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

1. Connect coolant supply and return lines to the fittings on the front of the compressor. Use two wrenches. Hold the bulkhead fitting's jam nut with a 15/16" wrench. See Figure 4. Connect the supply line to the customer's cooling water or coolant supply valve. Turn on the coolant and check the lines for leaks. Tighten the fittings if necessary. See Specifications for cooling requirements.



**Figure 4 Connect and Remove the Water Lines**

2. Be sure the circuit breaker on the compressor is open (handle is down). Plug the power cord into customer's receptacle or connect the hard wiring to the electrical power source. Switch on the supply power to the compressor.
3. Close the circuit breaker. Press the power switch. Power switch indicator will light and the compressor will start. Run the compressor for ten (10) minutes, then stop.

**NOTE**

An internal relief valve will open to prevent overloading the motor when the system gas lines are not connected to the running compressor.

This completes the checkout of the compressor.

**Interconnections**

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

 <b>WARNING</b>
<p><b>AVOID INJURY.</b> 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.</p>

**CAUTION**

**DAMAGE TO GAS LINES** can result from crimping by repeated bending and repositioning.

**CAUTION**

**AVOID GAS LEAKS.** Check the condition of the gasket 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.

**CAUTION**

**AVOID GAS LEAKS.** 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 threaded protective caps and plugs to re-cover the couplings when they are not in use. They protect the couplings from damage and prevent entry of contaminants.

1. Arrange the system components so that the interconnecting gas lines will be protected from stress and traffic. Observe the minimum bend radius. Routing of gas lines should consider the need for gas line supports.
2. Remove the dust caps from the compressor supply and return gas couplings.
3. Remove the dust plugs from the couplings on one end of each of the supply and return gas lines.

**NOTES**

If only one cold head is used with the compressor, connect the supply (red) and return (green) gas lines directly to their corresponding compressor gas couplings. Continue to Step 4.

If two cold heads are used with the compressor, connect supply and return manifolds to the compressor. Then connect the gas lines to the manifolds. See Figure 5. Skip to Step 6.



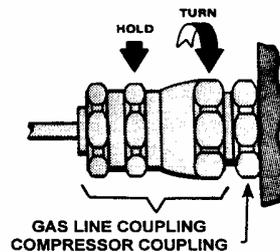
**Figure 5 Gas Manifolds Installed**

**D**

4. Connect the supply (red) gas line to the gas supply coupling on the compressor. Use two wrenches to tighten the coupling. See Figure 6.

Torque all Aeroquip couplings to  $4.87 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.). Tighten each coupling before proceeding to the next one.

5. Using two wrenches, connect the return (green) gas line to the compressor's return gas coupling. Torque the coupling as stated in the previous step. Skip to Step 10.



**Figure 6 Connect Gas Line to Compressor or Manifold**

6. Locate the Gas Manifold Kit P/N 266532A. It contains two manifold assemblies (P/N 266531B) which are charged with helium gas. **Do not vent.** Remove the dust plugs and caps from the manifolds. Using two wrenches, connect one manifold to the supply gas coupling on the compressor.

Torque all the Aeroquip couplings to  $4.85 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.).

7. Connect the other manifold to the compressor's return gas coupling. Use two wrenches.
8. Using two wrenches, connect the return (green) gas lines to the return manifold.
9. Using two wrenches, connect the supply (red) gas lines to the supply manifold.
10. Leak check all Aeroquip couplings. See the Leak Check procedure.
11. Read the equalization pressure. Compare it to the equalization pressure stated in the Specifications section.
12. Connect the other system components according to the instructions supplied for them. Connect the cold head power cable(s) to the cold head receptacle(s) on the front of the compressor.

After the installation procedures for all system components have been completed, startup can begin.

**Remote On/Off Cable (Optional Accessory)**

A remote on/off cable can be furnished as an accessory. See the Parts section for parts numbers.

1. Disconnect the power to the compressor.

2. Remove the heat shrink cap from one end of the remote on/off cable. Connect the cable to customer's remote switch. Use the green conductor to ground the switch box. Switch voltage will be the same as the customer's power source, single phase. See Figure 8, Electrical Schematic Diagram.
3. Connect the other end of the cable to the accessory receptacle on the compressor.
4. Reconnect the compressor to its power source.  
The system can now be operated from the compressor or from customer's remote switch. When using the customer's remote on/off switch, the power switch on the compressor must be in the stop (off) position.
5. To verify that the cable installation is correct, close customer's remote switch. Run the system for one minute, then stop.

### NOTE

When customer's remote switch starts the compressor, it cannot be stopped by the compressor's power switch. Open the compressor's circuit breaker to stop it locally. When the compressor is started at the compressor power switch, it cannot be stopped at the remote on/off switch.

### Compressor Shipping Preparation

#### **CAUTION**

**PREVENT EQUIPMENT DAMAGE.** Do not over tighten the shipping bolt.

#### **CAUTION**

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

A shipping bolt, P/N 70498, was installed on the compressor when it left the factory. If the compressor is to be shipped, reinstall the shipping bolt from the bottom of the compressor's base panel to restrain the compressor during shipment. Hand tighten the bolt until it bottoms. Use a 17-mm wrench to tighten the bolt 2½ turns.

Return the compressor using the original shipping container or reuse the packaging from a replacement compressor.

# OPERATION

## Operation

Starting and stopping are the only operating procedures performed at the compressor.

## Prestart Check

Before starting the compressor, be sure that all other system components to be used are properly connected and ready for operation. Refer to the instructions supplied with the other components.

When the compressor is at room temperature, 20° C (68° F), the pressure gauge should indicate 1895 - 1930 kPa (275 - 280 psig). 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. Refer to the Maintenance section for instructions on charging, cleaning and leak checking.

## Starting

Close the circuit breaker by pushing up the handle.

Press the power switch.

The indicator in the switch will light. The compressor will start. Any items drawing power from the compressor will start.

### **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.

## Stopping

At the compressor, press the power switch.

The indicator light in the switch will go off. The compressor will stop. Any items drawing power from the compressor will stop.

## Restarting after a Power Failure

If the compressor stops due to a power interruption, it is designed to restart immediately after power has been restored. If the compressor stops for other reasons, refer to the Troubleshooting section of this manual.

(This page is intentionally blank.)

## MAINTENANCE

### **WARNING**

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

### **WARNING**

**AVOID INJURY.** The compressor is charged with helium gas. Vent the compressor to atmospheric pressure before disassembly, except when disconnecting adsorber or the gas lines. Uncontrolled pressure release can cause injury.

### **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.

### **WARNING**

**AVOID INJURY FROM BURNS.** During operation, some surfaces in the compressor capsule become hot. Allow the compressor to cool for 1/2 hour after shutdown before removing the cover for maintenance.

### **WARNING**

**AVOID INJURY.** 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.

### **CAUTION**

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

### **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.

**CAUTION**

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

**CAUTION**

**AVOID GAS LEAKS.** Check the condition of the gasket 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.

**CAUTION**

**AVOID A MALFUNCTION.** Do not allow air to get into the system. Moisture from the atmosphere can seriously degrade cold head performance.

**Adsorber Replacement**

Tools required: Open end wrenches 17 mm, 1", 1 1/8", 1 3/16".  
#2 Phillips screwdriver.

The adsorbers in the HC- 8E2, HC-8E3 and HC-8E4 compressors must be replaced every 30,000 operating hours. A used adsorber has no salvage or repair value. Venting the compressor is not required when replacing the adsorber because the gas line couplings are self-sealing.

**Adsorber Removal**

1. Stop the compressor and disconnect the power from the compressor.
2. Disconnect the supply 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 nut with the other wrench.

3. Remove the compressor's top panel and the side panel nearest the gas supply coupling.

**NOTE**

Trace the outline of the adsorber base on the compressor base to help locate the proper position for the new adsorber.

4. Disconnect the self-sealing coupling on the inlet side of the adsorber. Use two wrenches.
5. Elevate the compressor to gain access underneath the bottom panel. Remove the M10 hex-head bolt and lock washer holding the adsorber to the base. Use a 17-mm wrench.

**CAUTION**

**AVOID EQUIPMENT FAILURE, CONTAMINATION OR A NUISANCE SHUTDOWN.** Do not tip the compressor greater than 5 degrees from horizontal to avoid flowing oil into unwanted places and causing a nuisance shutdown.

6. Remove the lock nut on the supply coupling on the front panel.
7. Pull the adsorber back until the supply coupling clears the front panel. Remove the adsorber. Remove the lock washer from the Aeroquip supply coupling. Retain all hardware to use with the new adsorber.

**WARNING**

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

**Adsorber Installation**

1. Remove the caps from the gas lines of the new adsorber. **Do not vent the new adsorber.**
2. Insert the supply coupling through the front panel and position the adsorber on the base within the traced outline. Be sure the lock washer is installed on the coupling prior to inserting it through the front panel.
3. Apply Loctite 242 to the threads of the bolt used to secure the adsorber to the base. Install and tighten this bolt and lock washer. Lower the elevated compressor to the floor.
4. Install the nylon washer and the locknut on the supply coupling. Torque the locknut to 5.5 kgf m (40 ft. lbs.).
5. Connect the adsorber's self-sealing coupling on its inlet side to the oil separator's outlet coupling. With wrenches, torque the Aeroquip coupling to  $4.85 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.).
6. Reconnect the supply gas line to the supply coupling on the compressor. Torque the coupling to  $4.85 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.).
7. Leak check all Aeroquip couplings just completed.
8. Check the equalization pressure. See Specifications.
9. Reinstall the top and side panels.

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 and 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.

See also the section Gas Cleanup.

Venting is required if leaking self-sealing couplings need to be disassembled for repairs.

#### **CAUTION**

**PRESERVE YOUR WARRANTY.** Specifications require the use of 99.995% pure helium gas. Using a lesser quality of helium can damage the system and void the warranty.

#### **CAUTION**

**AVOID CONTAMINATION.** Follow the charging and 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.

### Charging Procedure

Tools required: Adapter fitting P/N 266395C or 255919B2.

(2) Open-end wrenches 9/16"

Open end wrenches 1", 1 1/8", 1 3/16"

Helium gas cylinder with pressure regulator and charge line.

Swagelok fittings listed in step 4.

1. Stop the compressor. With two wrenches, remove the gas line or the gas manifold assembly from the return gas Aeroquip coupling on the compressor.
2. The adapter fitting is charged with helium gas; do not vent. Be sure the valve on the adapter fitting is closed. With two wrenches, attach the adapter fitting to the compressor's return gas Aeroquip coupling.
3. Remove the dust plug, Swagelok P/N B-400-P (SHI-APD P/N 17505), from the adapter fitting.
4. Connect a 1/4" O. D. 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 2070 kPa (300 psig). Use brass Swagelok nut and ferrules (P/N's B-402-1, B-403-1 and B-404-1; SHI-APD P/N's 12301, 12302 and 12303, respectively.) Adjust the pressure regulator to 35 kPa (5 psig).
5. While connecting the charge line to the adapter fitting, thoroughly purge the charge line from the regulator. Slightly open the adapter fitting's valve and release a small volume of gas from the compressor. While both the charge line and the charge/vent valve are venting, connect them together. It is important to remove all air contaminants to prevent them from entering the system.

6. Adjust the pressure regulator to the desired operating or equalization pressure. See Specifications. **Slowly**, fully open the adapter fitting's valve. Charge the system with helium gas until the desired pressure is indicated on the compressor's pressure gauge.
7. Close the adapter fitting's valve and the gas cylinder valve.
8. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.
9. Reinstall the dust plug on the adapter fitting. With two wrenches, remove the adapter fitting.
10. Reconnect the return gas line or the gas manifold to the compressor. Torque the coupling to  $4.85 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.).

This completes the charging procedure using a charge/vent adapter fitting.

### **Venting Procedure to Adjust the Equalization Pressure**

Tools required: Adapter fitting P/N 266395C or 255919B2.

Open end wrenches 1", 1 1/8", 1 3/16".

1. Stop the compressor.
2. Using two wrenches, disconnect the supply gas line or the supply gas manifold assembly from the compressor.
3. Be sure the valve on the adapter fitting is closed. Using two wrenches, attach it to the supply coupling on the compressor.
4. **Slowly** open the valve on the adapter fitting. Vent the compressor until the required equalization pressure is attained. See Specifications. Close the valve on the adapter fitting.
5. Remove the adapter fitting.
6. Reconnect the supply gas line or the gas manifold to the compressor. Torque the coupling to  $4.85 \pm 0.7$  kgf m ( $35 \pm 5$  ft. lbs.).

This completes the procedure for venting to adjust the equalization pressure.

### **Venting Procedure to Vent to Atmospheric Pressure**

Tools required: Adapter fitting P/N 266395C.

Open end wrenches 1", 1 1/8", 1 3/16".

#2 Phillips screwdriver

This procedure includes disconnecting the adsorber to prevent venting it.

1. Stop the compressor and disconnect the power from the compressor.
2. Using two wrenches, disconnect the supply and return gas lines or the gas manifolds from the couplings on the compressor. Screw dust plugs into the disconnected gas lines.
3. Remove the compressor's side panel nearest the gas supply coupling.

4. With wrenches, disconnect the Aeroquip coupling in the supply line between the oil separator and the inlet side of the adsorber. This keeps the adsorber pressurized.
5. Locate the adapter fitting; be sure its valve is closed. Move the part of the supply line fastened to the adsorber out of the way. Using two wrenches, connect the adapter fitting to the female Aeroquip coupling on the supply line from the oil separator.
6. **Slowly** open the valve on the adapter fitting. Vent the system to atmospheric pressure. Close the valve on the adapter fitting.
7. Remove the adapter fitting.
8. Perform the required maintenance.

**NOTE**

Do not reconnect the adsorber if the compressor has been vented to atmospheric pressure.

This completes the procedure to vent the compressor to atmospheric pressure.

**Gas Cleanup**

Tools required: 2 Adapter fittings with valves, P/N 255919B2 or P/N 266395C.  
Open end wrenches 1", 1 1/8", 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 140 kPa (20 psig) or lower. Gas cleanup is performed with the compressor disconnected from the other system components. The adsorber must be disconnected unless it also has been opened to the atmosphere or its charge pressure is less than 140 kPa (20 psig).

**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. Adsorber replacement will be required.

1. Disconnect the gas lines from the compressor. Screw dust plugs into the disconnected gas line couplings.
2. Locate two adapter fittings. Be sure their valves are closed. Attach them to the supply and return Aeroquip couplings on the compressor.

**NOTE**

If the adsorber has been disconnected, connect a P/N 266395C adapter fitting to the supply line from the oil separator, instead of connecting to the supply gas coupling, for venting during this procedure.

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 2070 kPa (300 psig). Adjust the gas cylinder pressure regulator to 35 kPa (5 psig).

4. While connecting the charge line to the adapter fitting on the compressor's return gas 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 1520 kPa (220 psig). Open the valve on the adapter fitting and charge the compressor to 1520 kPa (220 psig). If the adsorber is connected, increase the charge pressure to 1895 - 1930 kPa (275 - 280 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. Adjust the pressure regulator to 690 kPa (100 psig).
9. Open the vent valve on the supply coupling of the compressor. Watch the compressor's pressure gauge. When the pressure falls to 35 to 70 kPa (5 to 10 psig), close the vent valve. Open the charge valve to increase the pressure to 690 kPa (100 psig). Close the charge valve.
10. Repeat Step 9 five-(5) times.
11. Adjust the pressure regulator to the equalization pressure of the system. See Specifications.
12. Open the valve on the adapter fitting and charge the compressor to the equalization pressure. Close the charge valve on the adapter fitting. Start the compressor.
13. After running 30 to 45 seconds, stop the compressor. Open the vent valve and vent the compressor to 35 to 70 kPa (5 to 10 psig). Close the vent valve.
14. Repeat Steps 12 and 13 five-(5) times, then go to Step 15.
15. Open the charge valve on the adapter fitting. Charge the compressor to the equalization pressure. Close the charge valve.
16. 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.
17. Close the gas cylinder valve and adjust the pressure regulator to zero psig.
18. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.
19. Remove both adapter fittings.

### NOTE

Reconnect the adsorber if it was disconnected prior to gas cleanup.

20. If other components need cleaning, refer to the procedures in their technical manuals. Otherwise, reconnect the supply and return gas lines to the compressor. Torque the gas line couplings to 4.85 0.7 kgf m (35 ± 5 ft. lbs.).
21. Leak check the Aeroquip couplings. See the Leak Check procedure.

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. 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 one 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 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**

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

#2 Phillips screwdriver

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.

To repair a compressor coupling:

1. Stop the compressor and disconnect the power to the compressor.
2. Disconnect the gas line from the compressor coupling to be repaired.

3. Install dust caps on all disconnected gas couplings except the one to be repaired.
4. Remove the compressor's cover.
5. Use the Venting Procedure to Vent to Atmospheric Pressure to discharge all gas from the compressor. This procedure includes disconnecting the adsorber to prevent venting it.
6. At the coupling to be repaired, hold the stationary part with one wrench. Use a second wrench to disassemble the coupling.
7. Remove the old O-ring.
8. Wipe the O-ring groove to be sure it is clean. Lightly coat a new O-ring with vacuum grease. Install the new O-ring.
9. For a threaded joint sealed with Teflon tape, remove all old tape and apply new tape.
10. Reassemble the coupling using two wrenches.
11. Perform the Gas Cleanup procedure.

**CAUTION**

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

**NOTE**

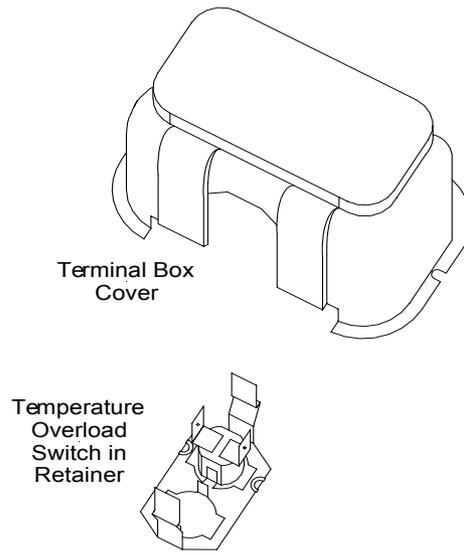
To repair a manifold assembly coupling, vent the manifold to atmospheric pressure using adapter fitting P/N 266395C or 255919B2. Follow steps 6 to 11 above.

**Replace the Compressor Shell High Temperature Switch**

Tool required: #2 Phillips screwdriver

The temperature switch fits into a depression on top of the compressor capsule under the terminal box cover.

1. Stop the compressor. Disconnect the power to the compressor.
2. Remove the compressor's top cover panel.
3. Lift off the cover of the terminal box on top of the compressor capsule. See Figure 7.
4. Disconnect wires 51 and 52 from the temperature switch terminals. Remove the retainer containing the temperature switch. Discard the switch. Keep the retainer for reuse.
5. Put a new temperature switch into the retainer. Put the assembly onto the compressor capsule and engage the retainer clips.
6. Connect wires 51 and 52 to the switch terminals.
7. Replace the terminal box cover.



**Figure 7 Compressor Shell High Temperature Switch**

# TROUBLESHOOTING

## Automatic Shutdown

The compressor will not start or will shut down automatically if any of the following are open:

- the compressor shell high-temperature switch;
- the water, oil or gas high-temperature switch;
- the motor over-current relay;
- the circuit breaker.

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.

If the unit shuts down again, refer to the Troubleshooting section to determine the cause and corrective action.

When the shutdown is caused by one 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, press the power switch to restart. Should the compressor fail to start, turn it off and allow more cooling time. Repeat the start procedure. Check the cooling water temperature and flow. Compare with Specifications.

The motor over-current relay automatically resets after the compressor shuts down and the relay cools. To restart the compressor, press the power switch to the on position. If the compressor fails to start, turn it off and allow more cooling time. Repeat the start procedure.

If the circuit breaker opens, reset the breaker by pushing its lever to the up position.

If a fuse is open, disconnect the power from the compressor, replace the fuse, then restart the compressor. The two fuses located in the front panel are in the cold head valve motor circuit.

Refer to the Troubleshooting Guide and the following procedures for checking the compressor's electrical components.

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

### **WARNING**

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

### **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.

**CAUTION**

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

**Troubleshooting Guide**

<b><u>Problem</u></b>	<b><u>Possible Cause</u></b>	<b><u>Corrective Action</u></b>
Compressor and items powered from it do not start when the start switch on the compressor is closed. Run light is not on.	No electrical power.	Check that the power source is on and the power cord is connected.
	Tripped circuit breaker in the compressor.	Check the voltage. Reset the circuit breaker. Consult a SHI-APD Service Center if the problem persists.
	Open fuse in the control circuit.	Check for a short circuit. Replace the fuse. Consult a SHI-APD Service Center if the problem persists.
Run light comes on for about one minute, then goes off, but the compressor does not start.	Defective motor control circuit.	Consult a SHI-APD Service Center.
	Wrong voltage.	Compare the electric service with system specifications.
Compressor starts but runs roughly and does not build significant pressure.	Motor is running in reverse due to a wrong phase sequence.	Interchange any two-(2) incoming power leads (except ground) at the power cord plug or at customer's disconnect switch. Check that the wiring to the compressor is correct. Consult a SHI-APD Service Center if the problem persists.
Compressor starts, but shuts down after approximately 30 seconds of operation.	Wrong equalization or operating pressure.	Refer to Specifications and the section on Charging and Venting. Leak check the system if the pressure is low.
	Gas equalization solenoid valve has failed.	Replace the solenoid valve.

<b><u>Problem</u></b>	<b><u>Possible Cause</u></b>	<b><u>Corrective Action</u></b>
Compressor starts, but shuts down after approximately 30 seconds of operation. (continued).	Low oil flow.	Look for oil leaks in the compressor capsule. Consult a SHI-APD Service Center.
	Orifice or the oil cooling line filter is blocked.	Replace the orifice and the filter.
Compressor starts but shuts down sometime later.	Water high-temperature switch is open.	Check the coolant flow and temperature. Refer to the Specifications.
	Circuit breaker or fuse is open.	Reset the circuit breaker or replace a fuse. Compare the electric service with system specifications. Consult a SHI-APD Service Center if the problem persists.
	Component failure in the power circuit.	Check for an open circuit breaker or fuse. Reset or replace if necessary. Check for a faulty component.
	Incorrect current draw.	Measure the current. Check motor winding resistances. If checks reveal failed motor windings or a locked rotor, consult an APD Service Center.
	Compressor overload relay opens.	If water and power checks indicate the utilities are within specifications, interlocks may be faulty. Consult a SHI-APD Service Center.
System starts but gas pressures are abnormally high or low.	Wrong equalization pressure.	Refer to Specifications and the section on Charging and Venting. Leak check the system if the pressure is low.
	Gas line couplings are not fully engaged.	Be sure that all Aeroquip couplings are fully engaged and torqued.
	Gas lines are connected wrong.	Reconnect. See the Installation section.

<u>Problem</u>	<u>Possible Cause</u>	<u>Corrective Action</u>
Gradual loss of helium gas pressure.	Gas is leaking from the compressor.	Leak check the compressor and repair.
Compressor runs; elapsed time meter does not run.	Defective elapsed time meter or motor contactor.	Consult a SHI-APD Service Center.

** WARNING**

**AVOID INJURY.** The compressor's elapsed time meter contains a lithium battery. Do not remove the battery. Do not recharge, disassemble, mutilate, wet or dispose of the meter in fire. Contact local environmental authorities for proper disposal of the lithium battery.

**Compressor Motor**

Compressor motor checks for winding continuity, resistance and grounding will isolate most motor electrical problems. Current measurements will separate a locked rotor condition from other electrical problems. When the checks indicate a faulty compressor, a replacement is needed. Contact a SHI-APD Service Center.

** 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 1/2 hour after shutdown before removing the cover for maintenance.

** 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.

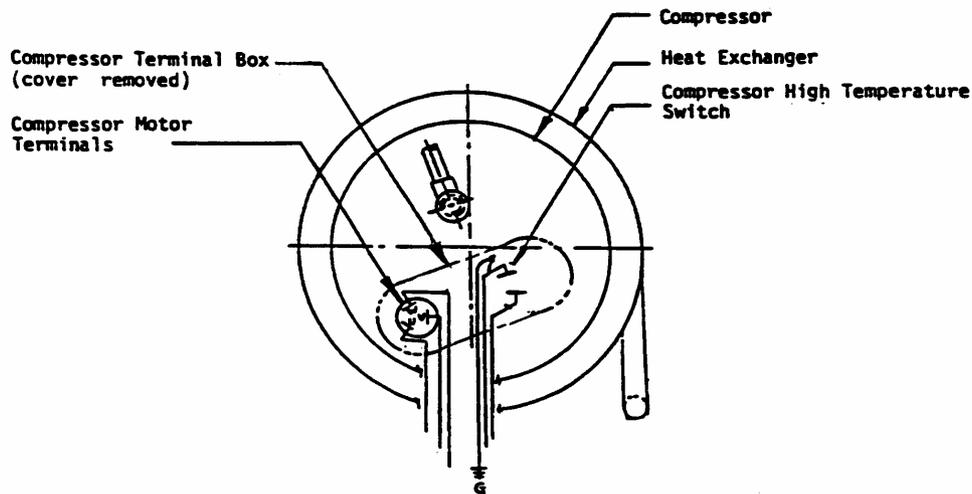
**Winding Continuity, Grounding and Resistance Checks**

Tool required: #2 Phillips screwdriver.  
Ohmmeter or multimeter

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

1. Disconnect the power to the compressor.

2. Remove the top cover or the right side panel of the compressor.
3. Remove the terminal cover from the top of the compressor capsule to expose the three terminals U, V and W. Alternately, locate wires 7, 8 and 9 connected to the terminals at the bottom of the motor contactor in the electrical chassis box. See Figures 8, 9 and 11. It is not necessary to remove the wires from their terminals.
4. With an ohmmeter, check the resistance across pairs of compressor terminals or across pairs of motor contactor terminals. Resistance should be about 1.6 ohms. If there is no continuity, there is an open circuit in the motor windings. Consult a SHI-APD Service Center.
5. With the ohmmeter, check for continuity between the motor windings and one of the copper tubes entering the compressor capsule's housing. Use the three compressor terminals or the three motor contactor terminals and one of the copper tubes from the compressor. If there is continuity, there is a short circuit to ground in the motor windings. Consult a SHI-APD Service Center.
6. If the motor passes these electrical checks, replace the terminal cover, top cover or side panel, unless current measurement is to be performed.



**Figure 8 Compressor Terminals**

### Current Measurement

Tools required: #2 Phillips screwdriver  
Clamp-on ammeter

1. Disconnect the power to the compressor
2. Remove the wiring terminal block access cover from the front panel.
3. Locate the incoming power leads at the terminal block.
4. Expose the power leads enough to use a clamp-on ammeter.

5. Clamp the ammeter on one of the power leads.
6. Reconnect the power to the compressor.
7. Start the compressor.
8. Read the current draw for each lead, then stop the compressor.
  - A reading of 0 amperes indicates an open circuit.
  - A reading of 10 to 14 amperes (steady state) is normal.
  - A reading slightly higher than 10 to 14 amperes suggests possible minor system problems, i.e. low-supply voltage, loose electrical connection, etc.
  - A reading of about 68 amperes indicates a mechanically locked rotor. Consult a SHI-APD Service Center.
  - A reading of full scale, along with a tripped circuit breaker or a blown control circuit fuse, means a short circuit in the chassis wiring or motor.
9. Remove the ammeter.
10. Replace the terminal block access cover.

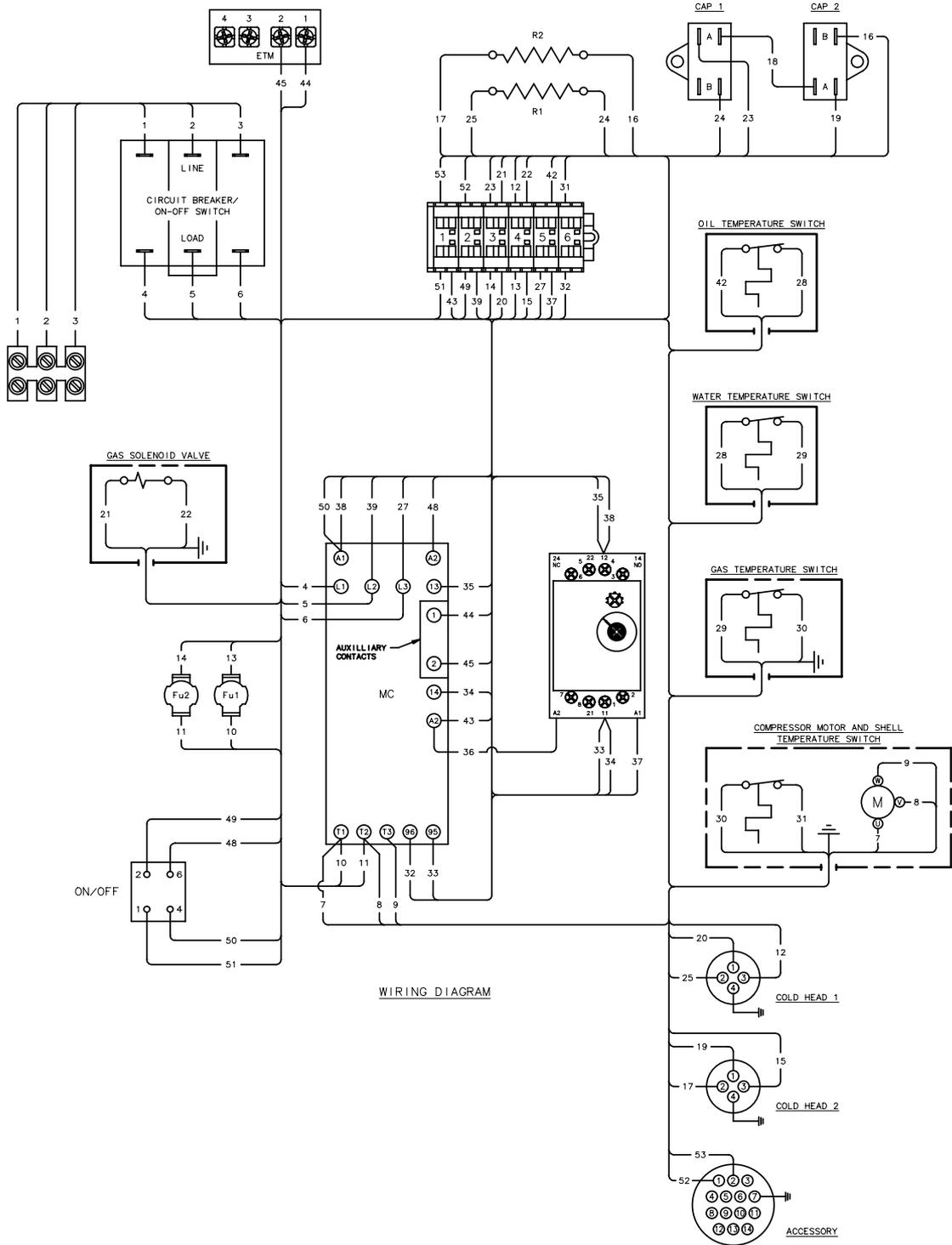


Figure 9 HC-8E2/HC-8E3 Wiring Diagram

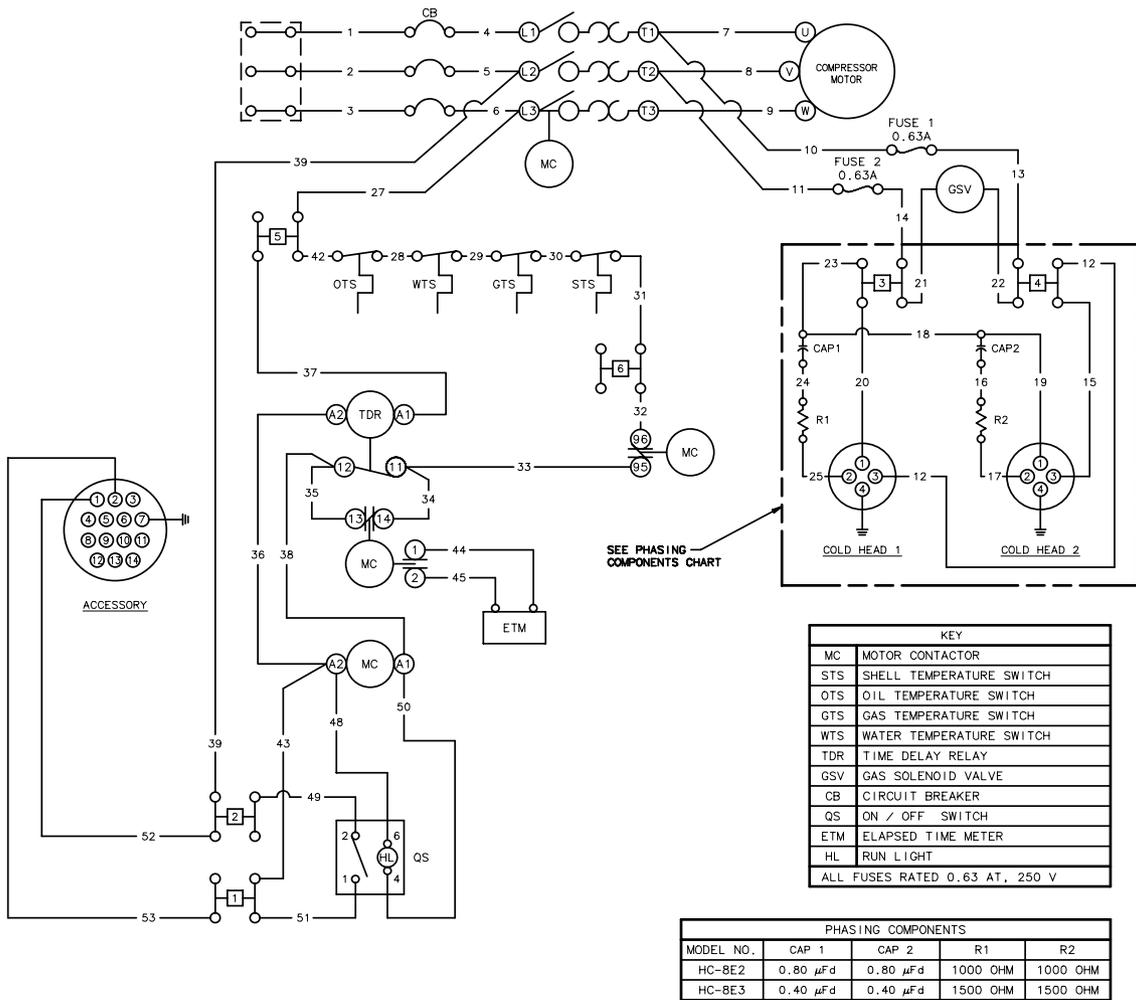


Figure 10 HC-8E2/HC-8E3 Electrical Schematic



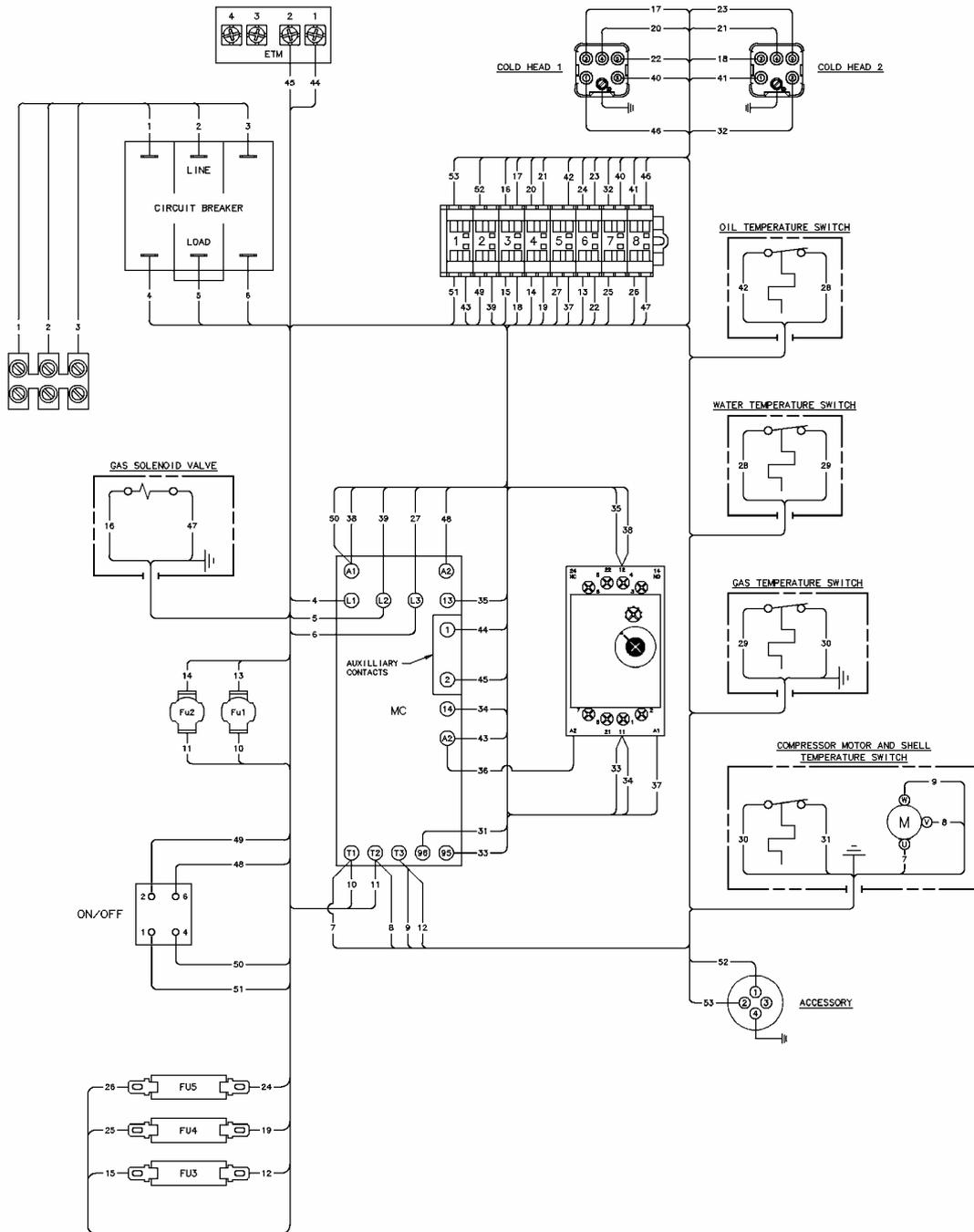


Figure 11 HC-8E4 Wiring Diagram



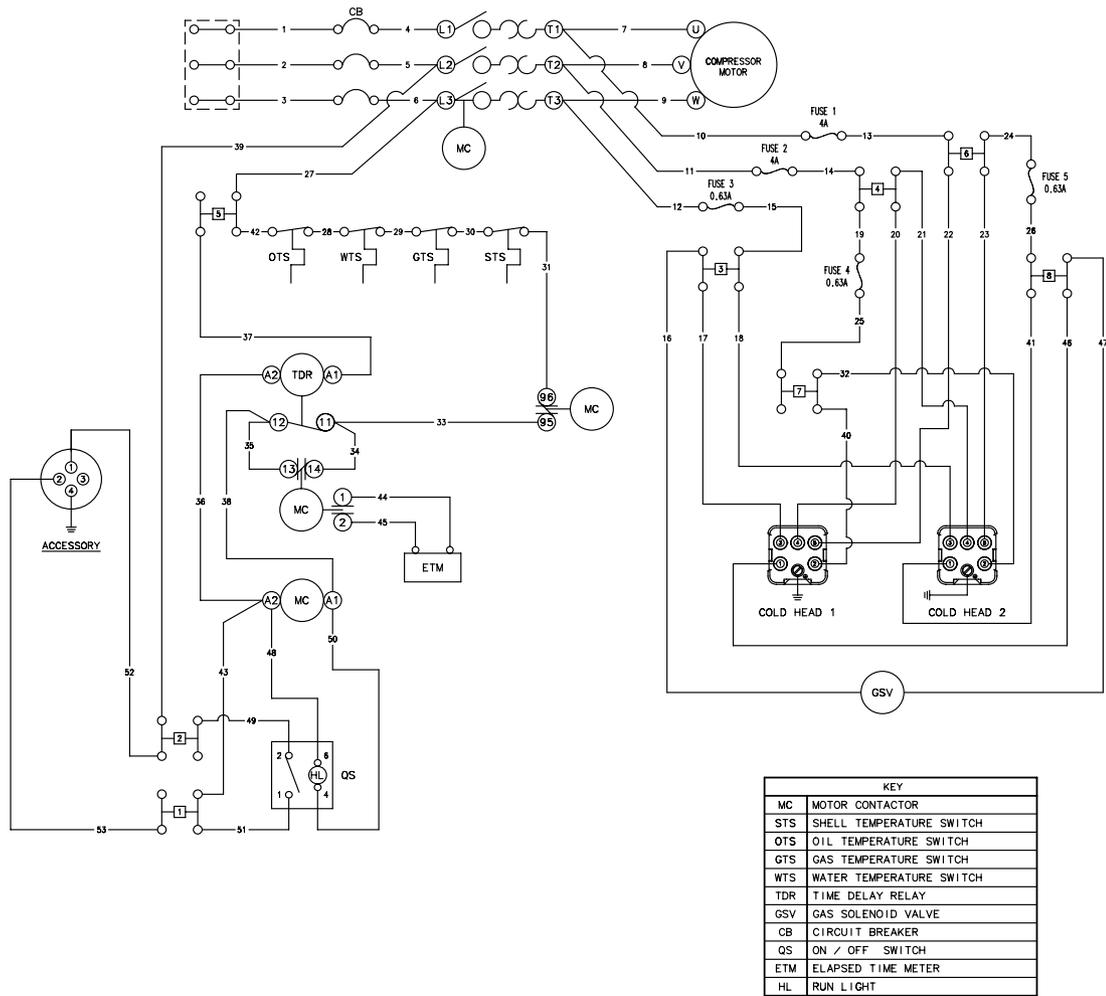


Figure 12 HC-8E4 Electrical Schematic



# PARTS

## Ordering

The nameplate fastened to the front panel of the compressor housing identifies the compressor as follows:

Model Number  
Part Number  
Serial Number  
Date of Manufacture

Furnish this complete information when ordering parts. Also, order parts by part number and name. Refer to the next section for Parts Identification and Numbers.

## HC-8E2/HC-8E3/HC-8E4 Compressor Parts Identification and Numbers

(See Figures 2, 3, 13 and 14).

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>	
		<u>HC-8E2</u> <u>HC-8E3</u>	<u>HC-8E4</u>
1	Pressure gauge, panel mount, 2" dial	50987	50987
2	Circuit breaker, 20A, 250 V3~, 3 pole	34675	34675
3*	O-ring (2), Aeroquip coupling	47102	47102
4*	Gasket face seal (2), 8M Aeroquip coupling	77002	77002
5*	Nylon washer (2), Aeroquip coupling	72628	72628
6*	Lock washer (2), Aeroquip coupling	46401	46401
7	Lock nut (2), Aeroquip coupling	46101	46101
8	Dust cap (2), Aeroquip coupling	44642	44642
9	Caster (4), swivel	49137	49137
10	Receptacle (2), cold head	34453	37651
11	Receptacle cap (2), cold head	34477	37616
12	Receptacle, accessory	34481	34453
13	Receptacle cap, accessory	34489	34477
14	Front ferrule (2), water fitting	12307	12307
15	Rear ferrule (2), water fitting	12308	12308
16	Nut (2), water fitting	12306	12306
17	Adapter (2), male, 1/2" O.D. tube x 1/2" male ISO tapered pipe	17656	17656

\* Part is not shown.

Item	Part Name	Part Number	
		<u>HC-8E2</u> <u>HC-8E3</u>	<u>HC-8E4</u>
18#	Compressor assembly	264257C	264257C
19#	Oil Injection orifice	256314B	256314B
20#	Oil separator assembly	258304A	258304A
21#	Pressure relief valve	53028	53028
22#	Gas equalization solenoid valve assembly	264903C	264903C
23#	Internal relief valve assembly	264971A	264971A
24	Adsorber assembly	F257428A	F257428A
25	Gas high-temperature switch	38891	38891
26	Oil high-temperature switch	38890	38890
27	Compressor shell high-temperature switch	38892	38892
28*	Water high-temperature switch	38862	38862
29	Motor contactor replacement kit	F79027A1	F79027A1
30	Time delay relay replacement kit	F37469A	F37469A
31	Power cord assembly	262801B	262801B
32*	Oil charging vessel (with oil)	263775A3	263775A3
33*	Shipping bolt	70498	70498
	<u>Electrical components for model HC-8E2 Compressor:</u>		
34	Electrical chassis assembly	266372D1	
35*	Resistor (2), 50 W, 1000 $\pm$ 1% ohms	37526	
36*	Capacitor (2), 0.80 $\pm$ 10% $\mu$ fd, 450 V~, 50/60 Hz	32517	
37*	Fuse (2), 0.63 ampere, 250 V	34687	

\* Part is not shown.

# Item is not replaceable in the field.

Item	Part Name	Part Number	
		<u>HC-8E2</u> <u>HC-8E3</u>	<u>HC-8E4</u>
	<u>Electrical components for model HC-8E3 Compressor:</u>		
<b>38</b>	Electrical chassis assembly	266372D2	
<b>39*</b>	Resistor (2), 50 W, 1500 $\pm$ 1% ohms	37520	
<b>40*</b>	Capacitor (2), 0.40 $\pm$ 10% $\mu$ fd, 450 V~, 50/60 Hz	32522	
<b>41*</b>	Fuse (2), 0.63 ampere, 250 V	34687	
	<u>Electrical components for model HC-8E4 Compressor:</u>		
<b>42</b>	Electrical chassis assembly		266816D
<b>43*</b>	Fuse (2), 4.0 ampere, 250 V		34154
<b>44*</b>	Fuse (3), 0.63 ampere, 250 V		34687

\* Part is not shown.

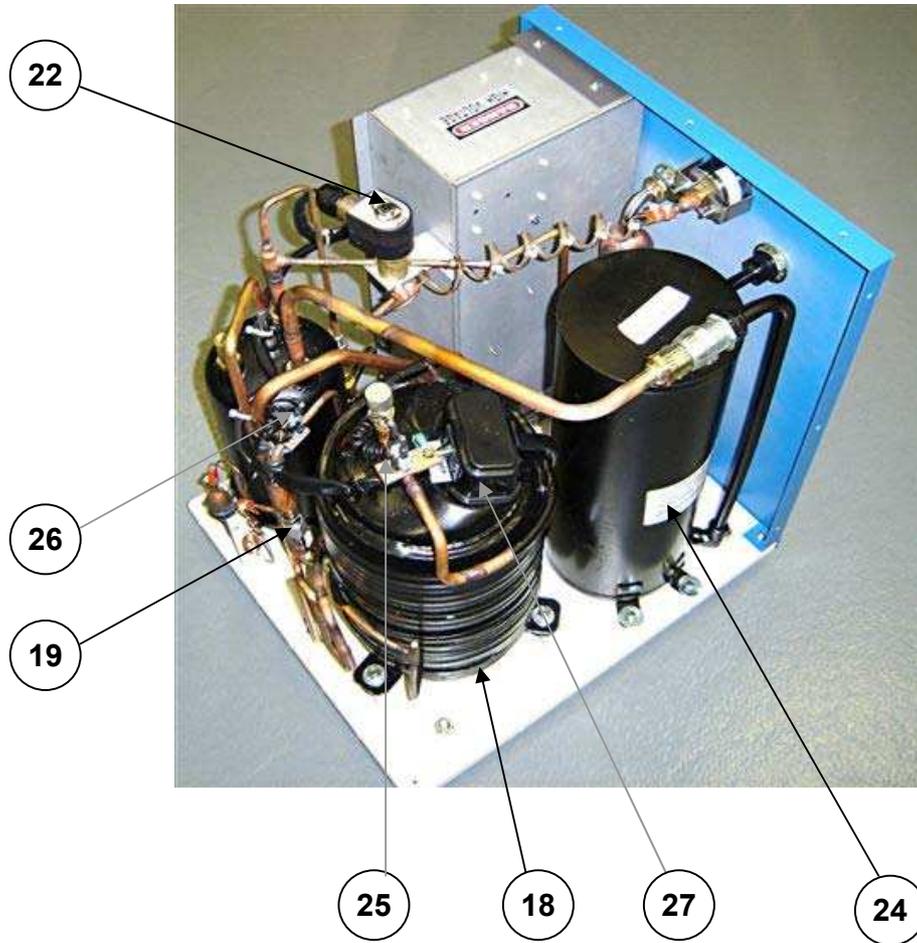


Figure 13 Parts Identification

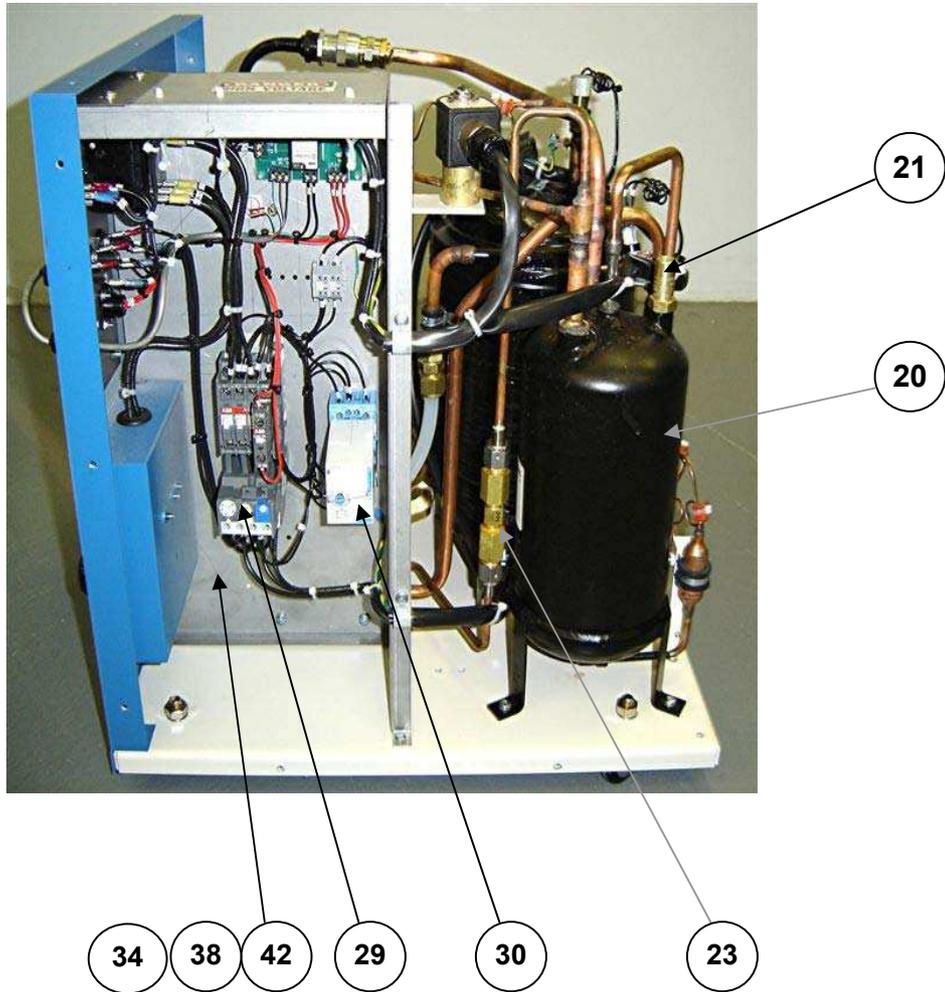


Figure 14 Parts Identification

||

**Adapter Fittings**

The following adapter fittings, required for servicing the HC-8E2, HC-8E3 and HC-8E4 Compressors, are available as accessories from SHI-APD.

<b><u>Item</u></b>	<b><u>Quantity</u></b>	<b><u>Part Name</u></b>	<b><u>Part Number</u></b>	<b><u>Figure</u></b>
<b>1</b>	2	Adapter fitting, 8F <sup>(1)</sup> and 8M <sup>(2)</sup> , with valve	266395C	15
<b>2</b>	2	Adapter fitting, 8F with valve	255919B2	16

<sup>(1)</sup>Denotes size 8, female, Aeroquip coupling.

<sup>(2)</sup>Denotes size 8, male, Aeroquip coupling.



**Figure 15 Adapter Fitting, 8F and 8M, with Valve**



**Figure 16 Adapter Fitting, 8F with Valve**

**Cables**

The following cables for use with the HC-8E2, HC-8E3 and HC-8E4 Compressors are available as accessories from SHI-APD.

<b><u>Item</u></b>	<b><u>Quantity</u></b>	<b><u>Description</u></b>	<b><u>Part Number</u></b>
<b>1</b>	1	Accessory cable for remote On/Off, for HC-8E2 and HC-8E3 Compressors 6 m (20 ft.) long.	263887B20
<b>2</b>		Accessory cable for remote On/Off, for HC-8E4 Compressor, 3 m (10 ft.) long.	266823B10
<b>3</b>	1 or 2	Cold head cable, HC-8E2, 3.3 m (11 ft.) long	264167B11
<b>4</b>	1 or 2	Cold head cable, HC-8E3, 3.3 m (11 ft.) long	264166B11
<b>5</b>	1 or 2	Cold head cable, HC-8E4, 3 m (10 ft.) long	266822B10

(This page is intentionally blank.)