



HC-4E1 and HC-4E2 Helium Compressors

Technical Manual

**Sumitomo (SHI) Cryogenics of America, Inc.
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U.S.A.**

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SAFETY

GENERAL

The HC-4E1 Helium Compressor is designed to operate safely when the installation, operation and servicing are performed in accordance with the instructions in this technical manual. Consult the nearest SCAI 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.



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

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SERVICE

HEADQUARTERS

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INTRODUCTION

Helium Compressor Models HC-4E1 and HC-4E2







The Compressors are single-stage, water-cooled, rotary, and designed to deliver high-pressure, oil-free helium gas to cryogenic refrigerators. Cold head cables are used 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-4E Series 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,

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

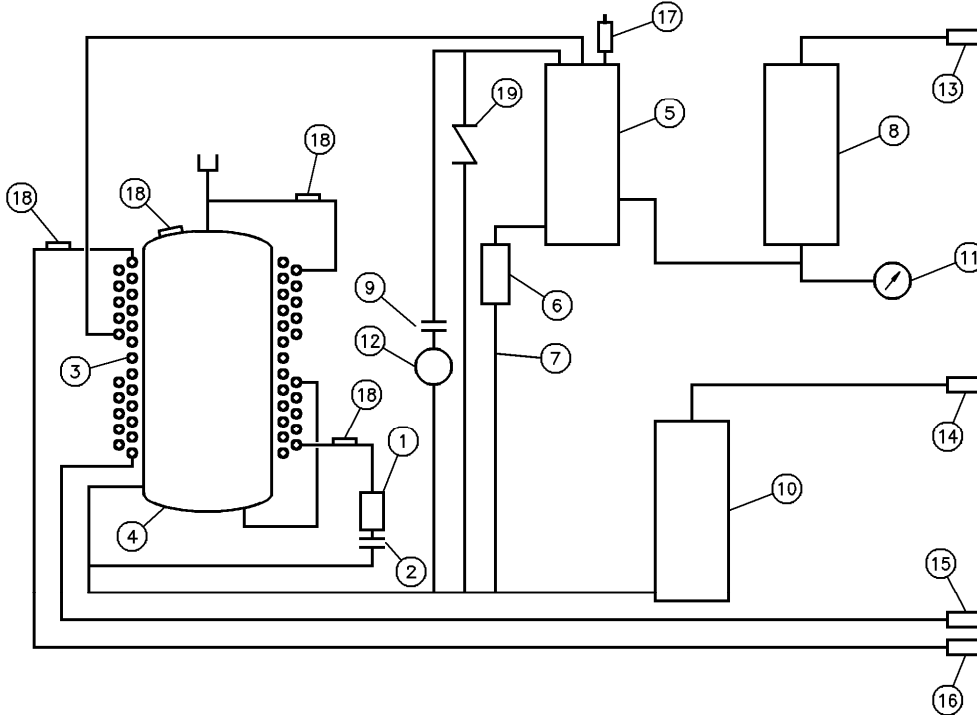
Definition of Symbols used in this manual and on equipment:

	Power Switch On		Protective Earth (Ground) Terminal
	Power Switch Off		WARNING Risk of Electric Shock
	CAUTION Refer to Manual		Volts, AC, 1 Phase

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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,
gas and compressor shell) |
| 9. Internal By-pass Orifice | 19. Internal Relief Valve |
| 10. Surge Bottle | |

Figure 1 HC-4E Flow Diagram

Principles of Operation

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-4E Series Compressors 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)

50/60 Hz Toggle Switch (HC-4E2 only): This switch is used to select different phasing circuits for cold head operation at 50 Hz or 60 Hz.

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.

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.

Circuit Breaker: A panel-mounted, 20 ampere, circuit breaker in the main power supply protects the compressor from electrical overload.

Cold Head Receptacle and Optional Cables - A 28-socket receptacle mounted on the front panel and a cold head cable supply electrical power from the compressor to the cold head. The compressor can be supplied with cables for operating a DE-202, DE-204SL, M204S or CH204S Cold Head.

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 SCAI.

Compressor Power Cord: Terminating with a 3-prong, NEMA L6-20P plug, the power cord supplies electrical power to the compressor.

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.

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.

Fuses:

#	Electrical Rating (250 VAC)		Circuit	Location
	HC-4E1	HC-4E2		
FU1	0.63 AT	1.0 AT	Cold head	Front panel
FU2	0.63 AT	1.0 AT	Cold head	Front panel
FU3	5.0 AT	5.0 AT	Cold head	Front panel
FU4	5.0 AT	5.0 AT	Cold head	Front panel
FU5	0.4 AT	0.4 AT	Control	Inside Electrical Chassis
FU6	0.4 AT	0.4 AT	Control	Inside Electrical Chassis

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.

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.

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.

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.

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.

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

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.

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.

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.

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.

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

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

Shell High Temperature Switch: Located on top of the compressor next to the compressor motor terminals, the switch opens at 80° C (176° F) and stops the compressor if the shell temperature is too high. The switch resets automatically after it cools.

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.

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

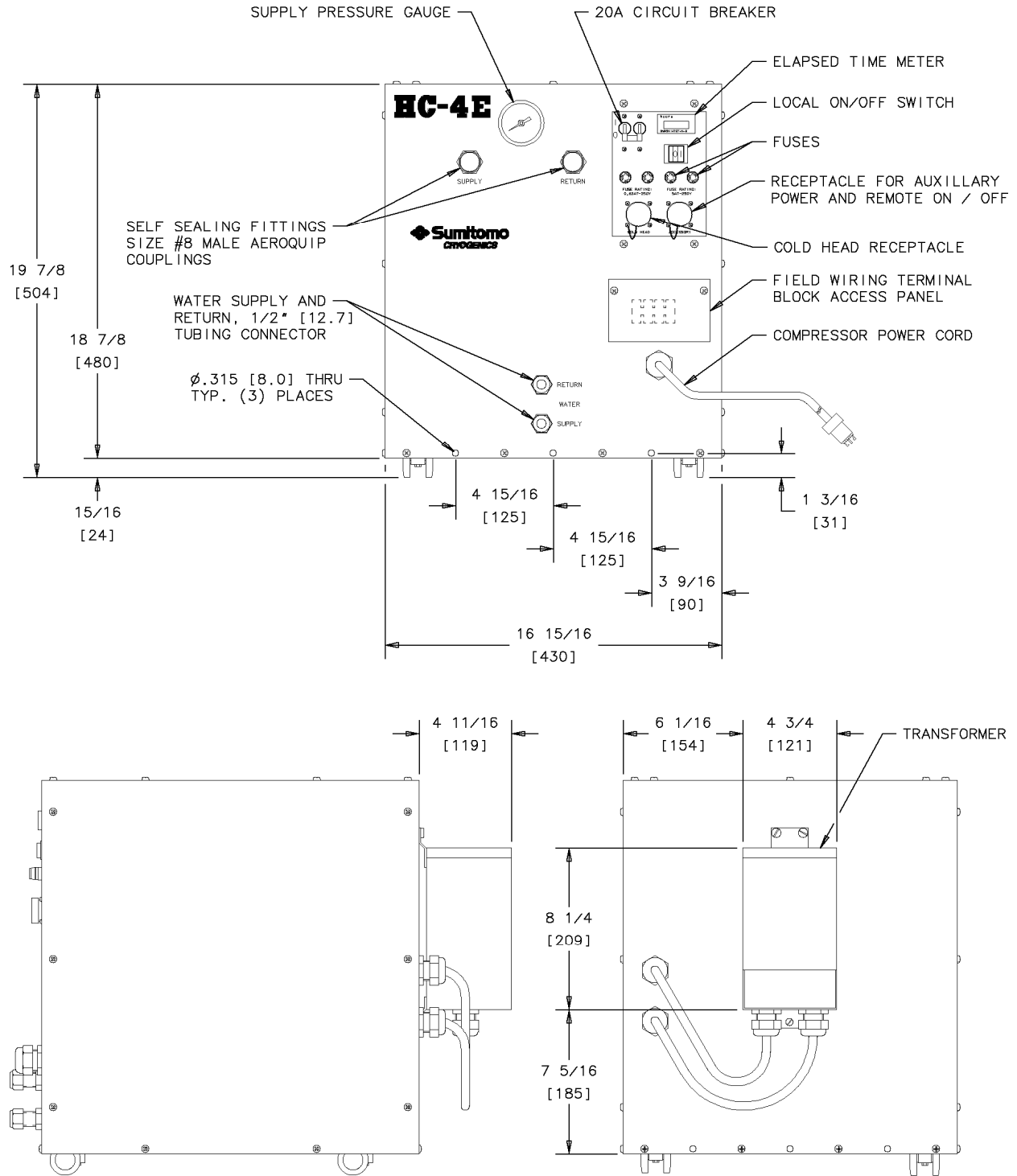


Figure 2 HC-4E1 Outline Dimensions and Parts Identification
(Dimensions in mm)

NOTE

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

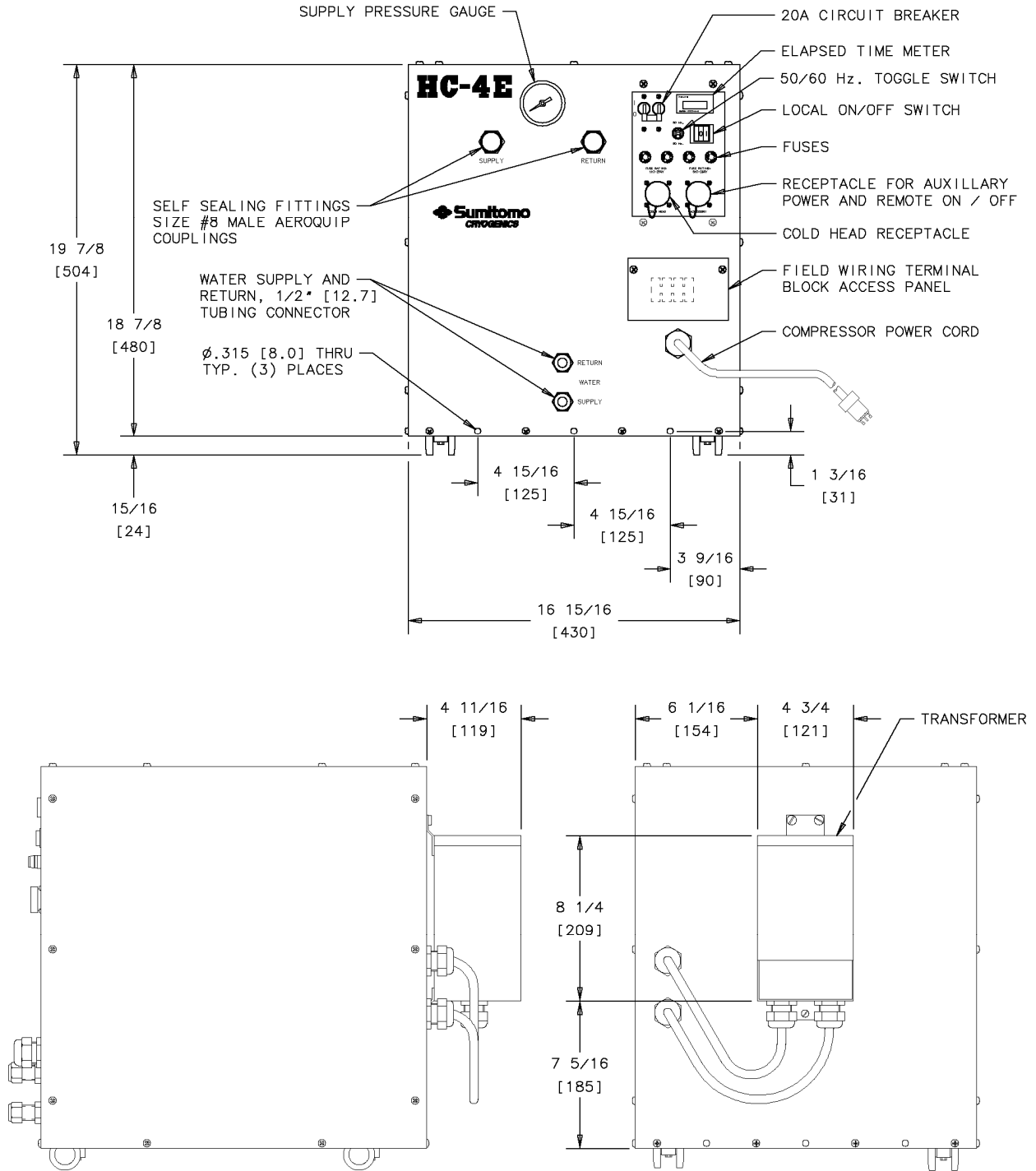


Figure 3 HC-4E2 Outline Dimensions and Parts Identification
(Dimensions in mm)

NOTE

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

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SPECIFICATIONS

Electrical Characteristics

Service required: 2 Pole, 3 Wire (single phase plus ground)

Compressor P/N	Customer's Electrical Service	Compressor RLA	Requires Setting of Transformer Voltage Taps
266958D18G 268159D18G	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz	15.5 A	NO
268609D18G 268228A	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz	8 A	NO
266958D1518G 268159D1518G	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz 220 V~ (± 5%), 50 Hz	15.5 A	YES
268609D1518G	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz 220 V~ (± 5%), 50 Hz	8 A	YES
266958D1618G 268159D1618G	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz 230/240 V~ (± 5%), 50 Hz	15.5 A	YES
268609D1618G	208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz 230/240 V~ (± 5%), 50 Hz	8 A	YES
266958D2518G 268159D2518G	200 V~ (± 5%), 60 Hz 208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz	15.5 A	YES
268609D2518G	200 V~ (± 5%), 60 Hz 208/230 V~ (± 5%), 60 Hz 200 V~ (± 5%), 50 Hz	8 A	YES

NOTE

Transformer voltage taps must be selected to match the incoming supply voltage.
See section on Mains Power Supply Connection.

Power required: 3.0 kW, 15.5 amperes full load at 208 V~, 60 Hz and
2.6kW, 13 amperes full load at 200 V~, 50 Hz.
58 amperes starting current, 68 amperes locked-rotor current.

Power Cord Connector: NEMA L6-20P (2 pole, 3 wire, 20 A, 250 V~) 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 mm²) copper wire rated at 250 V~ minimum, protected with oil-
resistant insulation. Two 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, 0.4 ampere, 0.63 ampere, 1.0 ampere
and 5.0 amperes. See the Description and the Parts sections.

Cold Head Receptacle: Receptacle on the compressor front panel used with a cold head cable
provides power to the cold head.

Specifications

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 27° C (40° F to 80° F)
Cooling Water Outlet Temperature:	40° C (104° F) maximum
Cooling Water Pressure:	210 kPa (30 psig) minimum 690 kPa (100 psig) maximum
Cooling Water Flow:	2.7 liters/min (0.7 gpm) minimum
Pressure Drop at Minimum Flow:	100 kPa (15 psid)
Water Chiller Cooling Capacity:	3.2 kW (11,000 BTU/hr)
Alternate Coolant:	50% pure ethylene glycol + 50% water
Ethylene glycol/water (50/50) flow rate:	3.5 liters/min (0.9 gpm) minimum

CAUTION

PREVENT EQUIPMENT DAMAGE. Use pure ethylene glycol/water (50/50) mixture recommended by chiller manufacturer. Avoid using commercial automotive antifreeze solutions. They may contain additives and grit material that can damage the cooling system.

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.

Specifications

Helium Gas Pressures

	Compressor Only	HC-4E1 with CH-202 Cold Head	HC-4E1 with CH-204S Cold Head	HC-4E2 with RDK-101D & ø 1/2" x 20 ft. Flex Gas Lines	HC-4E2 with RDK-101D & ø 1/2" x >20 ft. and ≤66 ft. Flex Gas Lines
Equalization Pressure at 68°F:	1860 - 1900 kPa (270 - 275 psig)	1790 - 1830 kPa (260 - 265 psig)	1860 - 1900 kPa (270 - 275 psig)	1650 - 1690 kPa (240 - 245 psig)	1450 - 1480 kPa (210 - 215 psig)
Operating Supply Pressure:	2070 - 2210 kPa (300 - 320 psig)	1930 - 2070 kPa (280 - 300 psig)	2000 - 2140 kPa (290 - 310 psig)	1860 - 2200 kPa (270 - 320 psig)	1860 - 2200 kPa (270 - 320 psig)

Equalization Pressures at Different Ambient Temperatures:

T° C	P psig with DE-202 Cold Head	P psig with DE-204SL, CH-204S, or M204S Cold Heads
4	246 – 251	255 – 260
10	251 – 256	261 – 266
15.6	256 – 261	266 – 271
20	260 – 265	270 – 275
26.7	266 – 271	276 – 281
37.8	275 – 281	286 – 291
40	278 – 283	288 – 294

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

Compressor Lubricant LB-300X, specially processed by SCAL.

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 of horizontal.

Environmental Requirements

	<u>Operating Environment</u>	<u>Storage</u>
Ambient Temperature	4° C to 40° C (40° F to 104° F)	-23° C to 65° C (-10° F to 149° F)
Magnetic Field Limits	Compressor ≤ 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 268390A, is included for connecting the cooling water supply and return lines. The kit contains:

<u>Item</u>	<u>Part No.</u>	<u>Qty.</u>	<u>Description</u>
1	255919B2	1	Charge & Vent Adapter
2	255438A	1	Wrench Kit, 1/2" Nom. I.D. Hose
3	02702	2	Adapter, Brass, 1/2"OD Tube x 1/2" ID Hose, Swagelok #B-8-HC-A-811
4	WH#C19	1	Carton, 11-3/4" X 10-3/4" X 2-1/4" inside dims., ULINE #S-650

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

Remote On/Off Cable (Optional Accessory): A cable is available from SCAI 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

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Regulatory Compliance

Declaration of Conformity – HC-4E Series Compressor

Manufacturer's Name	Sumitomo (SCAI) Cryogenics of America
Manufacturer's Address	1833 Vultee Street Allentown, PA 18103 U.S.A.
Authorized Representative's Name	Sumitomo (SHI) Cryogenics of Europe Limited
Authorized Representative's Address	3 Hamilton Close Houndmills Industrial Estate Basingstoke, Hants RG21 6YT England
Type of Equipment	Cryogenic Refrigeration Systems



Council Directives 2006/42/EC and 2004/108/EC

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directives.

By: Bruce Sloan
Bruce Sloan
Engineering Manager

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INSTALLATION

The HC-4E Compressor is 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.

Receipt Inspection Instructions

1. Upon receipt, inspect the shipping container and the compressor for damage.

CAUTION

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

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.

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 the container, 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 the compressor from its shipping container and inspect 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.
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").

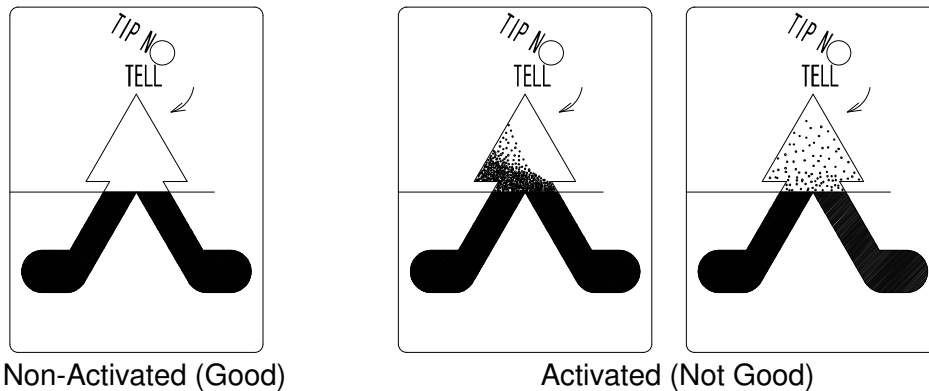
3. Use a 17-mm wrench to remove the bolt. Retain the bolt for future use. The shipping bolt must be reinstalled prior to shipment. See the section Compressor Shipping Preparation.
4. Remove the blocks and lower the compressor onto its wheels.

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 activated, the Tip-N-Tell sensor turns blue in the arrow, as shown below. Proceed to either Step 5.1 or 5.2:



⚠ 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 serious injury or death

- 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 Position, Mains Power Supply Connection, 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 SCAI 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 SCAI 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 serious 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 on all sides of the compressor for maintenance.

Mains Power Supply Connection

Before power is supplied, the following procedure must be used if the transformer voltage taps must be changed.

CAUTION

PREVENT EQUIPMENT DAMAGE. If the compressor boost transformer tap settings do not match the mains supply voltage, it can result in damage to the compressor.

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 serious injury or death.

Tools required: #2 Phillips screwdriver
Flat-blade torque screwdriver

1. Disconnect the mains power supply to the compressor (if connected).
2. Remove the field wiring access panel located on the compressor front panel.
3. Using Table 1, find the electrical supply voltage and frequency, then determine the proper terminal positions for connecting the mains power supply cable.
4. If required, move the mains power supply wires to the correct terminal positions determined from Table 1 and tighten to 1.3 N-m (11.5 in-lb) torque. See Figure 4.

Compressor Electrical Variation	Incoming Power		Terminal Position
	Hz	Volts	
1518G	60	220	L1 L2
	50	200	L1 L2
	50	220	L3 L4
1618G	60	220	L1 L2
	50	200	L1 L2
	50	230-240	L3 L4
18G	60	220	L1 L2
	50	200	L1 L2
	X	X	X
2518G	60	220	L1 L2
	50	200	L1 L2
	60	200	L3 L4

Table 1 Terminal Position for Mains Power Supply

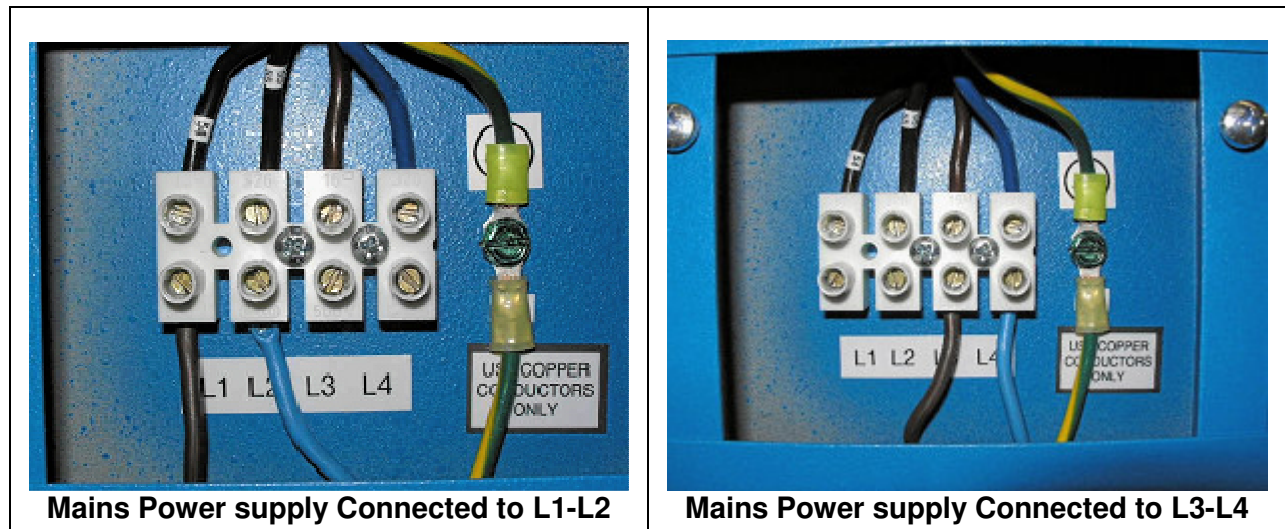


Figure 4 Connections for Mains Power Supply

Field Wire the Compressor

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

The HC-4E1 Compressor is normally furnished with a power cord attached. However, the compressor 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 field wiring access 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 two hot leads and ground.
5. Remove the complete power cord.

Instructions for field wiring follow. Use 12 AWG (3.3 mm²) copper wire with oil-resistant insulation. Two 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 two 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 two 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.
4. Reinstall the terminal block access cover.

This completes the procedure for hard wiring the compressor.

Compressor Checkout

Tools required: Open end wrenches, one 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 5. 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.

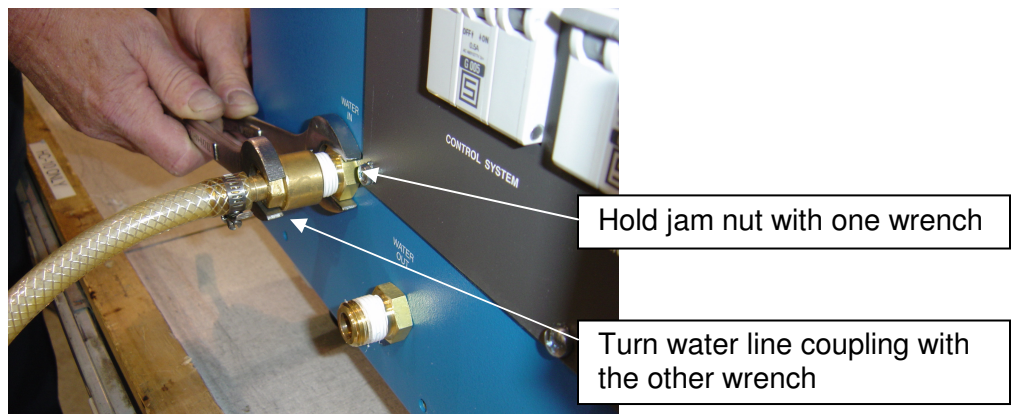


Figure 5 Connect and Remove the Water Lines

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".

⚠ 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

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.
4. Connect the supply (red) and return (green) gas lines directly to their corresponding compressor gas couplings.
5. 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 ± 0.7 kgf m (35 ± 5 ft. lbs.). Tighten each coupling before proceeding to the next one.

- 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.

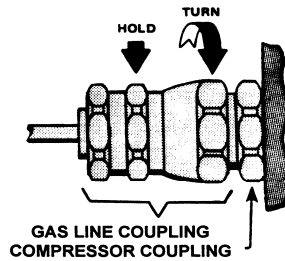


Figure 6 Connect Gas Line to Compressor or Manifold

- Leak check all Aeroquip couplings. See the Leak Check procedure.
- Read the equalization pressure. Compare it to the equalization pressure stated in the Specifications section.
- 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 part number.

- Disconnect the power to the compressor.
- 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 9, Electrical Schematic Diagram.
- Connect the other end of the cable to the accessory receptacle on the compressor.
- 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.

- 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 1650 - 1690 kPa (240 - 245 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.

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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 serious 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 serious injury.

WARNING

AVOID INJURY. Never use compressed helium gas from a cylinder without a proper regulator. Overpressure can cause serious 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 absorbers in the HC-4E 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 ± 0.7 kgf m (35 ± 5 ft. lbs.).
6. Reconnect the supply gas line to the supply coupling on the compressor. Torque the coupling to 4.85 ± 0.7 kgf m (35 ± 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 (SCAI 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; SCAI 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 ± 0.7 kgf m (35 ± 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 ± 0.7 kgf m (35 ± 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 or 255919B2
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 1650 - 1690 kPa (240 - 245 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 SCAI 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 SCAI 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 30 and 31 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 30 and 31 to the switch terminals.
7. Replace the terminal box cover.

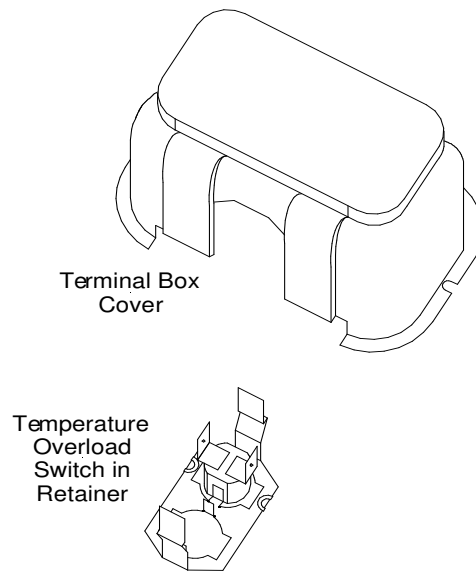


Figure 7 Compressor Shell High Temperature Switch

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 serious injury or death.

CAUTION

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

Troubleshooting Guide

<u>Problem</u>	<u>Possible Cause</u>	<u>Corrective Action</u>
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 SCAI Service Center if the problem persists.
	Open fuse in the control circuit.	Check for a short circuit. Replace the fuse. Consult a SCAI 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 SCAI 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 SCAI Service Center if the problem persists.
	Shipping bolt is engaged	Remove shipping bolt
Compressor starts, but shuts down after a few minutes 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.

Troubleshooting

<u>Problem</u>	<u>Possible Cause</u>	<u>Corrective Action</u>
Compressor starts, but shuts down after a few minutes of operation. (continued).	Low oil flow.	Look for oil leaks in the compressor capsule. Consult a SCAI 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 SCAI 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 SCAI 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>
Compressor runs, but cold head valve motor operation is abnormal	Wrong cold head cable.	Be sure correct cold head cable is connected (Page 56.)
	Cold head problem.	Consult cold head manual.
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 SCAI 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 Capsule


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 SCAI 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 serious injury or death.

Winding Continuity, Grounding and Resistance Checks

Tools required: Ohmmeter or multimeter
#2 Phillips screwdriver.

1. Disconnect the power to the compressor.

2. Remove the compressor's cover.
3. Remove the terminal box cover from the top of the compressor motor to expose the three terminals M, S, and C. See Figure 8. Disconnect wires 7, 8, and 9 from terminals C, M, and S respectively.
4. With an ohmmeter, check the resistance across compressor terminals C and M. Resistance should be 0.8 to 1.2 ohms. If the resistance is outside this range, consult a SCAI Service Center. If there is no continuity, the winding is open. Consult a SCAI Service Center.
5. With an ohmmeter, check the resistance across compressor terminals C and S. Resistance should be 1.8 to 2.2 ohms. If the resistance is outside this range, consult a SCAI Service Center. If there is no continuity, the winding is open. Consult a SCAI Service Center.
6. With an ohmmeter, check for continuity between compressor terminal C and one of the copper tubes entering the compressor housing. If there is continuity, the motor is grounded. Consult a SCAI Service Center.
7. If the motor passes these electrical checks, reconnect wires 7, 8, and 9 to compressor terminals C, M, and S respectively.
8. Replace the terminal box cover and the cover of the compressor module, unless current measurement is to be performed.

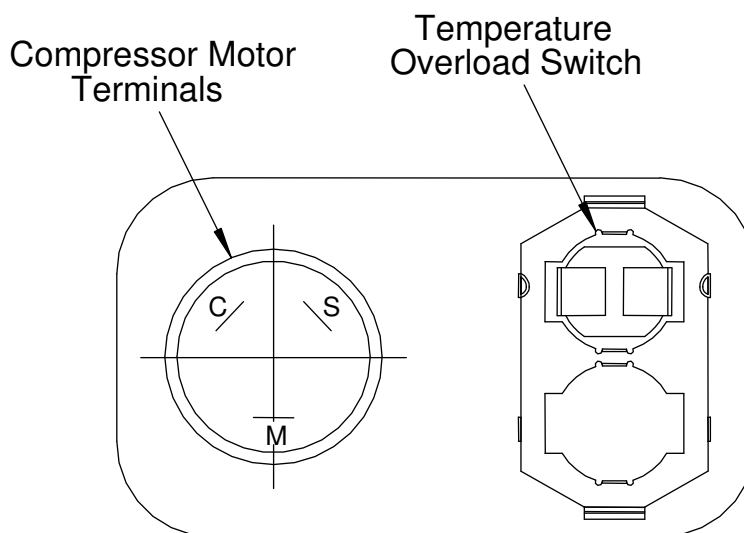


Figure 8 Compressor Terminals

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 SCAI 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.

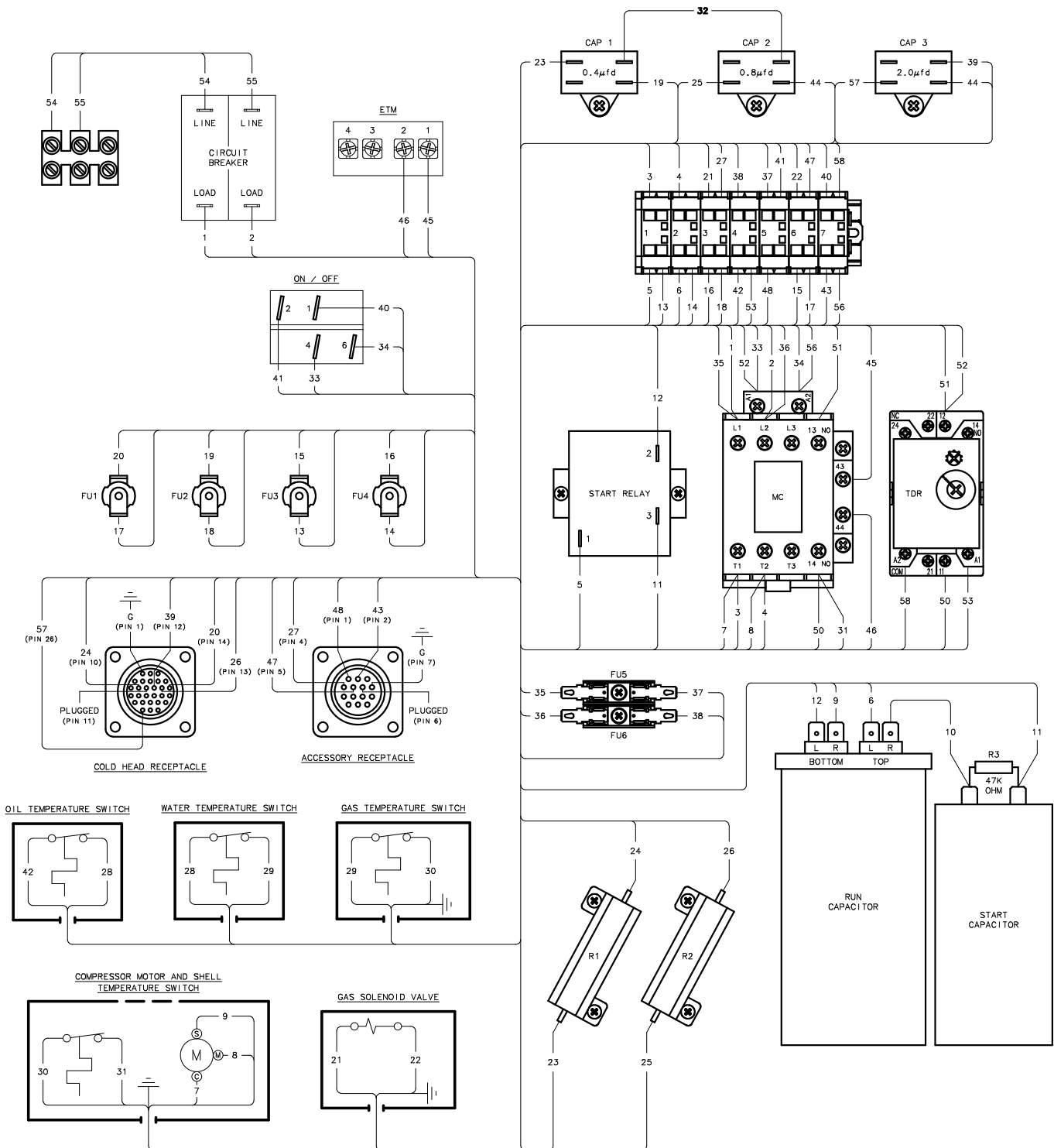


Figure 9 HC-4E1 Wiring Diagram

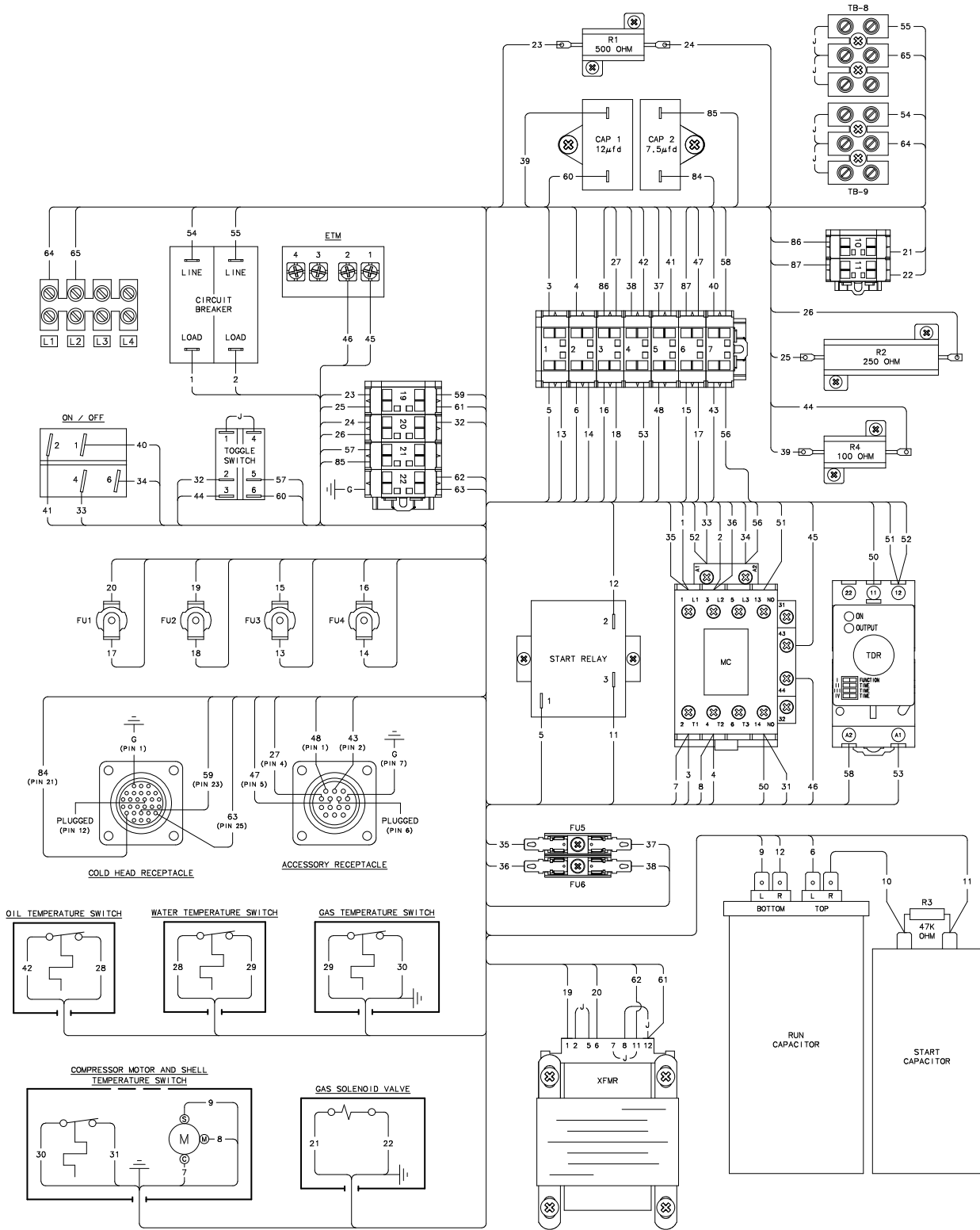
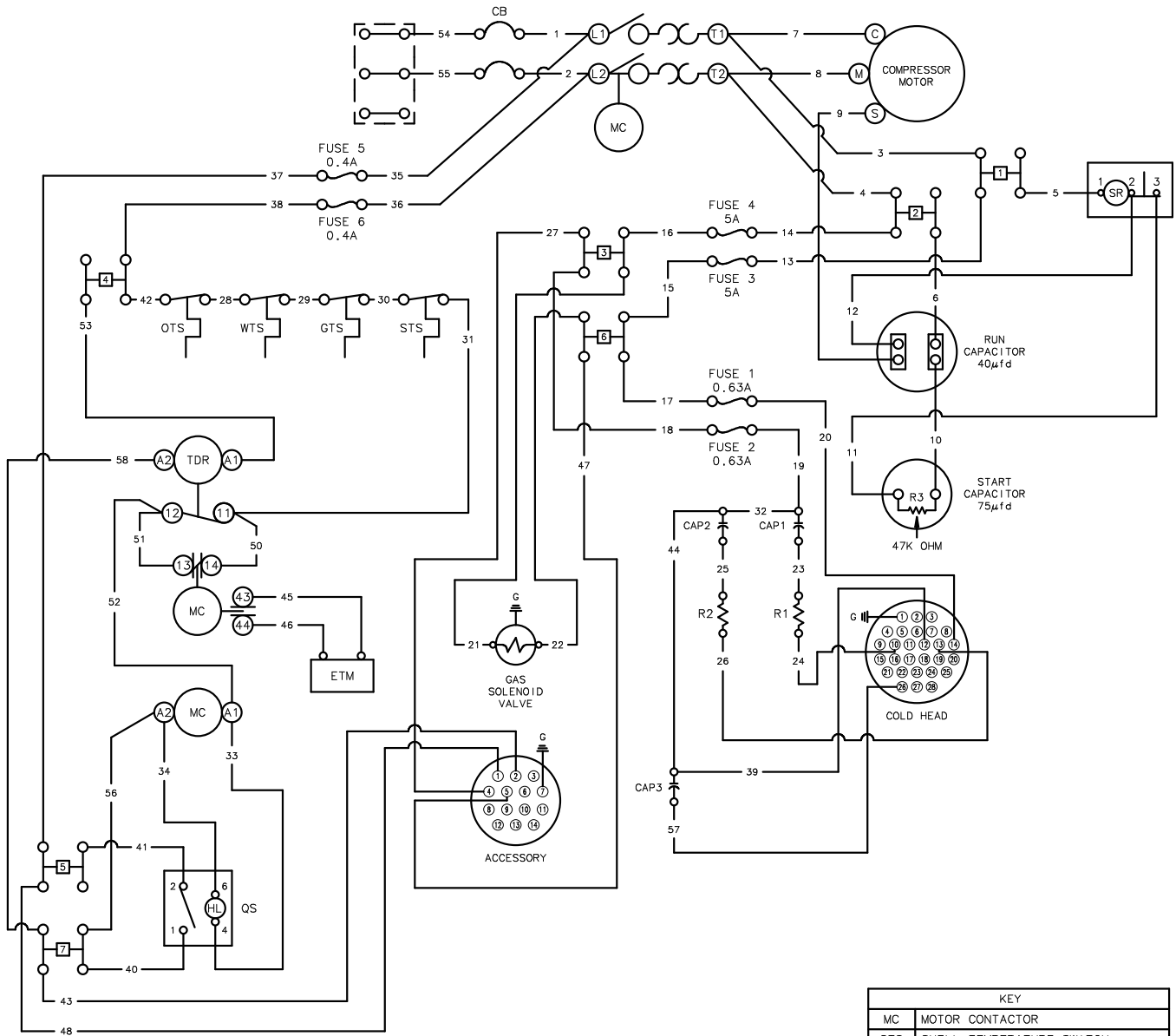


Figure 10 HC-4E2 Wiring Diagram

Troubleshooting



KEY	
MC	MOTOR CONTACTOR
STS	SHELL TEMPERATURE SWITCH
OTS	OIL TEMPERATURE SWITCH
GTS	GAS TEMPERATURE SWITCH
WTS	WATER TEMPERATURE SWITCH
TDR	TIME DELAY RELAY
SR	START RELAY
CB	CIRCUIT BREAKER
QS	ON / OFF SWITCH
ETM	ELAPSED TIME METER
HL	RUN LIGHT
CAP	CAPACITOR
R	RESISTOR

Figure 11 HC-4E1 Electrical Schematic

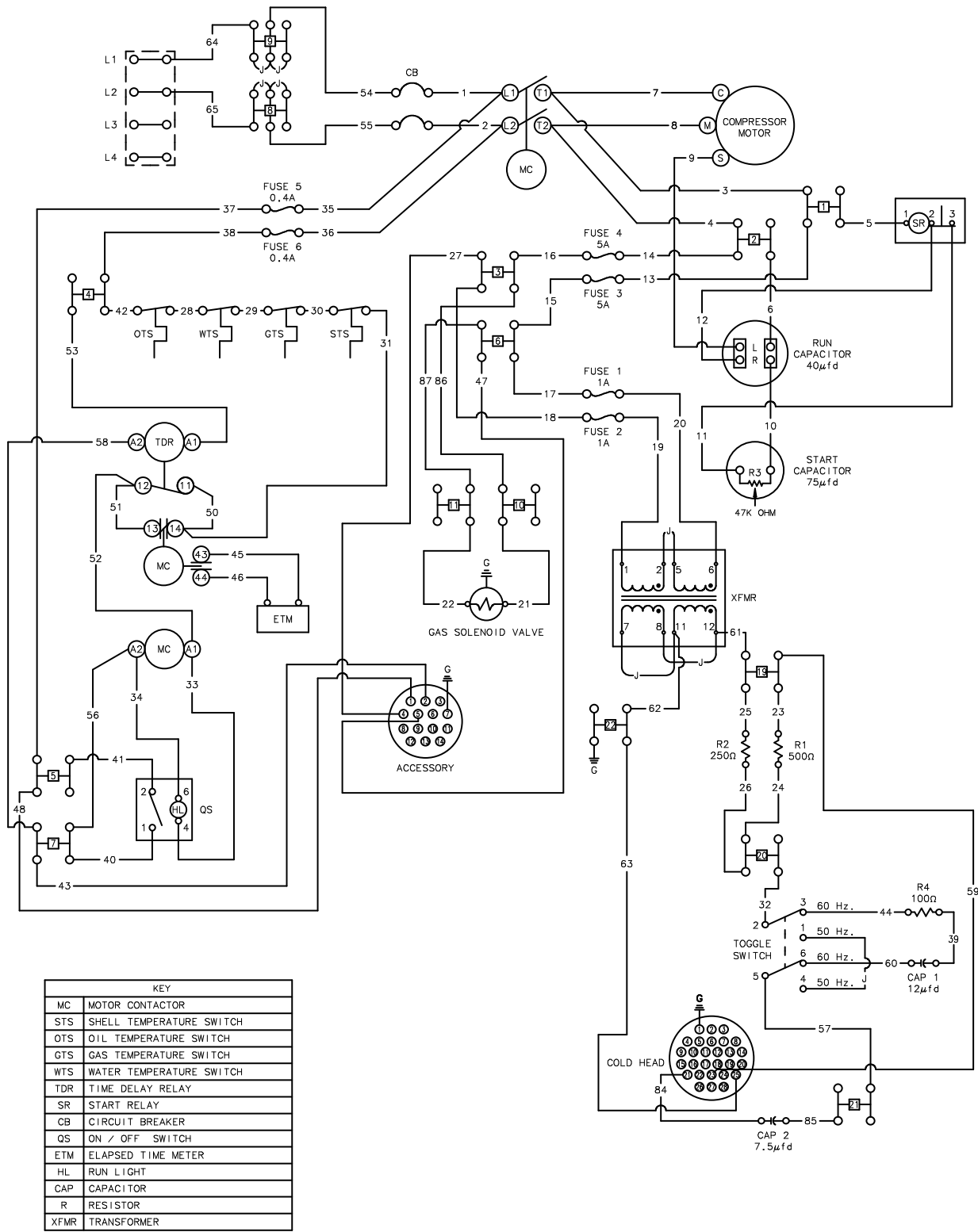


Figure 12 HC-4E2 Electrical Schematic

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.

Compressor Parts Identification and Numbers

(See Figures 2, 3, 13, 14 and 15).

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>
1	Pressure gauge, panel mount, 2" dial	50987
2	Circuit breaker, 20A, 250 V~, 2 pole	38888
3*	O-ring (2), Aeroquip coupling	47102
4*	Gasket face seal (2), 8M Aeroquip coupling	77002
5*	Nylon washer (2), Aeroquip coupling	72628
6*	Lock washer (2), Aeroquip coupling	46401
7	Lock nut (2), Aeroquip coupling	46101
8	Dust cap (2), Aeroquip coupling	44642
9	Caster (4), swivel	49137
10	Front ferrule (2), water fitting	12307
11	Rear ferrule (2), water fitting	12308
12	Nut (2), water fitting	12306

* Part is not shown.

<u>Item</u>	<u>Part Name</u>	<u>Part Number</u>
13#	Compressor assembly	266969C
14#	Oil Injection orifice	256066B
15#	Pressure relief valve	53028
16#	Gas equalization solenoid valve assembly	264903C
17#	Internal relief valve assembly	270095A
18	Adsorber assembly	F257428A
19	Gas high-temperature switch	38891
20	Oil high-temperature switch	38890
21	Compressor shell high-temperature switch	256034A2P
22*	Water high-temperature switch	38862
23	Time delay relay replacement kit	F37476A
24	Power cord assembly	267286B
25*	Oil charging vessel (with oil)	263775A3
26*	Shipping bolt	70498
27	Electrical chassis assembly, HC-4E1	266955D
28	Electrical chassis assembly, HC-4E2	268685D
29*	Fuse, 0.4 ampere, 250 V	34691
30*	Fuse, 0.63 ampere, 250 V	34687
31*	Fuse, 5.0 ampere, 250 V	34688
32*	Fuse, 1.0 ampere, 250 V (HC-4E2 only)	34694

* Part is not shown.

Item is not replaceable in the field.

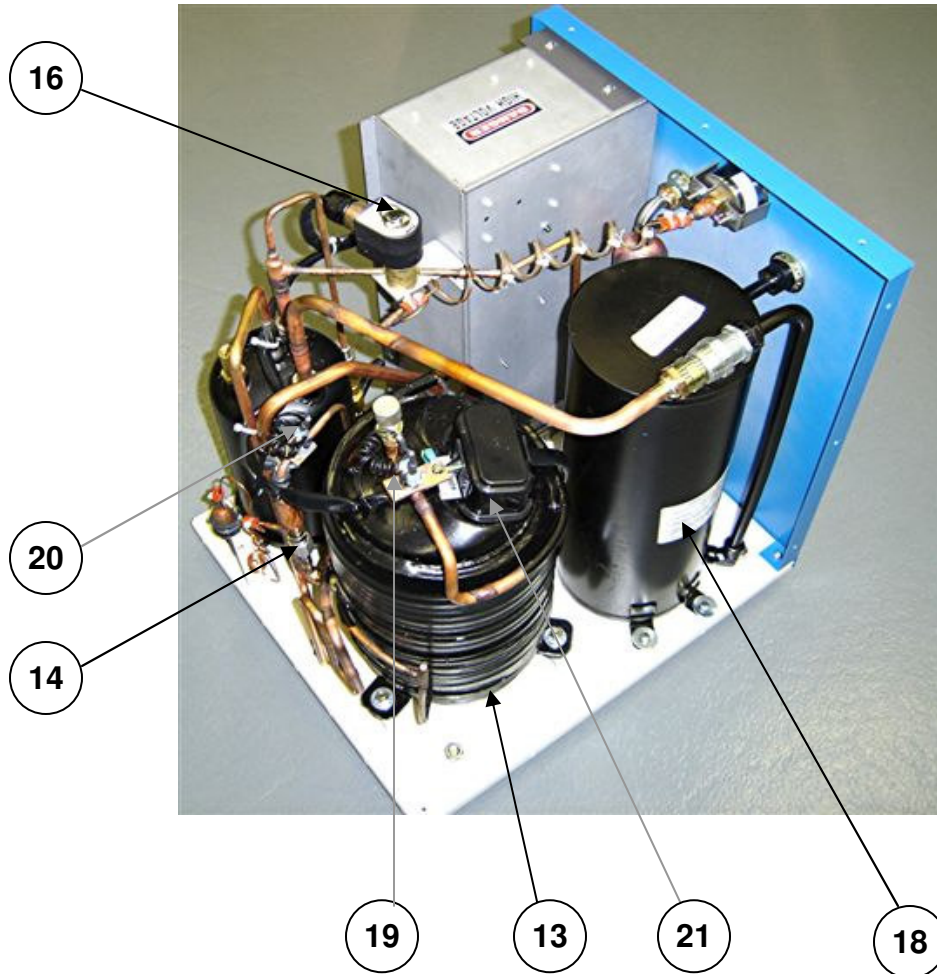


Figure 13 Parts Identification



Figure 14 Parts Identification for HC-4E1

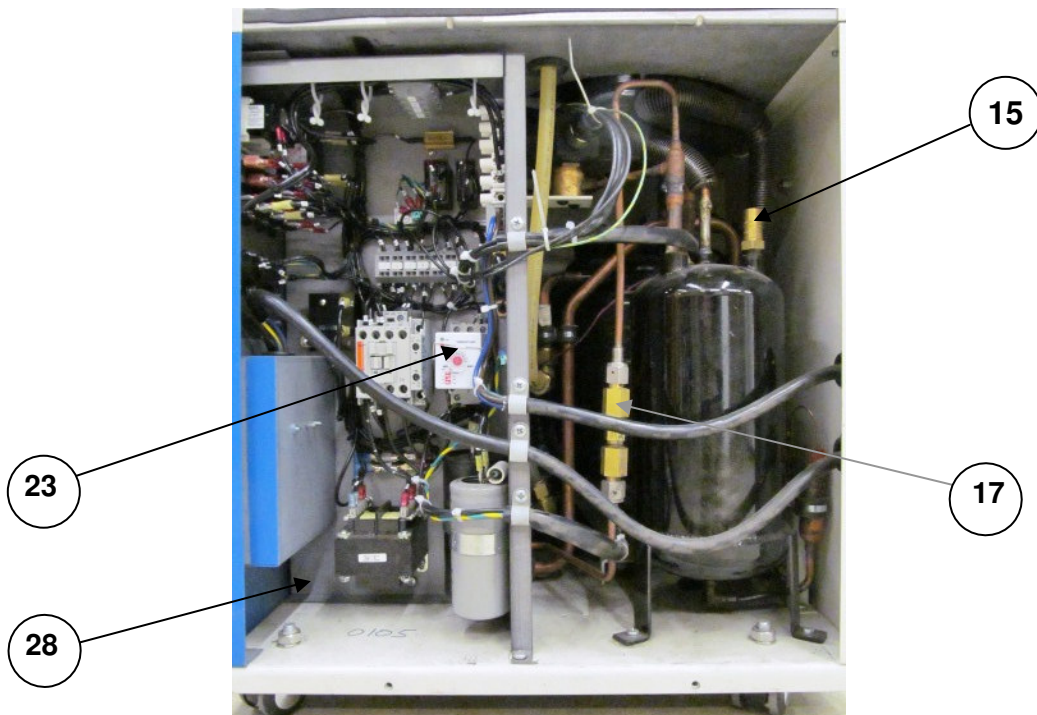


Figure 15 Parts Identification for HC-4E2

Adapter Fittings

The following adapter fittings, required for servicing the HC-4E1 Compressor, are available as accessories from SCAI.

<u>Item</u>	<u>Quantity</u>	<u>Part Name</u>	<u>Part Number</u>	<u>Figure</u>
1	2	Adapter fitting, 8F ⁽¹⁾ and 8M ⁽²⁾ , with valve	266395C	16
2	2	Adapter fitting, 8F with valve	255919B2	17

⁽¹⁾Denotes size 8, female, Aeroquip coupling.

⁽²⁾Denotes size 8, male, Aeroquip coupling.



Figure 16 Adapter Fitting, 8F and 8M, with Valve

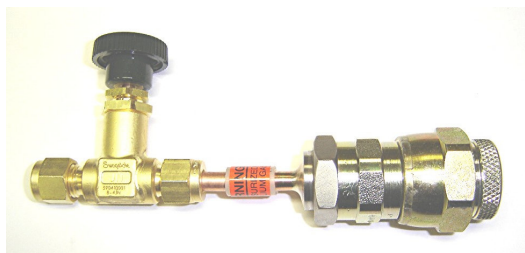


Figure 17 Adapter Fitting, 8F with Valve

Cables

The following cables are available for use with the HC-4E Series Compressors as accessories from SCAI.

<u>Item</u>	<u>Quantity</u>	<u>For Use</u> <u>With:</u>	<u>Description</u>	<u>Part Number</u>
1	1	HC-4E1/ HC-4E2	Accessory cable for remote On/Off, 6 m (20 ft.) long.	263887B20
2	1	HC-4E1	Cold head cable, DE202/204SL, 3.3 m (11 ft.) long	263941B11
3	1	HC-4E1	Cold head cable, M204S, 3.3 m (11 ft.) long	264187B11
4	1	HC-4E1	Cold head cable, CH204S, 3 m (10 ft.) long	267285C11
5	1	HC-4E2	Cold head cable, RDK-101, 3.3 m (11 ft.) long	268094C11